

**OBE Curriculum for the Undergraduate Program of the  
Department of Computer Science and Engineering (CSE),  
Bangladesh University of Engineering and Technology (BUET)**



**Prepared by**

**Department of Computer Science and Engineering (CSE), Bangladesh  
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## **Outcome Based Education (OBE) Curriculum**

Department of Computer Science and Engineering (CSE)  
Bangladesh University of Engineering and Technology (BUET)

### **PART A: Overview of the Program**

The Department of Computer Science and Engineering (CSE) of Bangladesh University of Engineering and Technology (BUET) is the first department of its kind in Bangladesh. The department offers Bachelor's degree in Computer Science and Engineering (CSE). The undergraduate education of the department is world-class in both the curricula and research activity. The best students from all over Bangladesh join this prestigious department. The highly-competitive environment, world-class facilities, and hard-working faculties nourish every student to be the prime in the field. The Bachelor's degree in Computer Science and Engineering in the department thrives for achieving the vision and mission of the university.

The Academic Council (Meeting No. 483 on October 12, 2022) determined the following vision and mission for the university:

#### **1. Vision of BUET**

To be a leader in education, research and innovation in science, engineering and technology for sustainable future

#### **2. Mission of BUET**

1. To provide advanced transformative education, promote cutting-edge research, and foster innovation for producing competent graduates with ethical values.
2. To create an inspiring, diverse and inclusive learning environment for planning, design and innovation.
3. To enhance collaboration for improving knowledge and skill ensuring lifelong learning opportunity.
4. To contribute towards reshaping for wellbeing of the society.

#### **3. Title of the Academic Program/Degree**

- Bachelor of Science in Computer Science and Engineering

#### **4. Name of the Department**

Department of Computer Science and Engineering (CSE).

#### **5. Vision of the Department**

To enable innovation through research and advancement of educational programs in Computer Science and Engineering (CSE) and allied fields, thereby establishing this department as a pioneering center of excellence at the national and international levels.

#### **6. Mission of the Department**

1. To advance and ensure quality education in CSE and its allied fields to enable problem solving in a changing and challenging technological world for contributing towards the benefit of humanity.
2. To conduct high-quality research culminating human talent and enhancing collaboration among industry, academia, and society for the welfare of the country and mankind, and to apply the research outcomes to support and influence national and international agenda.
3. To lead the development of human resources with knowledge, expertise, high ethics, and moral values in the field of CSE and its allied fields through building a strong relationship with industry, academia, and society.
4. To enhance collaboration and life-long learning to overcome contemporary and future complex challenges for contributing to the overall advancement of the domains both inside and outside CSE.

#### **7. Description of the Program**

The Department of Computer Science and Engineering offers prospective undergraduate students a four-year Bachelor of Science degree program. Students who are interested in learning both in-depth and widely about the theory, design, and applications of the broad area of Computer Science and Engineering enroll in this program. Students finish their core mathematics, physics, and basic computer science courses in the first two years. In the third year, when the fundamental computer science study is over, students broaden their intellectual horizons by enrolling in advanced and elective courses. During their fourth year, every student has the chance to study more about advanced topics that especially interest them and to do research-based thesis.

To be eligible for graduation, a student must have completed 157 credit hours, which must include the required core courses. A 2.20 cumulative grade point average is needed to earn an engineering

Bachelor's degree from the department. With the advisor's approval, a student may enroll in extra courses to boost their GPA, however, they are limited to a maximum of 15 credits throughout the length of their entire course of study.

### 8. Program Educational Objectives (PEOs)

PEO-1: Graduates will excel in academia and industries associated with computer science and engineering, and will blend human, social and environmental factors with technology to advance human civilization.

PEO-2: Graduates will actively contribute to government, national and international organizations in the country and around the world addressing both contemporary and future challenges.

PEO-3: Graduates will conduct impactful research creating new knowledge and educate through disseminating knowledge in computer science and engineering.

PEO-4: Graduates will pursue lifelong learning through graduate studies and other professional education, and generate innovative solutions using research and problem-solving skills.

### 9. Mapping Mission of BUET with the Mission of the Department

	BUET Mission 1	BUET Mission 2	BUET Mission 3	BUET Mission 4
Department Mission 1	√	√	-	-
Department Mission 2	√	-	-	√
Department Mission 3	√	-	√	√
Department Mission 4	-	-	√	-

## 10. Mapping Missions of the Department with the PEOs

PEOs	Department Mission 1	Department Mission 2	Department Mission 3	Department Mission 4
PEO-1	-	-	√	-
PEO-2	-	√		√
PEO-3	√	-		-
PEO-4	-	-	-	√

## 11. Program Outcomes (PO)

PO-1: **Engineering knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and computer science and engineering to the solution of complex engineering problems.

PO-2: **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems as well as analyze computational requirements or needs of information systems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO-3: **Design/development of solutions:** Design solutions for complex engineering problems and design computing systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO-4: **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, synthesis of information, and interpret results of computational modules appropriate to computer science and engineering and information technology to provide valid conclusions.

PO-5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex computer science and engineering problems, with an understanding of the limitations.

PO-6: **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.

PO-7: **Environment and sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.

PO-8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO-9: **Individual work and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

PO-10: **Communication:** Communicate effectively on complex computer science and engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11: **Project management and finance:** Demonstrate knowledge and understanding of engineering and IT project management principles and economic decision-making and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO-12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## 12. Mapping of PEOs with POs

POs	PEO-1	PEO-2	PEO-3	PEO-4
PO-1	√	√	√	√
PO-2	√	√	-	√
PO-3	-	√	√	-
PO-4	-	√	-	-
PO-5	√	√	-	-
PO-6	√	√	-	-
PO-7	√	-	-	-
PO-8	√	-	-	√
PO-9	√	√	-	-
PO-10	√	√	√	√
PO-11	-	√	-	√
PO-12	-	-	-	√

## **PART B: Overview of the Curriculum**

### **13. Structure of the Curriculum**

#### **13.1 Admission Requirements:**

Students are be admitted in undergraduate curricula in the Departments of Architecture, Urban and Regional Planning, Chemical Engineering, Civil Engineering, Water Resources Engineering, Computer Science and Engineering, Electrical and Electronic Engineering, Biomedical Engineering Mechanical Engineering, Industrial & Production Engineering, Materials and Metallurgical Engineering and Naval Architecture and Marine Engineering as per existing rules of the University. The Registrar's Office serves as the Admission Office.

#### **13.2 Duration of the Program:**

Years: 4                      Semesters: 8

#### **13.3 Total minimum credit requirement to complete the program:**

Minimum credit hour requirements for the award of Bachelor's degree in engineering and architecture is proposed by the BUGS and approved by the Academic Council. However, at least 157 credit hours for engineering and 190 credit hours for architecture must be earned to be eligible for graduation, and this must include the specified core courses.

#### **13.4 Total class weeks in a Term:**

There will be two terms (Term I and Term II) in an academic year. The duration of each Term will be 18 weeks which will be used as follows:

Classes	14 weeks
Recess before term final exam	02 weeks
Term final exam	02 weeks
Total	18 weeks

#### **13.5 Minimum CGPA requirements for graduation:**

The minimum GPA requirement for obtaining a bachelor's degree in engineering, URP or architecture is 2.20.

#### **13.6 Maximum academic years of completion: 7 years (14 semesters)**

## 14. Course requirements for the B.Sc.Engg. in CSE Program<sup>1</sup>

### 14.1 Natural Science

Requirement 8.25 credits (6+2.25)		
Theoretical		
PHY 129	Structure of Matter, Electricity & Magnetism, Wave Mechanics	3 credits
CHEM 113	Chemistry	3 credits
Sessional		
PHY 114	Physics Sessional	1.5 credits
CHEM 118	Chemistry Sessional	0.75 credits

### 14.2 Mathematics

Requirement 12.00 credits (12.00+0.00)		
Theoretical		
MATH 141	Calculus I	3 credits
MATH 143	Linear Algebra	3 credits
MATH 241	Advanced Calculus	3 credits
MATH 243	Probability and Statistics	3 credits

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<sup>1</sup> Subsection under section 14 may have different headings from department to department

### 14.3 Humanities and Social Sciences

Requirement 13.50 credits (12.00+1.50)		
Theoretical		
HUM 347	Ethics in Society and E-Governance	3 credits
HUM 475	Engineering Economics	3 credits
HUM 403	Communication in English	3 credits
HUM 429	Accounting and Entrepreneurship for IT Business	3 credits
Sessional		
HUM 402	Professional Communication in English Sessional	1.5 credits

### 14.4 Departmental Core Courses

Requirement 87.75 credits (66.00+21.75)		
Theoretical		
CSE 101	Structured Programming Language	3 credits
CSE 103	Discrete Mathematics	3 credits
CSE 105	Data Structures and Algorithms I	3 credits
CSE 107	Object Oriented Programming Language	3 credits
CSE 205	Digital Logic Design	3 credits
CSE 207	Data Structures and Algorithms II	3 credits
CSE 215	Database	3 credits
CSE 209	Computer Architecture	3 credits
CSE 211	Theory of Computation	3 credits

CSE 213	Software Engineering	3 credits
CSE 219	Signals and Linear Systems	3 credits
CSE 301	Mathematics for Computing and Data Science	3 credits
CSE 309	Compiler	3 credits
CSE 313	Operating System	3 credits
CSE 315	Microprocessors, Microcontrollers, and Embedded Systems	3 credits
CSE 317	Artificial Intelligence	3 credits
CSE 311	Data Communication	3 credits
CSE 321	Computer Networks	3 credits
CSE 325	Information Systems Development and Management	3 credits
CSE 329	Machine Learning	3 credits
CSE 401	Numerical Analysis, Simulation and Modeling	3 credits
CSE 405	Cyber Security	3 credits
Sessional		
CSE 102	Structured Programming Language Sessional	1.5 credits
CSE 106	Data Structures and Algorithms I Sessional	1.5 credits
CSE 108	Object Oriented Programming Language Sessional	1.5 credits
CSE 206	Digital Logic Design Sessional	1.5 credits
CSE 208	Data Structures and Algorithms II Sessional	1.5 credits
CSE 216	Database Sessional	1.5 credits
CSE 200	Technical Writing and Presentation	0.75 credits

CSE 210	Computer Architecture Sessional	0.75 credits
CSE 214	Software Engineering Sessional	0.75 credits
CSE 220	Signals and Linear Systems Sessional	1.5 credits
CSE 310	Compiler Sessional	0.75 credits
CSE 314	Operating System Sessional	0.75 credits
CSE 316	Microprocessors, Microcontrollers, and Embedded Systems Sessional	0.75 credits
CSE 318	Artificial Intelligence Sessional	0.75 credits
CSE 322	Computer Networks Sessional	1.5 credits
CSE 326	Information Systems Development and Management Sessional	1.5 credits
CSE 330	Machine Learning Sessional	1.5 credits
CSE 402	Numerical Analysis, Simulation and Modeling Sessional	0.75 credits
CSE 406	Cyber Security Sessional	0.75 credits

#### 14.5 Optional Courses

Requirement 13.50 credits (12.00+1.50)		
Theoretical		
CSE 417	Cyber-Physical Systems	3 credits
CSE 419	Internet of Things (IoT)	3 credits
CSE 421	Basic Graph Theory	3 credits
CSE 423	Fault Tolerant Systems	3 credits

CSE 425	Human Computer Interaction	3 credits
CSE 429	Deep Learning	3 credits
CSE 435	Introduction to Quantum Computing	3 credits
CSE 441	Mobile Computing	3 credits
CSE 445	Data Mining and Information Retrieval	3 credits
CSE 453	High Performance Database System	3 credits
CSE 455	Next Generation Wireless Networks	3 credits
CSE 457	Wireless Networks	3 credits
CSE 459	Communication Systems	3 credits
CSE 463	Bioinformatics	3 credits
CSE 467	Software Architecture	3 credits
CSE 477	Cloud Computing	3 credits
EEE 463	Optical Communications	3 credits
EEE 465	Telecommunication Systems	3 credits
MATH 441	Mathematical Optimization	3 credits
MATH 443	Game Theory	3 credits
PHY 405	Quantum Mechanics	3 credits
CSE 409	Computer Graphics	3 credits
CSE 411	Simulation and Modeling	3 credits
CSE 413	High Performance Computing	3 credits
CSE 415	Real-time Embedded Systems	3 credits
CSE 427	Network Security	3 credits

CSE 431	Natural Language Processing	3 credits
CSE 433	Image Processing and Computer Vision	3 credits
CSE 437	Data Science and Big Data Analytics	3 credits
CSE 439	Functional Programming	3 credits
CSE 447	Introduction to Blockchain	3 credits
CSE 461	Algorithm Engineering	3 credits
CSE 469	Software Testing and Quality Assurance	3 credits
CSE 475	Robotics	3 credits
CSE 481	VLSI Design	3 credits
CSE 483	Interfacing	3 credits
CSE 485	Digital Signal Processing	3 credits
CSE 487	Mobile Applications Development	3 credits
EEE 469	Electrical Machines and Instrumentation	3 credits
Sessional		
CSE 410	Computer Graphics Sessional	0.75 credits
CSE 412	Simulation and Modeling Sessional	0.75 credits
CSE 414	High Performance Computing Sessional	0.75 credits
CSE 416	Real-time Embedded Systems Sessional	0.75 credits
CSE 428	Network Security Sessional	0.75 credits
CSE 432	Natural Language Processing Sessional	0.75 credits
CSE 434	Image Processing and Computer Vision Sessional	0.75 credits

CSE 438	Data Science and Big Data Analytics Sessional	0.75 credits
CSE 440	Functional Programming Sessional	0.75 credits
CSE 448	Introduction to Blockchain Sessional	0.75 credits
CSE 462	Algorithm Engineering Sessional	0.75 credits
CSE 470	Software Testing and Quality Assurance Sessional	0.75 credits
CSE 476	Robotics Sessional	0.75 credits
CSE 482	VLSI Design Sessional	0.75 credits
CSE 484	Interfacing Sessional	0.75 credits
CSE 486	Digital Signal Processing Sessional	0.75 credits
CSE 488	Mobile Applications Development Sessional	0.75 credits
EEE 470	Electrical Machines and Instrumentation Sessional	0.75 credits

#### 14.6 Thesis/Project

Requirement 9.00 credits (0.00+9.00)		
CSE 450	Capstone Project	3 credits
CSE 400	Project and Thesis	6 credits

#### 14.7 Non-departmental Engineering Courses

Requirement 16.50 credits (12.00+4.50)		
Theoretical		
EEE 163	Introduction to Electrical Engineering	3 credits
ME 165	Basic Mechanical Engineering	3 credits
EEE 263	Electronic Circuits	3 credits

IPE 493	Industrial Management	3 credits
Sessional		
EEE 164	Introduction to Electrical Engineering Sessional	1.5 credits
ME 174	Mechanical Engineering Drawing and CAD	1.5 credits
EEE 264	Electronic Circuits Sessional	1.5 credits

#### 14.8 Summary of the Requirements for B.Sc.Engg. in CSE Degree

Courses	Requirements (Credit Hours)
A. Natural Science	8.25
B. Mathematics	12.00
C. Humanities and Social Sciences	13.50
D. Departmental Core Courses	87.75
E. Non-departmental Engineering Courses	16.50
F. Optional Courses	13.50
Total	151.50
UG Thesis	6.00
Capstone Project	3.00
<b>Grand Total</b>	<b>160.50</b>

#### 15. Courses offered in Different Terms

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
1	1	CSE 101	Structured Programming Language	3.00	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 102	Structured Programming Language Sessional	1.50	
		CSE 103	Discrete Mathematics	3.00	
		EEE 163	Introduction to Electrical Engineering	3.00	
		EEE 164	Introduction to Electrical Engineering Sessional	1.50	
		MATH 141	Calculus I	3.00	
		PHY 129	Structure of Matter, Electricity & Magnetism, Wave Mechanics	3.00	
		PHY 114	Physics sessional	1.50	
			Total	19.50	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
1	2	CSE 107	Object Oriented Programming Language	3.00	CSE 101
		CSE 108	Object Oriented Programming Language Sessional	1.50	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 105	Data Structures and Algorithms I	3.00	CSE 101, CSE 103
		CSE 106	Data Structures and Algorithms I Sessional	1.50	
		CHEM 113	Chemistry	3.00	
		CHEM 118	Chemistry Sessional	0.75	
		MATH 143	Linear Algebra	3.00	
		ME 165	Basic Mechanical Engineering	3.00	
		ME 174	Mechanical Engineering Drawing and CAD	1.50	
			Total	20.25	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
2	1	CSE 205	Digital Logic Design	3.00	
		CSE 206	Digital Logic Design Sessional	1.50	
		CSE 207	Data Structures and Algorithms II	3.00	CSE 105
		CSE 208	Data Structures and Algorithms II Sessional	1.50	
		CSE 215	Database	3.00	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 216	Database Sessional	1.50	
		EEE 263	Electronic Circuits	3.00	EEE 163
		EEE 264	Electronic Circuits Sessional	1.50	
		MATH 241	Advanced Calculus	3.00	MATH 141
			Total	21.00	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 200	Technical Writing and Presentation	0.75	
		CSE 209	Computer Architecture	3.00	CSE 205
		CSE 210	Computer Architecture Sessional	0.75	
		CSE 211	Theory of Computation	3.00	
2	2	CSE 213	Software Engineering	3.00	
		CSE 214	Software Engineering Sessional	0.75	
		CSE 219	Signals and Linear Systems	3.00	MATH 141
		CSE 220	Signals and Linear Systems Sessional	1.50	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		MATH 243	Probability and Statistics	3.00	
			Total	18.75	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
3	1	CSE 301	Mathematics for Computing and Data Science	3.00	MATH 243
		CSE 309	Compiler	3.00	CSE 211
		CSE 310	Compiler Sessional	0.75	
		CSE 313	Operating System	3.00	
		CSE 314	Operating System Sessional	0.75	
		CSE 315	Microprocessors, Microcontrollers, and Embedded Systems	3.00	CSE 205
		CSE 316	Microprocessors, Microcontrollers, and Embedded Systems Sessional	0.75	
		CSE 317	Artificial Intelligence	3.00	
		CSE 318	Artificial Intelligence Sessional	0.75	
				Total	18.00

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
3	2	CSE 311	Data Communication	3.00	CSE 219
		CSE 321	Computer Networks	3.00	
		CSE 322	Computer Networks Sessional	1.50	
		CSE 325	Information Systems Development and Management	3.00	
		CSE 326	Information Systems Development and Management Sessional	1.50	
		CSE 329	Machine Learning	3.00	CSE 301, CSE 317
		CSE 330	Machine Learning Sessional	1.50	
		CSE 450	Capstone Project	1.50	
		HUM 347	Ethics in Society and E- Governance	3.00	
				Total	21.00

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
4	1	CSE 400	Project and Thesis	3.00	
		CSE 401	Numerical Analysis, Simulation and Modeling	3.00	
		CSE 402	Numerical Analysis, Simulation and Modeling Sessional	0.75	
		CSE 405	Cyber Security	3.00	CSE 321
		CSE 406	Cyber Security Sessional	0.75	
			Option 1	3.00	
			Option 2	3.00	
		CSE 450	Capstone Project	1.50	
		HUM 475	Engineering Economics	3.00	
			Total	21.00	
Option 1, Option 2		CSE 417	Cyber-Physical Systems	3.00	
		CSE 419	Internet of Things (IoT)	3.00	
		CSE 421	Basic Graph Theory	3.00	CSE 103
		CSE 423	Fault Tolerant Systems	3.00	
		CSE 425	Human Computer Interaction	3.00	
		CSE 429	Deep Learning	3.00	CSE 329

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 435	Introduction to Quantum Computing	3.00	
		CSE 441	Mobile Computing	3.00	
		CSE 445	Data Mining and Information Retrieval	3.00	
		CSE 453	High Performance Database System	3.00	CSE 215
		CSE 455	5G: Technology, Architecture and Protocols	3.00	
		CSE 457	Wireless Networks	3.00	CSE 321
		CSE 459	Communication Systems	3.00	CSE 219
		CSE 463	Bioinformatics	3.00	CSE 207
		CSE 467	Software Architecture	3.00	
		CSE 477	Cloud Computing	3.00	CSE 313, CSE 321
		EEE 463	Optical Communications	3.00	
		EEE 465	Telecommunication Systems	3.00	
		MATH 441	Mathematical Optimization	3.00	
		MATH 443	Game Theory	3.00	
		PHY 405	Quantum Mechanics	3.00	PHY 129

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
4	2	CSE 400	Project and Thesis	3.00	
			Option 3	3.00	
			Option 3 Sessional	0.75	
			Option 4	3.00	
			Option 4 Sessional	0.75	
		IPE 493	Industrial Management	3.00	
		HUM 402	Professional Communication in English Sessional	1.50	
		HUM 403	Communication in English	3.00	
		HUM 429	Accounting and Entrepreneurship for IT Business	3.00	
			Total	21.00	
Option 3, Option 3 Sessional, Option 4, Option 4 Sessional	CSE 409	Computer Graphics	3.00		
	CSE 410	Computer Graphics Sessional	0.75		
	CSE 411	Simulation and Modeling	3.00		
	CSE 412	Simulation and Modeling Sessional	0.75		

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 413	High Performance Computing	3.00	CSE 209
		CSE 414	High Performance Computing Sessional	0.75	
		CSE 415	Real-time Embedded Systems	3.00	
		CSE 416	Real-time Embedded Systems Sessional	0.75	
		CSE 427	Network Security	3.00	CSE 321, CSE 405
		CSE 428	Network Security Sessional	0.75	
		CSE 431	Natural Language Processing	3.00	CSE 329
		CSE 432	Natural Language Processing Sessional	0.75	
		CSE 433	Image Processing and Computer Vision	3.00	CSE 329
		CSE 434	Image Processing and Computer Vision Sessional	0.75	
		CSE 437	Data Science and Big Data Analytics	3.00	CSE 329
		CSE 438	Data Science and Big Data Analytics Sessional	0.75	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 439	Functional Programming	3.00	
		CSE 440	Functional Programming Sessional	0.75	
		CSE 447	Introduction to Blockchain	3.00	
		CSE 448	Introduction to Blockchain Sessional	0.75	
		CSE 461	Algorithm Engineering	3.00	CSE 207
		CSE 462	Algorithm Engineering Sessional	0.75	
		CSE 469	Software Testing and Quality Assurance	3.00	
		CSE 470	Software Testing and Quality Assurance Sessional	0.75	
		CSE 475	Robotics	3.00	CSE 317
		CSE 476	Robotics Sessional	0.75	
		CSE 481	VLSI Design	3.00	CSE 205
		CSE 482	VLSI Design Sessional	0.75	
		CSE 483	Interfacing	3.00	CSE 205
		CSE 484	Interfacing Sessional	0.75	
		CSE 485	Digital Signal Processing	3.00	

Level	Term	Course No.	Course Title	Credit Hours	Remarks/ Pre-requisite
		CSE 486	Digital Signal Processing Sessional	0.75	
		CSE 487	Mobile Applications Development	3.00	CSE 107
		CSE 488	Mobile Applications Development Sessional	0.75	
		EEE 469	Electrical Machines and Instrumentation	3.00	
		EEE 470	Electrical Machines and Instrumentation Sessional	0.75	

## 16. Course wise content as approved by the Academic Council

### Level-1, Term-1

#### CSE 101 - Structured Programming Language (3 credit hours)

Data type, variables, operators, expressions, type-casting; Control structure: if-else, switch-case, ternary operator, while/do-while/for loops, nested control structure, break and continue; Function: parameter passing, return type; One-dimensional array: searching and sorting with one-dimensional arrays; Character and string: basic string operations, string related library functions; Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion; Bitwise operations; User-defined data types: structure, union, bitfield, enumeration; Pointers: pointer to string, array, structure, and function, dynamic memory allocation; Input/Output (I/O): console I/O, formatted I/O, file I/O, command line arguments; Header files and preprocessors; Variable argument function; Error handling.  
Reference language: C.

#### CSE 102 - Structured Programming Language Sessional (1.5 credit hours)

Sessional based on CSE 101; A project work will be included.

### **CSE 103 - Discrete Mathematics (3 credit hours)**

Sets, functions, sequences, sums; Relations and partial ordered sets; Mathematical logic: propositional calculus and predicate calculus; Mathematical reasoning and proof techniques: induction; Counting: permutations, combinations, principles of inclusion and exclusion, generating functions; Discrete probability; Recurrence relations and recursive algorithms; Graph theory: graphs, paths, and trees; Introduction to number theory and algebraic structures.

### **EEE 163 - Introduction to Electrical Engineering (3 credit hours)**

Direct current: voltage, current, resistance and power; Laws of electrical circuits and methods of network analysis; Alternating current: instantaneous and RMS values of current, voltage and power, average power, for various combination of R, L and C circuits, phasor representation of sinusoidal quantities; Balanced three phase circuits; Introduction to filters.

### **EEE 164 - Introduction to Electrical Engineering Sessional (1.5 credit hours)**

Sessional based on EEE 163.

### **MATH 141 - Calculus I (3 credit hours)**

**Differential Calculus:** Continuity and differentiability; Successive differentiation: Leibnitz's forms; Maxima and minima of functions of single variable: Rolle's theorem, mean value theorem; Evaluation of indeterminate forms by L'Hospital's rule; Expansion of functions: Taylor's and Maclaurin's theorems, Lagrange's and Cauchy's forms of remainders; Partial differentiation, Euler's Theorem; Tangent, normal.

**Integral Calculus:** Definite integrals and its properties; Wallis' formula; Improper integrals; Beta function and Gamma function; Parametric equations and polar coordinates; Applications of integration: area under a plane curve, area of a region enclosed by two curves and arc lengths in Cartesian and polar coordinates, volume and surface area of solids of revolution; Multiple integrals.

**Ordinary Differential Equations (ODE):** Definition. Formation of differential equations. Solution of first order differential equations by various methods with applications. Solution of general linear equations of second and higher orders with constant coefficient. Solution of Euler's homogeneous linear equations.

### **PHY 129 - Structure of Matter, Electricity & Magnetism, Wave Mechanics (3 credit hours)**

**Structure of Matter:** Crystalline and amorphous solids, crystal systems, crystal directions, Miller indices, co-ordinations number, packing factor, Bragg's law of X-ray diffraction, crystal structure analysis, defects in crystal, bonds in solids, cohesive energy and bonding energy, free electron theory of metals, band theory of solids, solid state devices.

**Electricity and Magnetism:** Electrostatics: electric field, Gauss's law and its applications for various charge distributions, electric potential and equipotential surface, dielectrics and electrostatic energy in capacitors; Magnetostatics: magnetic field and forces, Hall effect, application of Biot-Savart and Ampere's laws, electromagnetic induction and inductance, energy in a magnetic field, Electromagnetic oscillations: RC, LR, LC and LRC circuits, working principle of transformers, motors and generators, magnetic materials and its applications in a computing device.

**Wave Mechanics:** Failure of classical mechanics and historical origins of the quantum mechanics, wave particle duality, uncertainty principle, postulates of quantum mechanics, wave function, operators, Schrödinger equation, expectation value, Ehrenfest theorem, eigen function and eigen values, particle in a box, square well potential, linear harmonic oscillator.

### **PHY 114 - Physics Sessional (1.5 credit hours)**

Physics sessional based on the theory course PHY 129.

## **Level-1, Term-2**

### **CSE 105 - Data Structures and Algorithms I (3 credit hours)**

Introduction to algorithms; Asymptotic analysis: growth of functions,  $O$ ,  $\Omega$ ,  $\Theta$ ,  $o$ ,  $\omega$  notations; Correctness proof of algorithms; Analysis of algorithms: Master theorem, etc.; Elementary data structures: arrays, linked lists, stacks, queues, trees and tree traversals, graphs and graph representations, heaps, binary search trees; Graph traversals: DFS, BFS, applications of DFS and BFS; Methods for the design of efficient algorithms: divide and conquer, greedy methods, dynamic programming; Sorting: sorting algorithms, sorting in linear time; Lower bound theory; Data structures for set operations.

### **CSE 106 - Data Structures and Algorithms I Sessional (1.5 credit hours)**

Sessional based on CSE 105.

### **CSE 107 - Object Oriented Programming Language (3 credit hours)**

Philosophy of object oriented programming (OOP); Basic principles of OOP: abstraction, encapsulation, polymorphism, inheritance; Advantages of OOP over structured programming; C++: Classes and objects: specifying a class, access specifiers; Functions: inline functions, friend functions; Constructors and destructors; Operator overloading and type conversions; Inheritance: single inheritance, multilevel inheritance, multiple inheritance; Polymorphism: function overloading, virtual functions, pure virtual functions; Templates: class templates, function templates, introduction to the standard template library (STL); Java: Nested and Inner classes; Local variable type inference; Strings: String, StringBuffer, StringBuilder; Inheritance: abstract class and anonymous subclasses, object class; Access protection with package; Interface; Exception; Thread: multithreading, Introduction to Java concurrency utilities; Generics and collections; Stream API and lambda expressions; Networking: ServerSocket, Socket.

### **CSE 108 - Object Oriented Programming Language Sessional (1.5 credit hours)**

Sessional based on CSE 107; A project work will be included.

### **CHEM 113 - Chemistry (3 credit hours)**

Quantum concept in atomic structure, VSEPR; molecular geometry, Quantum concept in bonding;

VBT and MOT, Frontier MOT and electronic transition, Silicon chemistry, Properties of solutions, Colloid and Nanochemistry, Phase rule and phase diagram; Energy and chemistry, Electrochemistry; electrolytic conduction, corrosion, devices for energy storage, Chemistry of biodegradable and conductive polymer; LED, LCD/touch screen, Chemistry of proteins, nucleic acids (DNA, RNA), carbohydrates and lipids; Introduction to computational chemistry; Design of new molecules, materials and drug.

### **CHEM 118 - Chemistry Sessional (0.75 credit hours)**

Determination of the concentration of battery acid, study of redox system (iodometric study of copper determination), calorimetric determination of heat of reaction, Molecular geometry model based on VSEPR, phase diagram.

### **MATH 143 - Linear Algebra (3 credit hours)**

Introduction to vectors, their products, matrices and systems of linear equations; Solving linear equations: Gaussian elimination, inverse and transpose of a matrix, factorization into  $A = LU$ ; Vector spaces and subspaces: four fundamental subspaces, solving  $Ax = 0$  and  $Ax = b$ , independence, basis and dimension, dimensions of the four subspaces; Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt; Determinants: properties, formulas, Cramer's rule, inverses and volumes; Eigenvalues and eigenvectors: eigendecomposition, systems of differential equations, symmetric and positive definite matrices; Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations; Complex vectors and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.

### **ME 165 - Basic Mechanical Engineering (3 credit hours)**

Statics of particles and rigid bodies; Forces in trusses and frames; Relative motion; Kinematics of particles: Newton's Second Law of Motion; Kinematics of rigid bodies. Introduction to Robotics; Plane, rotational and spatial motion with applications to manipulators; Geometric configurations: structural elements, linkage, arms and grippers; Motion characteristics. Sources of energy: conventional and renewable; Introduction to IC engines, Refrigeration and Air conditioning systems.

### **ME 174 - Mechanical Engineering Drawing and CAD (1.5 credit hours)**

Introduction; Instruments and their uses; Third angle projection; Orthographic drawing; Isometric views; Sectional views; Introduction to computer graphic software: Computer aided design (CAD).

## **Level-2, Term-1**

### **CSE 205 - Digital Logic Design (3 credit hours)**

Digital logic: Boolean algebra, theorems and properties, logic gates and their truth tables, canonical and standard forms, Boolean functions, minimization techniques; Combinational logic: arithmetic and data handling logic, decoder and encoders, multiplexer and demultiplexers; Asynchronous and synchronous

logic design: flip-flops and latches, race around problems, modes of asynchronous sequential circuits, clocked sequential circuits, state diagram, Mealy and Moore machines; state minimizations and assignments; Registers; Counters: asynchronous and synchronous counters and their applications; Pulse mode logic; Fundamental mode design; Memory and Programmable logic: internal construction of RAM and ROM, address multiplexing, PLA design.

### **CSE 206 - Digital Logic Design Sessional (1.5 credit hours)**

Sessional based on CSE 205 including 4-bit ALU design and implementation.

### **CSE 207 - Data Structures and Algorithms II (3 credit hours)**

Graph algorithms: minimum spanning tree algorithms, shortest path algorithms, maximum flow and maximum bipartite matching; Advanced data Structures: balanced binary search trees (AVL trees, red-black trees, splay trees) skip list, advanced heaps (Fibonacci heaps, binomial heaps); Hashing; NP-completeness; NP-hard and NP-complete problems; Coping with hardness: backtracking, branch and bound, approximation algorithms; String matching algorithms.

### **CSE 208 - Data Structures and Algorithms II Sessional (1.5 credit hours)**

Sessional based on CSE 207.

### **CSE 215 - Database (3 credit hours)**

Concepts of database systems; Introduction to the relational model; Database design using the Entity-Relationship model; Query Languages: Relational algebra, SQL; Constraints, functions and procedures, triggers; Functional dependencies and normalization; Data storage architectures; Indexing: primary and secondary indices, B+ tree index, hash indices; Query processing and optimization; Transaction management; Concurrency control; Recovery system; Introduction to parallel and distributed databases; Introduction to Big data analytics; NoSQL databases.

### **CSE 216 - Database Sessional (1.5 credit hours)**

Sessional based on CSE 215; A project work will be included.

### **EEE 263 - Electronic Circuits (3 credit hours)**

Ideal device characteristics of Diode, Bipolar Junction Transistor (BJT), Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET); Wave shaping circuits: Diode wave shaping techniques, clipping and clamping circuits, comparator circuits, switching circuits; Amplifiers: BJT and MOSFET amplifiers; Linear Integrated Circuits: Op-amps, linear applications of OpAmps; Oscillators: Timers (555), function generators.

### **EEE 264 - Electronic Circuits Sessional (1.5 credit hours)**

Sessional based on EEE 263.

### **MATH 241 - Advanced Calculus (3 credit hours)**

**Vector Calculus:** Vector and scalar fields; Differentiation and integration of vectors; Gradient of a scalar field: directional derivative; Divergence and curl of a vector field; Vector calculus identities: Jacobian, Hessian, Laplacian; Line integrals.

**Complex Calculus:** Functions of a complex variable; Limits and continuity of functions of complex variables; Complex differentiation: analytic functions, Cauchy-Riemann equations; Elementary complex functions: exponential, trigonometric, hyperbolic; Line integral of a complex function.

**Partial Differential Equations (PDE):** Introduction and formation of PDE; Solution of linear and non-linear PDE of order one; Second order linear PDE: classifications to standard forms; Parabolic, elliptic, hyperbolic; Solution of second order linear PDE by separation of variables.

### **Level-2, Term-2**

### **CSE 200 - Technical Writing and Presentation (0.75 credit hours)**

Issues of technical writing and effective oral presentation in Computer Science and Engineering; Writing styles of definitions, propositions, theorems and proofs; Preparation of reports, research papers, theses and books: abstract, preface, contents, bibliography and index; Writing of book reviews and referee reports; Writing tools: \LaTeX, etc.; Diagram drawing software; presentation tools.

### **CSE 209 - Computer Architecture (3 credit hours)**

Information representation; Measuring computer performance; Instruction set architectures: MIPS/ARM, operations and operands of computer hardware, representing Instructions in machine instructions; Computer Arithmetics: Integer and floating point operations; Processor design: single cycle datapath and control, pipelined datapath and control, Hazards, Exceptions; Instruction-Level Parallelism: multiple issue, speculation, superscalar and dynamic pipelining, out-of-order execution, register renaming; Memory organization: cache, cache performance, cache optimization techniques, virtual memory; Multiprocessors: introduction to SISD, MIMD, SIMD, SPMD, vector; Parallel architectures: data level parallelism, performance, GPU architecture.

### **CSE 210 - Computer Architecture Sessional (0.75 credit hours)**

Sessional based on CSE 209; Assignments, project work will be included such as the following: Booth Multiplier Design and Implementation, Small Microprocessor Design and Implementation, FPGA programming.

### **CSE 211 - Theory of Computation (3 credit hours)**

Regular languages; Finite automata: deterministic finite automata, nondeterministic finite automata, equivalence and conversion between deterministic and nondeterministic finite automata; Regular expressions: equivalence with finite automata; Nonregular languages: pumping lemma for regular languages; Context free languages: context free grammars, ambiguity, Chomsky normal form, pumping lemma for context free languages; Pushdown automata: equivalence with context-free grammar; Turing machines: basic machines, variants of Turing machines, computing with Turing machines; Computability: Church-Turing thesis, Hilbert's problems, diagonalization language; Decidability: decidable languages, undecidability, halting problem, reducibility; Complexity: time complexity, class P, class NP, NP-completeness, Cook's theorem, space complexity, Savitch's theorem.

### **CSE 213 - Software Engineering (3 credit hours)**

Software engineering: professional software development, ethics; Software development life cycle; Requirements analysis: functional and non-functional requirements, requirement elicitation and specification, use cases, requirement validation; System modeling and design: unified modeling language (UML) diagrams, user interface design; Design patterns: creational, structural, and behavioral patterns; Development: code review and documentation, version control, code smell, code refactoring; Testing and debugging: unit testing, test doubles, integration testing, regression testing, white box and black box testing, performance and security testing, A/B testing, bug reporting.

### **CSE 214 - Software Engineering Sessional (0.75 credit hours)**

Sessional based on theory course; Sample topics include the following: use cases, UML, design pattern implementation, software testing, software documentation, version control, etc.

### **CSE 219 - Signals and Linear Systems (3 credit hours)**

Introduction to signals and systems: continuous and discrete-time signals, basic operation on signals, unit impulse and unit step function, systems and their properties; Linear time invariant (LTI) systems: continuous and discrete-time LTI systems, convolution integral and convolution sum, properties of LTI systems; Time domain analysis of LTI systems: differential and difference equations; Frequency domain analysis of LTI systems: Fourier series representation of continuous and discrete-time periodic signals, properties of continuous and discrete-time Fourier series, Fourier series and LTI systems; Continuous and discrete-time Fourier transform: representation of aperiodic signals, Fourier transform for periodic signals, properties, duality; Time and frequency characterization of signals and systems; Sampling: the sampling theorem, interpolation, aliasing; Laplace transform: properties, inverse Laplace transform, analysis and characterization of LTI systems; Z-transform: properties, inverse Z-transform, analysis of LTI systems.

### **CSE 220 - Signals and Linear Systems Sessional (1.5 credit hours)**

Sessional based on CSE 219.

### **MATH 243 - Probability and Statistics (3 credit hours)**

Introduction to Statistics: variability in data, populations and samples, descriptive statistics, inferential statistics and probability, sampling procedures; Measures of location: mean, median; Measures of variability: standard deviation, variance; Higher moments: skewness, kurtosis; Graphical representation of data: scatter plot, stem and leaf plot, histogram, box plot; Probability: sample space and events, rules of probability, conditional probability, independence, Bayes' rule; Random variables: discrete and continuous probability distributions, joint probability distributions, marginal distributions and independence; Expectations, variance and covariance of random variables and their properties, Chebyshev's theorem; Discrete probability distributions: Bernoulli, binomial, multinomial, Poisson distributions and their properties; Continuous probability distributions: uniform, Gaussian (normal), chi-square distributions and their properties; Sampling distributions: sample mean, central limit theorem, sample variance, t-distribution, F-distribution, quantile and probability plots; Statistical inference: parameter estimation, confidence intervals; Hypothesis testing: null and alternative hypotheses, test statistic, P-values and significance levels, Z-test, t-test, goodness-of-fit test; Regression and correlation: least squares, coefficient of determination, correlation coefficient; Analysis of variance (ANOVA).

### **Level-3, Term-1**

#### **CSE 301 - Mathematics for Computing and Data Science (3 credit hours)**

Advanced counting and discrete probability: recurrences and sums, binomial coefficients, special numbers, generating functions, probability generating function; Random variables: discrete and continuous random variables, multivariate distributions, moment generating functions; Conditional probability and conditional expectation; Probability bounds: Markov and Chebyshev inequalities, Chernoff bound, Cauchy-Schwarz and Jensen inequalities; Convergence of random variables: law of large numbers, central limit theorem; Statistical inference: parametric and nonparametric models, point estimation, confidence intervals, bootstrapping; Parametric inference: maximum likelihood estimation; Bayesian inference: maximum a posteriori estimation; Hypothesis testing: permutation test, likelihood ratio test, multiple testing; Stochastic processes: Poisson process, Gaussian process; Markov chains: discrete-time, continuous-time, birth-death process; Queuing theory: exponential models, open and closed queuing network, applications of queuing models.

#### **CSE 309 - Compiler (3 credit hours)**

Basic issues, compiler structure, front end, optimizer, back end; Lexical Analysis: Tokens, patterns, and lexemes, transition diagrams, lexical-analyzer generator; Syntax Analysis: Top-down parsing, bottom-up parsing, LR parsing, parser generators; Syntax-Directed Translation: Syntax-directed definitions, dependency graphs, syntax trees, syntax-directed translation schemes; Intermediate-Code Generation: Directed acyclic graphs for expressions, three-address Code, quadruples, triples, static single-assignment form, types and declarations, type checking, control flow; Run-Time Environments: Storage organization, static versus dynamic storage allocation, activation trees, activation records, heap management and garbage collection; Code Generation: Basic blocks and flow graphs, optimization of basic blocks, peephole optimization, register allocation and assignment, instruction selection; Machine-

independent optimizations: principal sources of optimization; Interprocedural Analysis: Call graphs, pointer analysis.

### **CSE 310 - Compiler Sessional (0.75 credit hours)**

Sessional based on CSE 309.

### **CSE 313 - Operating System (3 credit hours)**

Operating system concepts: its role in computer systems, operating system structures, multiuser and multitasking OS; Process: process concepts, user and kernel threads, synchronization, inter-process communication, communication in client-server systems; CPU scheduling: scheduling criteria and algorithms, thread scheduling; Process synchronization: critical-section problem, semaphores, monitors; Deadlock: resource allocation and deadlock, deadlock detection, prevention and recovery; Memory management: swapping, paging, segmentation, virtual memory; Input/Output: hardware, software, disk, terminals, clocks; File Systems: files, directories, security, protection; Multi Processor System: Multiprocessor OS types, multiprocessor synchronization and scheduling, case study of a multiprocessor system; Case study of some operating systems.

### **CSE 314 - Operating System Sessional (0.75 credit hours)**

Sessional based on CSE 313.

### **CSE 315 - Microprocessors, Microcontrollers, and Embedded Systems (3 credit hours)**

Introduction to embedded systems: microprocessors and microcontrollers, applications; Microprocessors and computers: architecture, addressing modes, x86 instruction set, arithmetic co-processor, evolution of microprocessors, multitasking, virtual memory; Microcontrollers: architecture, ARM/AVR instruction set, single-board microcontrollers; Assembly language programming; Memory architectures: von Neuman and Harvard architecture, memory hierarchy, DMA; I/O modes: memory mapped I/O, general purpose I/O; Interfaces and peripherals; Interrupts and timers; Bus interfaces: UART, SPI, I2C, USB; Sampling and pulse width modulation (PWM); Interfacing with stepper motor, liquid-crystal display (LCD), analog-to-digital converter (ADC), digital-to-analog converter (DAC), sensors and actuators; Wireless communication; Embedded systems design: design flow, specifications and modeling; Power management; Distributed embedded systems and the Internet of Things (IoT); Embedded and real time OS.

### **CSE 316 - Microprocessors, Microcontrollers, and Embedded Systems Sessional (0.75 credit hours)**

Sessional based on CSE315 including assembly language programming and experiments using microprocessors/microcontrollers.

### **CSE 317 - Artificial Intelligence (3 credit hours)**

Introduction to AI, intelligent agents; Solving problems by searching: informed search strategies, greedy best-first search, A\* search, inadmissible heuristics and weighted A\*, heuristic functions; Local search and optimization problems: hill-climbing search, simulated annealing, local beam search, evolutionary algorithms; Adversarial search and games: alpha-beta tree search, Monte Carlo tree search; Constraint satisfaction problems (CSP): backtracking and local search for CSPs; Knowledge, reasoning, and planning: logical agents, inference in first-order logic, knowledge representation, automated planning; Learning from examples: forms of learning, supervised learning, learning decision trees, model selection and optimization, theory of learning; Parametric models: linear regression and classification; Nonparametric models: nearest-neighbor models, support vector machines (SVM); Ensemble learning: bagging, random forests, stacking, boosting, gradient boosting, online learning; Markov decision process (MDP), partially observable MDP, learning from rewards, passive and active reinforcement learning, Q-learning, policy search; Robotics: robotic perception, planning and control, reinforcement learning in robotics; Ethics and future of AI.

### **CSE 318 - Artificial Intelligence Sessional (0.75 credit hours)**

Sessional based on CSE 317.

## **Level-3, Term-2**

### **CSE 311 - Data Communication (3 credit hours)**

Introduction to analog and digital communication: bandwidth, signal-to-noise ratio, capacity; Analog modulation: amplitude modulation (AM), DSB-SC, SSB, VSB, frequency modulation (FM), phase modulation (PM); Analog-to-digital conversion: sampling, quantization, pulse code modulation (PCM), DPCM, ADPCM, delta modulation, digital telephony and video compression; Line coding, pulse shaping, intersymbol interference; Digital modulation: amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), differential, binary and M-ary PSK, quadrature AM (QAM), binary and M-ary FSK, minimum shift keying (MSK), Gaussian minimum shift keying (GMSK); Multiplexing and multiple access: time division multiplexing (TDM), frequency division multiplexing (FDM), orthogonal frequency domain multiplexing (OFDM), spread spectrum, code division multiple access (CDMA); Noise in communication, additive white Gaussian noise (AWGN), errors due to noise; Information theory: entropy, mutual information, Huffman and Lempel-Ziv source coding, Shannon's information capacity theorem; Error control coding: linear block codes, cyclic codes, convolutional codes, Viterbi decoding; Introduction to modern communication systems: cellular, satellite, optical fiber and power-line carrier communication.

### **CSE 321 - Computer Networks (3 credit hours)**

Introduction to computer networks; Protocol hierarchies; Data link control: Link layer and services; Multiple access protocol: Standards IEEE 802.\*; Hubs, Bridges, and Switches, Fast Ethernet; Routing architecture and algorithms; IPV4, IPV6, ARP, RARP, DHCP, BGP; Introduction to transport layer:

UDP,TCP; Principles of Reliable data transfer, Principles of congestion control, TCP, Congestion control; Application layer services: Web, HTTP, FTP, SMTP, DNS architecture; IoT fundamentals: edge devices, wireless communication, routing, IoT applications; IoT advanced: edge-cloud IoT platforms, load balancing, energy management, IoT security; Datacenter topology.

### **CSE 322 - Computer Networks Sessional (1.5 credit hours)**

Sessional based on CSE 321.

### **CSE 325 - Information Systems Development and Management (3 credit hours)**

Project management: risk management, stakeholder management, team management, issue management; Project planning: software pricing, project scheduling, estimation techniques, COCOMO cost modeling; Software development methodologies: Agile, Waterfall; Agile software development: Scrum, Kanban; Software quality assurance: software measurement, metrics, static analysis; Delivery management: acceptance criteria, Software architecture: software as a service (SaaS), service oriented architecture (SOA), microservices, model-view-controller (MVC), n-tier; Deployment: deployment architecture, continuous integration and continuous delivery (CI/CD), containerization/virtualization; Monitoring and maintenance: metrics, APM (application performance monitoring)

### **CSE 326 - Information Systems Development and Management Sessional (1.5 credit hours)**

Sessional based on CSE 325; Sample topics include design, full stack development of a simple software and deployment in cloud, browser and mobile with UML modeling and Agile project management.

### **CSE 329 - Machine Learning (3 credit hours)**

Developing machine learning systems: problem formulation, data collection, manipulation and preprocessing, exploratory data analysis and visualization; Deep learning: linear regression as a neural network, simple feedforward networks, forward propagation, backward propagation, computation graphs, numerical stability and initialization; Optimization: batch and stochastic gradient descent (SGD); Convolutional neural networks (CNN): convolution, padding, stride, pooling, modern CNNs (AlexNet, VGG, GoogLeNet, ResNet), batch normalization; Recurrent neural networks (RNN): language modeling with RNNs, modern RNNs, long short-term memory (LSTM), gated recurrent units (GRU), recursive neural networks, sequence-to-sequence (seq2seq) models; Generalization in deep learning: designing neural network architectures, weight decay, dropout; Probabilistic modeling and reasoning: Bayesian networks, exact inference, variable elimination algorithm, approximate inference, direct sampling methods, inference by Markov chain simulation, Gibb's sampling; Probabilistic reasoning over time: inference in temporal models, hidden Markov model, Kalman filters; Learning probabilistic models: learning with complete data, Bayesian learning, naive Bayes models, generative and discriminative models, generalized linear model; Learning with hidden variables: expectation-maximization (EM) algorithm, mixture models, learning mixtures of Gaussians, K-means clustering, learning hidden Markov models; Dimensionality reduction: principal component analysis (PCA); Recommender systems: collaborative filtering using matrix factorization.

### **CSE 330 - Machine Learning Sessional (1.5 credit hours)**

Sessional based on CSE 329.

### **CSE 450 - Capstone Project (1.5 credit hours)**

Solving complex engineering problems related to computer science and engineering.

### **HUM 347 - Ethics in Society and E-Governance (3 credit hours)**

**Ethics and society:** Ethics: approaches, ethical dimensions of technology, historical perspectives; Categorical imperative: motivation of action; Deviance, delinquency, morals, law, ethics; Ethics in social survey; Online communication: manifest and latent functions; Social group dynamics; Technology and inequality: class and gender issues; Social media: effect on individual autonomy, socialization, privacy, cyberbullying; Dramaturgy: presentation of self; Social interaction: distant learning, work from home; Value system, cultural ethics; Other social issues: individualism, community, minority; Digital Bangladesh and SDGs; Professional ethics: ACM code of ethics and professional conduct, responsibility, liability, loyalty, whistleblowing, trust and reliability in research and testing, conflict of interest; Intellectual property: licensing, copyrights, patents, trade secrets, plagiarism; Environmental impact: energy consumption by computing systems, electronic waste, repairing and recycling.

**E-Governance:** Defining government, institutional framework, democracy, leadership, bureaucracy, accountability and transparency in decision-making, concept of governance, citizen engagement in good governance, e-governance for good governance, e-government and public service delivery, public-private partnership for e-government system, legal and ethical issues in e-government, e-government development index (EGDI), ICT policy and smart government.

## **Level-4, Term-1**

### **CSE 400 - Project and Thesis (3 credit hours)**

Study of problems in the field of Computer Science and Engineering.

### **CSE 401 - Numerical Analysis, Simulation and Modeling (3 credit hours)**

Introduction to Numerical Analysis, approximations, round-off errors, truncation errors; Visualization and plotting; Root finding: bisection method, false position method, Newton-Raphson method, Bairstow's method; Solution of systems of equations: Gauss elimination method, Gauss-Jordan elimination method, LU decomposition; Eigenvalue decomposition: power method, QR method; Optimization: golden-section search, Newton's method, gradient methods, constrained optimization; Curve fitting, interpolation and approximation: least squares regression, linear interpolation, Lagrange polynomial interpolation, Newton's polynomial interpolation, spline interpolation; Numerical integration and differentiation: Newton-Cotes integration, trapezoidal rule, Simpson's rule, Romberg's integration, Richardson's extrapolation; Solution of ordinary differential equations: Euler's method,

Runge-Kutta methods, finite difference methods; Modeling with linear and differential equations; Introduction to simulation and modeling, Discrete event simulation models; Steps in a simulation study; Model validation and verification; Random number generation; Monte Carlo methods: Metropolis-Hastings algorithm.

#### **CSE 402 - Numerical Analysis, Simulation and Modeling Sessional (0.75 credit hours)**

Sessional based on CSE 401.

#### **CSE 405 - Cyber Security (3 credit hours)**

Fundamental concepts: confidentiality, integrity and availability, assurance, authenticity and anonymity; threats and attacks, security principles, Ethical issues in security; Cryptographic concepts: encryption, digital signatures, simple attacks on cryptosystems, cryptographic hash functions, digital certificates, Diffie-Hellman Key Exchange Algorithm; Cryptography: symmetric cryptography, public-key cryptography, cryptographic hash functions, digital signatures, details of AES and RSA cryptography; Security: Operating systems concepts, process security, memory and file system security, physical security, application program security, network security concepts, browser security, Security Attacks: buffer overflow and other vulnerabilities due to insecure programming, foot printing, social engineering, Trojans and backdoors, sniffing, denial of service, session hijacking, dictionary attack on password protected systems, threats on components like web servers, web applications, mobile platforms, wireless networks; Security Measures: Firewall, Intrusion detection and prevention.

#### **CSE 406 - Cyber Security Sessional (0.75 credit hours)**

Sessional based on CSE 405.

#### **CSE 450 - Capstone Project (1.5 credit hours)**

Solving complex engineering problems related to computer science and engineering.

#### **CSE 417 - Cyber-Physical Systems (3 credit hours)**

Cyber-physical systems: tight integration of computing, control, and communication; Applications of cyber-physical systems: vehicle systems, smart buildings, mobile computing, and medical devices; Hardware platforms: processors, sensors, actuators, and networks; Software and control: RTOS, scheduling, optimization, optimal control, and algorithm development; Modeling: system modeling, model-based design, and timed-automata; Resource-constrained platforms; Security in cyber-physical systems.

#### **CSE 419 - Internet of Things (IoT) (3 credit hours)**

Basics of the Internet of Things (IoT): IoT and its importance, elements of an IoT ecosystem, IoT

applications; Sensors and sensor nodes: sensing components and devices; Actuators; Connectivity and networks: wireless technologies for the IoT, edge connectivity and protocols, wireless sensor networks; Variants of IoT: low power embedded systems, distributed systems, cloud, and edge IoT systems, and real-time IoT systems; Basics of IoT security; Performance analysis of IoT systems; Analytics and applications: signal processing, real-time and local analytics, databases, and cloud analytics.

### **CSE 421 - Basic Graph Theory (3 credit hours)**

Graphs: simple graphs, digraphs, subgraphs, vertex-degrees, walks, paths and cycles; Trees, spanning trees in graphs, distance in graphs; Complementary graphs, cut-vertices, bridges and blocks, k-connected graphs; Euler tours, Hamiltonian cycles, Chinese Postman Problem, Traveling Salesman Problem; Chromatic number, chromatic polynomials, chromatic index, Vizing theorem, planar graphs, perfect graphs.

### **CSE 423 - Fault Tolerant Systems (3 credit hours)**

Introduction of Fault Tolerant Systems and architectures; Fault detection and location in combinational and sequential circuits; Fault test generation for combinational and sequential circuits; Digital simulation as a diagnostic tool; Automatic test pattern generator; Fault modeling; Automatic test equipment, faults in memory, memory test pattern and reliability; Performance monitoring, self checking circuits, burst error correction and triple modular redundancy; Maintenance processors.

### **CSE 425 - Human Computer Interaction (3 credit hours)**

Introduction to human-computer interaction; Interaction design: understanding users, cognitive and affective factors; Web interfaces; Introduction to interactive system design: data gathering and requirements analysis, interfaces design; UI design models: system model, interface model, user model; Usability: consistency, simplicity, learnability, efficiency, safety, ergonomics, aesthetics; Accessibility: kinds of impairments, assistive technology, universal design; Internationalization and localization: translation, text direction, sort order, formatting, color conventions, icons; User research methods: experiments, experiment design techniques, field study, survey; Prototyping; Usability testing; Analytic evaluation; Design thinking; Participatory design; Contextual inquiry; Case studies.

### **CSE 429 - Deep Learning (3 credit hours)**

Modern practices in deep neural networks: hidden units, architectural design, back-propagation and automatic differentiation; Regularization: norm penalties, dataset augmentation, noise robustness, early stopping, parameter tying and parameter sharing; Optimization algorithms: adaptive gradient methods, approximate second-order methods; Linear factor models: probabilistic PCA, factor analysis, independent component analysis (ICA), sparse coding, manifold interpretation of PCA; Deep generative models: autoencoders, generative adversarial networks (GAN), variational autoencoder (VAE); Representation learning: transfer learning and domain adaptation, semi-supervised, self-supervised deep learning, contrastive learning; Deep recommender systems: neural collaborative filtering for personalized ranking, deep factorization machines; Deep learning on graphs; Deep reinforcement learning; Bayesian deep learning; Efficient neural networks: sparsity, parameter and compute efficient neural networks; Multi-task and meta learning, multi-modal learning; Energy-based models; Interpretability and analysis of deep neural networks; Causality and explainability in deep learning.

### **CSE 435 - Introduction to Quantum Computing (3 credit hours)**

Quantum computation: evolution and applications; Basics of quantum computing: qubit representation, measurement, and superposition; Multi-qubit operations; Quantum circuits: design and architecture; Bell state and Bell-basis; Quantum operations: entanglement and teleportation; Noise and error correction; Quantum hardware; Quantum algorithms; Quantum artificial intelligence; Quantum networking.

### **CSE 441 - Mobile Computing (3 credit hours)**

Mobile technologies: anatomy of a mobile device, survey of mobile devices, usability issues of mobile devices; Mobile application development: mobile operating systems and development environments/frameworks, mobile SDKs, programming for smart-phones; Cellular communications: standards for cellular wireless networks, mobile IPv4 and mobile IPv6; Mobility in cellular networks: types of mobility, mobility management, mobility models, traffic models, channel allocation, interferences, handoffs, and location management; User interaction: user interface issues, the united look and feel paradigm, common human interface guidelines; Context aware mobile computing: types of context, modeling context information, collecting and disseminating context, applications development for changing context; Data and information management: mobile database, transactions, web services; Privacy and security issues.

### **CSE 445 - Data Mining and Information Retrieval (3 credit hours)**

Introduction to Data Mining; Finding similar items: applications of set similarity, shingling of documents, locality-sensitive hashing, distance measures, the theory of locality-sensitive functions, LSH families for other distance measures, applications of locality-sensitive hashing, methods for high degrees of similarity; Mining Data Streams: the stream data model, sampling, filtering, counting distinct elements, estimating moments, counting ones in a window, decaying windows; Link Analysis: PageRank algorithms, topic-sensitive PageRank, link spam, hubs and authorities; Frequent itemsets: the Market-Basket model, the A-Priori algorithm; Clustering: hierarchical clustering, K-means algorithms, the CURE algorithm, clustering in non-Euclidean spaces, clustering for streams and parallelism; Advertising on the Web: issues in on-line advertising, on-line algorithms, the matching problem, adwords, search engine optimization; Recommendation systems: content-based recommendations, collaborative filtering, UV-decomposition; Mining social-network: clustering of social-network graphs, discovery of communities, partitioning of graphs, finding overlapping communities, Simrank, counting triangles, neighborhood properties of graphs; Dimensionality reduction: principal component analysis (PCA), singular-value decomposition, CUR Decomposition.

### **CSE 453 - High Performance Database System (3 credit hours)**

Distributed DBMS: design issues, architectures; Distributed and parallel database design: data fragmentation, allocation; Data control: view management, access control, integrity control; Query processing: data localization, query optimization, cost model; Transaction processing: concurrency control, reliability; Replication: consistency, update management, replication protocols; Multidatabase systems: integration; Parallel database systems: parallel architectures, load balancing, fault tolerance; Big Data databases: storage systems, processing frameworks; NoSQL systems: data models, system architectures; Hybrid data stores: NewSQL, multi-model NoSQL.

### **CSE 455 - Next Generation Wireless Networks (3 credit hours)**

5G architecture: interfaces and protocols; New radio (NR) architecture: physical channels and signals,

frame structure, resource block, carrier aggregation, use of TDD; 5G core: 5G system architecture, function of each network and function of 5G core, 5G reference point architecture, 5G service based architecture; Network Function Virtualisation (NFV); Network Slicing; Multi Access Edge Computing (MEC); Quality of service in 5G: QoS architecture, QoS Flow, QoS Rule, QoS Profile, 5G numbering, addressing and identities, Dynamic spectrum sharing: coexistence of 5G NR with 4G LTE; Open radio access network (open RAN) and 5G: basic concept of traditional RAN, vRAN and open RAN, Centralised RAN, Cloud RAN; Network function virtualization and 5G: Concept of Softwarisation, Virtualization; Transmission requirement for 5G: backhaul , mid-haul and fronthaul for 5G; 5G Security: security enhancement in 5G, new challenges and its mitigation.

### **CSE 457 - Wireless Networks (3 credit hours)**

Cellular concepts: frequency reuse, handoff strategies, interference and system capacity, grade of service, improving capacity and coverage, call blocking probability; Propagation effects: outdoor propagation models, indoor propagation models, power control, Doppler's effect, small and large scale fades; Wireless LAN Technology; IEEE 802.11: standard, protocol architecture, physical layer and media access control; Mobile IP; Wireless Application Protocol; IEEE 802.16 Broadband Wireless Access; Brief review of 2nd and 3rd generation wireless: GSM, GPRS, CDMA; Cordless system; Wireless local loop; Bluetooth: overview and baseband specifications.

### **CSE 459 - Communication Systems (3 credit hours)**

Communication link engineering: Fundamental noise processes, Brightness and antenna noise, Polarization-wave and antenna, Wave propagation, Channel impairment effects, Receiver system noise, Receiver types and sub-assembly survey, Low noise antenna design; Signal power budgets and system design techniques; Interference and frequency reuse; System- and circuit-level design and implementation of communication hardware: mixers, RF amplifiers, filters, oscillators and frequency synthesizers, modulators and detectors, carrier and symbol timing recovery subsystems; Issues in software-defined radio transmitter and receiver implementation

### **CSE 463 - Bioinformatics (3 credit hours)**

Molecular biology basics: DNA, RNA, genes, and proteins; Genome sequencing: graph-based assembly; Protein sequencing; Sequence alignment: dynamic programming, local and global alignment; Combinatorial pattern matching: rapid string matching, database search, BLAST; Genome rearrangements; Evolutionary trees and phylogenetics; Computational phylogenomics; Statistical and machine learning methods in bioinformatics: clustering and classification, gene expression analysis, protein classification and attribute prediction.

### **CSE 467 - Software Architecture (3 credit hours)**

Definition and overview; Architecture design: patterns, Attribute-Driven Design (ADD) method; Architecture influence cycle: what influences software architects and software architecture; Understanding and achieving quality attributes: Quality Attribute Workshop (QAW) method for identifying critical quality attributes; Documenting software architecture; Evaluating software architecture: Architecture Tradeoff Analysis Method (ATAM) for evaluating software architecture; Architecture reuse; Architecture review; Improving an existing architecture design; Software Architecture in Agile projects; Software Architecture in service oriented systems; Software Architecture in embedded and mobile systems.

### **CSE 477 - Cloud Computing (3 credit hours)**

Cloud computing paradigms: cluster computing, grid computing, parallel and distributed computing; Cloud computing service models: infrastructure as a service, platform as a service, software as a service; Distributed computation models: MapReduce, Spark, remote procedure call, message passing; Virtualization: consolidation, resource provisioning, cost/profit optimization, customer satisfaction optimization, virtual machine management; Cloud system architecture: high availability, horizontal/vertical scaling, thin client, disaster recovery, performance measurement and monitoring; Cloud computing models: federation/presence/identity/security/privacy in cloud computing, multi-party computation; Mobile cloud computing: architecture, applications, privacy and security; Green cloud computing: dynamic capacity provisioning, power saving policies, geographical load balancing.

### **EEE 463 - Optical Communications (3 credit hours)**

Introduction to optical communication; Guided and unguided optical communication system, Light propagation through guided medium; Optical Fibers: SMF and MMF, SI fibers and GI fibers; Transmission impairments: fiber loss, chromatic dispersion in a fiber, polarization mode dispersion (PMD); Different types of fibers: DSF, DCF, Dispersion compensation schemes, Fiber cabling process, Fiber joints/connectors and couplers; Optical transmitter: LED and laser, Operating principles and characteristics; Optical receivers: PN, PIN and APD detectors, Noise at the receiver, SNR and BER. IM/DD and Coherent communication systems; Nonlinear effects in optical fibers; Optical amplifiers, Optical modulators; Multichannel optical systems: Optical FDM, OTDM and WDM; Lightwave networks: WDMA, FDMA, TDMA and CDMA, Optical Access Network, Optical network access protocols, Optical link design.

### **EEE 465 - Telecommunication Systems (3 credit hours)**

Introduction: Principle, evolution and telecommunication networks; National and International regulatory bodies, Basic elements of Telecommunication, Message source and bandwidth; Transmission media: twisted pair cable, coaxial cable, wireless channel and electromagnetic spectrum, satellite channel and fiber-optic cable, Transmission impairments, Noise and signal-to-noise ratio, Transmission capacity, Analog and digital transmission; Telephone apparatus, telephone exchanges, subscriber loop, supervisory tones, PSTN; Switching systems: Introduction to analogy system: Strowger and Crossbar switching systems, Stored program control (SPC) systems; Digital switching systems: space division switching, time division switching; Traffic analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing; Integrated services digital network (ISDN): N-ISDN and B-ISDN, architecture of ISDN, B-ISDN implementation; Digital subscriber loop (DSL), Wireless local loop (WLL), FTTx, PDH and SONET/SDH, WDM Network, IP telephony and VoIP, ATM network and Next Generation Network (NGN).

### **MATH 441 - Mathematical Optimization (3 credit hours)**

Introduction; Classical methods with single and multi variables; Basics of mathematical programming; Linear programming; Graphical method with mathematical definitions and theorems; Nonlinear programming: one dimensional problems by elimination and interpolation methods; Unconstrained and constrained techniques; Geometrical programming, stochastic programming; Calculus of variations; Optimality and relaxation, Lagrangian relaxation; Convexity and subgradient Optimization; Subgradient optimization for the Lagrangian dual.

### **MATH 443 - Game Theory (3 credit hours)**

Introduction to game theory and its applications; Solution concepts: dominant strategies, pure and mixed strategies, Nash equilibrium; Zero sum games: two-player zero-sum games, existence of Nash equilibria, computation by linear programming, multiplayer zero-sum games; Learning in games: fictitious play, multiplicative weights updates; Price of anarchy: congestion games, potential games, existence of equilibria; Market equilibria: Arrow-Debreu existence theorem; Mechanism design: Vickrey auction, social choice theory, Arrow's impossibility theorem, Vickrey-Clarke-Groves (VCG) mechanism, application of the VCG mechanism in routing, Myerson auction; Evolutionary game theory.

### **PHY 405 - Quantum Mechanics (3 credit hours)**

Introduction to quantum mechanics, Born's interpretation of wave function, Hilbert space, Schrödinger equation in one dimension.: potential step, potential barrier, tunneling and its applications in metal-oxide-semiconductor, field-effect transistor and other electronic devices, rectangular potential well, linear harmonic oscillator, Schrödinger equation in three-dimension: analytical solution of hydrogen atom, orbital angular momentum and spin angular momentum, addition of angular momenta, Time independent and time dependent perturbation theory, quantum confinement in semiconductors and its energy considerations, applications of quantum mechanics in quantum computation.

### **HUM 475 - Engineering Economics (3 credit hours)**

Economics and engineering; microeconomics and macroeconomics; theory of demand and supply and their elasticities; demand estimation; price determination; indifference curve technique; theory of production; theory of cost and cost estimation; market structure; national income accounting; depreciation; circular flow of income and expenditure; cost-benefit analysis; payback period, net present value (NPV), internal rate of return (IRR), inflation; economic feasibility of engineering undertakings; Development Economics.

## **Level-4, Term-2**

### **CSE 400 - Project and Thesis (3 credit hours)**

Study of problems in the field of Computer Science and Engineering.

### **CSE 409 - Computer Graphics (3 credit hours)**

Basics of computer graphics and its applications; Raster graphics: images and colours; 3D rasterization pipeline: modelling, viewing, projection and viewport transformations; Visible surface detection and hidden surface removal methods: back-face detection, depth buffer method, scan-line algorithm, depth-sorting method, BSP trees method; Scan conversion and antialiasing; Direct illumination; Global illumination: radiosity, shadows; Shading and textures; Ray casting and ray tracing; Fractals; 3D modeling: parametric curves and surfaces using B-spline and Bezier curves and surfaces, polygonal meshes; Graphics hardware and computer games; Computer animation and computer-generated imagery (CGI).

### **CSE 410 - Computer Graphics Sessional (0.75 credit hours)**

Sessional based on CSE 409.

### **CSE 411 - Simulation and Modeling (3 credit hours)**

Systems, models, and simulation: the nature of simulation, discrete and continuous systems, simulation software, areas of application, advantages and disadvantages of simulation; Agent-based simulation and system dynamics, Spreadsheet simulation; Input modeling: selecting input probability distributions; Generating random variates: inverse-transform method, acceptance-rejection, composition, convolution; Output analysis; Variance-reduction techniques: Experimental design and optimization; Building valid, credible, and appropriately detailed simulation models; Analysis and modeling of some practical systems.

### **CSE 412 - Simulation and Modeling Sessional (0.75 credit hours)**

Sessional based on CSE 411.

### **CSE 413 - High Performance Computing (3 credit hours)**

Introduction to high performance computing: motivation, applications, challenges; Multi-processor computer organization: architecture, memory hierarchy, and pipelines; Performance measures and analysis: speedup, efficiency and scalability; Program optimization and vectorization; Parallelization strategies: task parallelism, data parallelism, and work sharing techniques; Parallel algorithms: algorithmic techniques, problem decomposition, partitioning and load balancing; High performance parallel programming: shared memory and message passing models, OpenMP and MPI programming; High performance computing with graphics processing unit (GPU): GPU architecture, GPU programming model, GPU languages; High performance cloud and cluster computing: MapReduce programming model, Apache Hadoop.

### **CSE 414 - High Performance Computing Sessional (0.75 credit hours)**

Sessional based on CSE 413.

### **CSE 415 - Real-time Embedded Systems (3 credit hours)**

Embedded architectures: 16/32/64-bit embedded processors; Interaction with devices: buses, memory architectures, memory management, device drivers; Concurrency: software and hardware interrupt, timers; Real-time principles: synchronization, scheduling, multi-tasking; Real-time task scheduling: schedulability analysis, rate, and deadline monotonic scheduling, fixed and dynamic priority scheduling; Feed-back control theory and application; Profiling and code optimization; Embedded software systems: exception handling, loading, mode-switching, programming embedded systems.

### **CSE 416 - Real-time Embedded Systems Sessional (0.75 credit hours)**

Sessional based on CSE 415.

### **CSE 427 - Network Security (3 credit hours)**

Network security policies, strategies and guidelines; Network security assessments and matrices; Security at Transport layer: SSL, TLS, SSH; Security on Network layer: IPSec; Security for wireless network protocols: WEP, WPA, WPA2; Security protocols for Ad-hoc network; Security protocols for Sensor network; Security for communication protocols; Security for operating system and mobile agents; Security for LAN and WAN; Switching and routing security; Network security applications: AAA standards, e-mail securities, PGP, S/MIME; PKI smart cards; Sandboxing; Firewalls and Proxy server.

### **CSE 428 - Network Security Sessional (0.75 credit hours)**

Sessional based on CSE 427.

### **CSE 431 - Natural Language Processing (3 credit hours)**

Introduction to Natural Language Processing (NLP): NLP tasks and applications; Language Models: The role of language models, Simple N-gram models, Estimating parameters and smoothing, Evaluating language models; Sequence Labeling; Topic modeling: TF-IDF, LSI, LDA; Deep Learning for NLP: word embeddings, RNNs, LSTMs, sequence-to-sequence models; Self-attention and Transformers; Parsing: semantic parsing, dependency parsing, constituency parsing; NLP for information extraction and information retrieval; Transfer learning and pre-trained language models: ELMo, GPT, BERT, T5; NLP for social media; Interpretability and analysis of language models; Advanced topics in NLP.

### **CSE 432 - Natural Language Processing Sessional (0.75 credit hours)**

Sessional based on CSE 431.

### **CSE 433 - Image Processing and Computer Vision (3 credit hours)**

Introduction; Digitization of images and its properties; Data structures for image analysis; Image processing; Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region-oriented segmentation, use of motion in segmentation; Image transforms: Z-transform, 2D Fourier transform, discrete cosine transform; Image compression: run-length coding, transform coding, standards.

Introduction to computer vision; Image classification using convolutional neural networks; CNN architectures; image augmentation; semantic segmentation, object detection, and instance segmentation with RCNN and YOLO networks, Deep generative models: variational autoencoders (VAE) and generative adversarial networks (GAN) for computer vision; Image style transfer; Computer vision for multi-modal and video data; Advanced topics in computer vision.

### **CSE 434 - Image Processing and Computer Vision Sessional (0.75 credit hours)**

Sessional based on CSE 433.

### **CSE 437 - Data Science and Big Data Analytics (3 credit hours)**

Introduction to data science and big data: business intelligence, application domains; Data analytics life cycle: discovery, data preparation, model planning, model building, communicating results & operationalize; Exploratory data analysis and statistical evaluation using R; Data wrangling and visualization: feature extraction, handling missing values, dimensionality reduction, PCA, t-SNE, UMAP, plotting with ggplot2, visualization with Tableau; Machine learning: libraries and platforms for classification, regression, clustering, association rules, recommendations and ranking; Time series analysis: Box-Jenkins method, ARIMA; Text analysis: TF/IDF, LDA, topic modeling; Streaming, spatial, audio, video and graph data analytics; Advanced data analytics using deep learning; Data engineering: extract, transform, and load (ETL), database, parallel database, data warehouse, data lake, OLAP, JSON, XML, NoSQL; Big data analytics: characteristics of big data, analytics using MapReduce, Hadoop, Spark, managing big data, HDFS, Hive, MongoDB, Cassandra; Data provenance, privacy, security and ethics; Applications in financial technology (Fintech), cybersecurity, governance, social media, smart city, healthcare, bioinformatics, physical sciences, environmental and climate sciences.

### **CSE 438 - Data Science and Big Data Analytics Sessional (0.75 credit hours)**

Sessional based on CSE 437.

### **CSE 439 - Functional Programming (3 credit hours)**

Fundamental theories of programming languages: lambda-calculus and programming computable functions (PCF); Functional and imperative languages; Functional programming: types, pattern matching, functions, recursion, higher-order functions, modules, custom types and type classes, input and output, applicative functors, monads; Functional data structures; Concurrent programming and parallelism; Program analysis, formal verification and abstraction using functional programming. Reference language: Haskell/Kotlin.

### **CSE 440 - Functional Programming Sessional (0.75 credit hours)**

Sessional based on CSE 439.

### **CSE 447 - Introduction to Blockchain (3 credit hours)**

Basics of Blockchain: P2P networks, hashing, cryptography, digital signature, key exchange, checksum, blocks, and bitcoin; Distributed ledger systems; Miners; Block creation; Security on Blockchain; Categories of Blockchain; Consensus in Blockchain; Ethereum and Hyperledger; Applications of Blockchain.

### **CSE 448 - Introduction to Blockchain Sessional (0.75 credit hours)**

Sessional based on CSE 447.

### **CSE 461 - Algorithm Engineering (3 credit hours)**

Computational complexity; Exact Algorithms; Parameterized complexity; Practical computing and heuristics; Approximation algorithms; LP based approximation algorithms; Randomized algorithms; On-line algorithms; Experimental algorithmics; Contemporary and state-of-the-art.

### **CSE 462 - Algorithm Engineering Sessional (0.75 credit hours)**

Sessional based on CSE 461.

### **CSE 469 - Software Testing and Quality Assurance (3 credit hours)**

Objectives of software testing, Software Testing Life Cycle (STLC), Test Driven Development, Software Testing Terminology and Methodology; Test Plan, Testcase design and Testdata generation, Equivalence Partitioning, Boundary Value Analysis, Test Coverage; Review of Common testing methods: Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Alpha and Beta Testing, White box and black box testing; GUI Testing, API Testing; Code Review; Performance testing: Load and Stress Testing, Volume Testing, Capacity Testing; Software Security: Concept of software security, Common Vulnerabilities and their mitigation, Buffer Overflow, SQLInjection, Cross-site Scripting, Automated Security Testing, Fuzz Testing; Testing tools and Test Automation : Open source and commercial software testing tools; Automatic Bug Detection, Automated Program Repair Techniques; Software Quality, Quality Control and Quality Assurance, Software Quality Metrics.

### **CSE 470 - Software Testing and Quality Assurance Sessional (0.75 credit hours)**

Sessional based on CSE 469.

### **CSE 475 - Robotics (3 credit hours)**

Introduction: what is a robot, types of robots, robotics and AI; Automation & autonomy architectures; Introduction to Robot Operating System (ROS); Robot hardware: sensors and effectors; Localization: Markov localization, particle filter, Kalman filter, extended Kalman filter, and multi-object localization; Mapping; Simultaneous localization and mapping (SLAM); Navigation and path planning; Locomotion and manipulation; Robot Kinematics: forward and inverse kinematics; Robot dynamics: dynamics of a Rigid Body, Newton-Euler Formula, and Euler-Lagrange Formula; Human-robot interaction; Control system of robots; Image processing and analysis with vision systems; Robotics and multi-agent systems.

### **CSE 476 - Robotics Sessional (0.75 credit hours)**

Sessional based on CSE 475.

### **CSE 481 - VLSI Design (3 credit hours)**

VLSI design methodology: PLA, FPGA, cell-based and full custom design methods, System-on-chip design, Design Partitioning: structural and behavioral design with HDL, Physical design, Introduction

to CMOS technology: characteristics and performance, CMOS processing technology, CMOS building blocks: inverters and basic gates, adder, multiplier, data path and memory structures, CMOS layout design rules, Design robustness: Variability, Reliability and Scaling, Testing, Debugging and Verification. VLSI Design Automation and Optimization: partitioning, floor-planning, channel routing, data-path synthesis.

#### **CSE 482 - VLSI Design Sessional (0.75 credit hours)**

Sessional based on CSE 481.

#### **CSE 483 - Interfacing (3 credit hours)**

Interfacing with floppy and hard-disk controller; serial communication interface; Barcode reader; Sound card; MIDI interface; Printer interface; ISA, PCI, AGP, PS/2 and USB interfaces; Interfacing with stepper motors, controlling semiconductor power switches - BJT, MOSFET, SCR and Triac, Application of Opto-coupler and relays, Embedded Processors, Embedded Computing Platform, Real Time Embedded Systems, Real Time Operating Systems, Embedded Systems Programming, Mapping between languages and hardware, Embedded Communication Systems, Embedded Computer Security.

#### **CSE 484 - Interfacing Sessional (0.75 credit hours)**

Sessional based on CSE 483.

#### **CSE 485 - Digital Signal Processing (3 credit hours)**

Discrete time signals and systems: Fourier and Z transforms, DFT, 2-dimensional versions; Linear time invariant discrete time systems; Digital signal processing topics: flow graphs, realizations, FFT, quantization effects, linear prediction; Digital filter design methods: windowing, frequency sampling, S-to-Z methods, frequency-transformation methods, optimization methods, 2-dimensional filter design; Quantization of signals and filter coefficients; Oversampling techniques for ADC and DAC.

#### **CSE 486 - Digital Signal Processing Sessional (0.75 credit hours)**

Sessional based on CSE 485.

#### **CSE 487 - Mobile Applications Development (3 credit hours)**

Mobile platforms: anatomy of mobile devices, mobile OS (e.g., Android, iOS), mobile programming (e.g., Java, Swift); Android programming basics: SDKs, activities, life cycles, views, intent, resource, storage, UIs; Android advanced programming: SQLite, networking, maps, multimedia; iOS programming basics: Swift, SDKs, views, view controllers, gestures, storage; iOS advanced programming: memory management, data management, networking, graphics, location technologies; Web-based mobile applications (e.g., HTML5); Best practices to develop secure mobile app.

### **CSE 488 - Mobile Applications Development Sessional (0.75 credit hours)**

Sessional based on CSE 487.

### **EEE 469 - Electrical Machines and Instrumentation (3 credit hours)**

Introduction to conversion of energy; Single phase transformer - equivalent circuit and laboratory testing, introduction to three phase transformers; Principles of operation of DC, synchronous, induction, universal, and stepper motors; Introduction to Alternators; Measurement and instrumentation: applications, functional elements of a measurement system and classification of instruments; Measurement of electrical quantities; Transducers: mechanical, electrical and optical; Measurement of non-electrical quantities; Instrumentation amplifier, source of noise, noise reduction; Recording and display devices; Data acquisition systems.

### **EEE 470 - Electrical Machines and Instrumentation Sessional (0.75 credit hours)**

Sessional based on EEE 469.

### **IPE 493 - Industrial Management (3 credit hours)**

Introduction, evolution, management function, organization and Environment; Organization: Theory and structure; Coordination; Span of control; Authority delegation; Groups; Committee and task force; Manpower Planning; Personnel Management: Scope; Importance; Need hierarchy; Motivation; Job redesign; Leadership; Participative management; Training; Performance Appraisal; Wages and incentives; Informal groups; Organizational change and conflict; Cost and Financial Management: Elements of costs of products depreciation; Break-even analysis; Investment analysis; Benefit cost analysis. Management Accounting: Cost planning and control; Budget and budgetary control; Development planning process. Marketing Management: Concepts; Strategy; Sales promotion; Patent Laws; Technology Management: Management of innovation and changes; Technology life cycle; Case studies.

### **HUM 403 - Communication in English (3 credit hours)**

Communication in society: forms of communication, communication for specific purposes, communication in the digital age, communicating across cultures, linguistic barriers; Grammar: construction of correct sentences; Paragraph; Composition; Vocabulary enrichment: techniques of enriching stock of words for global communication; Phonetics: places and manners of articulation of sounds; Summarizing and expansion of ideas; Reading: analysing literary and non-literary texts; Business communication: anticipating the audience, organizing messages, communicating in internal and client meetings, digital media, positive, neutral, negative and persuasive messages; Report writing: types and layouts of reports, information collection through research, usage of graphics and charts; Business presentations: creating effective business presentations; Employment communication: job search, resumes, cover letters, interviewing and following up.

### HUM 402 - Professional Communication in English Sessional (1.5 credit hours)

Communication basics: level of appropriateness, colloquial and standard, informal and formal, correct pronunciation and grammar in professional communication; Vocabulary building: correct and precise diction, affixes; Communication today: communication over digital media, communication at meetings, internal and client meetings; Improving reading skills: analyzing, interpreting and understanding text varieties, practicing comprehension, study of literary and non-literary texts; Improving listening skills: overcoming barriers to effective listening, building powerful listening skills; Written communication: sentence variety, generating sentences, clarity and correctness of sentences, linking sentences to form paragraphs, writing paragraph and composition; Writing reports and proposals; Business presentations: organizing content, connecting to audience, preparing engaging multimedia presentations; Employment communication: interviewing and following up.

### HUM 429 - Accounting and Entrepreneurship for IT Business (3 credit hours)

**Accounting:** Basic accounting concepts; Accounting as information systems; Conceptual framework of accounting; Double entry mechanism; Accounting equation; The recording process: journal, ledger and trial balance; Adjusting entries, preparing an adjusted trial balance; Financial statements preparation: statement of financial position, statement of comprehensive income, statement of owners' equity and statement of cash flows; Financial statements analysis and interpretation; Some applications of accounting in excel; Cost concepts: cost classifications and cost functions; Cost Behavior: analysis and use; Job order costing and preparing job cost sheet; Cost allocation; Standard costing; Working capital management.

**Entrepreneurship for IT Business:** Foundations of entrepreneurship; Inside the entrepreneurial mind, from ideas to reality: creativity and innovation; Rewards and challenges of entrepreneurship: ethics and social responsibility; Entrepreneurial process: conducting a feasibility analysis, designing a competitive business model, crafting a business plan and building a strategic plan; Forms of business ownership: buying an existing business; Building a marketing plan; Building a financial plan; Building an operational plan; Global aspects of entrepreneurship; Planning for the future: exit strategies.

### 17. Mapping of POs with course outcomes (COs) of all offered courses

Level and Term	Courses	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
L - 1 T - 1	CSE 101												
	CSE 102	√	√	√	√	√							
	CSE 103												
L - 1 T - 2	CSE 105												
	CSE 106	√	√	√	√	√	√			√			√
	CSE 107												

Level and Term	Courses	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
	CSE 108	√		√	√	√	√						√
L - 2 T - 1	CSE 205	√	√	√	√								
	CSE 206	√	√	√	√		√						
	CSE 207	√	√	√	√	√	√			√			√
	CSE 208	√	√	√	√	√	√			√			√
	CSE 215	√	√	√	√	√		√					
	CSE 216				√	√	√			√	√	√	
L - 2 T - 2	CSE 200					√				√	√		
	CSE 209	√		√		√		√					
	CSE 210	√	√	√	√		√						
	CSE 211	√	√	√	√								√
	CSE 213	√	√	√		√			√				
	CSE 214	√	√	√		√							
	CSE 219	√	√										
	CSE 220	√	√			√							
L - 3 T - 1	CSE 301		√	√	√	√							
	CSE 309	√	√	√		√							√
	CSE 310			√	√	√							√
	CSE 313	√	√	√	√	√	√	√					
	CSE 314	√	√	√	√	√	√	√					
	CSE 315	√	√	√	√		√						
	CSE 316	√	√	√	√	√	√						
	CSE 317	√							√				
	CSE 318	√	√	√		√							
L - 3 T - 2	CSE 311		√	√	√	√	√	√					
	CSE 321	√	√	√		√			√	√			
	CSE 322	√	√	√		√			√	√		√	

Level and Term	Courses	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
	CSE 325	√	√	√	√	√		√	√		√	√	√
	CSE 326	√	√	√		√							
	CSE 329	√	√	√		√	√	√	√				
	CSE 330	√		√	√	√	√	√	√	√			√
	CSE 450	√	√	√	√	√	√	√	√	√	√	√	√
L - 4 T - 1	CSE 400	√	√	√	√	√	√	√	√	√	√		√
	CSE 401	√	√	√	√	√							
	CSE 402	√		√		√							
	CSE 405	√	√	√	√	√	√	√	√				
	CSE 406	√	√	√	√	√	√	√	√				
	Option 1												
	Option 2												
	CSE 450	√	√	√	√	√	√	√	√	√	√	√	√
Option 1 Option 2	CSE 417	√	√	√	√		√						
	CSE 419	√	√	√	√		√						
	CSE 421	√	√										
	CSE 423	√	√	√	√	√	√	√					
	CSE 425	√	√	√	√		√						
	CSE 429	√	√	√	√	√	√	√	√				√
	CSE 435	√	√	√	√		√						
	CSE 441	√		√		√							
	CSE 445		√	√	√								
	CSE 477		√	√		√							
	CSE 453	√	√	√		√							
	CSE 455	√	√	√	√								
	CSE 457	√	√	√	√	√							
	CSE 459	√	√	√	√	√							√

Level and Term	Courses	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
	CSE 463	√	√	√	√	√							√
	CSE 467	√	√	√	√								
L - 4 T - 2	CSE 400	√	√	√	√	√	√	√	√	√	√		√
	Option 3												
	Option 3 Sessional												
	Option 4												
	Option 4 Sessional												
Option 3 Option 3 Sessional Option 4, Option 4 Sessional	CSE 409		√	√	√	√							√
	CSE 410			√	√	√							√
	CSE 411	√	√	√	√		√						
	CSE 412		√	√	√	√							
	CSE 413	√	√	√		√							
	CSE 414		√	√		√							
	CSE 415	√	√	√	√		√						
	CSE 416	√	√	√	√		√						
	CSE 427	√	√	√	√	√							
	CSE 428	√	√	√		√							
	CSE 431	√	√	√	√	√							
	CSE 432	√	√	√	√	√							
	CSE 433	√	√	√	√	√							
	CSE 434	√	√	√	√	√							
	CSE 437	√	√	√	√	√							
	CSE 438		√	√	√	√				√			√
	CSE 439	√	√	√	√								
	CSE 440	√	√	√	√	√							
CSE 447	√	√	√	√		√							

Level and Term	Courses	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
	CSE 448	√	√	√	√		√						
	CSE 461	√	√	√	√								
	CSE 462	√	√	√									
	CSE 469	√	√		√	√							
	CSE 470	√	√	√		√							
	CSE 475	√											
	CSE 476	√		√		√							
	CSE 481			√	√	√							
	CSE 482	√	√	√	√		√						
	CSE 483	√	√	√	√		√						
	CSE 484	√	√	√	√		√						
	CSE 485	√	√	√	√		√						
	CSE 486	√	√	√	√		√						
	CSE 487	√	√	√	√	√	√			√		√	√
	CSE 488	√	√	√	√	√	√			√		√	√

**PART C: Detailed Description of Courses with outcome mapping**

*(Changes in PART C can be made through the approval of the respective BUGS. The changes made in this part cannot be conflicting with the content of PART A, PART B and the UG Ordinance of BUET.)*

**18. CO-PO Mapping**

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
L - 1 T - 1	CSE 101	CO 1													
		CO 2													
		CO 3													
	CSE 102	CO 1	√	√											
		CO 2			√	√									
		CO 3					√								
	CSE 103	CO 1													
		CO 2													
		CO 3													
	EEE 163	CO 1	√												
		CO 2	√												
		CO 3			√										

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 4		√										
		CO 5	√											
	EEE 164	CO 1					√							
		CO 2				√								
	MATH 141	CO 1												
		CO 2												
		CO 3												
		CO 4												
	PHY 129	CO 1	√											
		CO 2	√											
		CO 3	√											
	PHY 114	CO 1	√											
		CO 2	√											
		CO 3	√											
	L - 1 T - 2	CSE 105	CO 1	√	√									
CO 2			√				√							

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 3			√		√	√						√
	CSE 106	CO 1	√	√		√					√			
		CO 2		√	√		√							√
		CO 3			√				√					
	CSE 107	CO 1												√
		CO 2	√	√	√									
		CO 3			√	√	√	√						√
	CSE 108	CO 1												√
		CO 2	√		√									
		CO 3			√	√	√	√						√
	CHEM 113	CO 1	√											
		CO 2	√											
		CO 3												
		CO 4												
	CHEM 118	CO 1	√											
		CO 2												

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 3												
		CO 4												
	MATH 143	CO 1												
		CO 2	√											
		CO 3	√											
	ME 165	CO 1	√											
		CO 2	√											
		CO 3												
		CO 4												
		CO 5	√											
	ME 174	CO 1	√											
		CO 2	√											
		CO 4	√											
		CO 4	√											
	L - 2 T - 1	CSE 205	CO 1	√	√									
			CO 2			√	√							

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 3		√	√									
	CSE 206	CO 1	√	√										
		CO 2			√	√								
		CO 3							√					
	CSE 207	CO 1	√	√		√								
		CO 2		√	√		√	√						√
		CO 3				√					√			√
	CSE 208	CO 1	√	√		√								
		CO 2		√	√		√	√						√
		CO 3				√					√			√
	CSE 215	CO 1	√	√		√								
		CO 2	√	√	√		√							
		CO 3	√	√						√				
		CO 4	√	√	√									
	CSE 216	CO 1												
		CO 2					√	√						

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 3						√			√	√	√		
	EEE 263	CO 1	√												
		CO 2		√											
		CO 3	√												
		CO 4				√									
		CO 5				√									
	EEE 264	CO 1						√							
		CO 2				√									
		CO 3				√									
	MATH 241	CO 1													
		CO 2													
		CO 3	√												
	L - 2 T - 2	CSE 200	CO 1					√							
CO 2											√				
CO 3												√			
CO 4												√			

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
	CSE 209	CO 1													
		CO 2			√		√								
		CO 3	√						√						
	CSE 211	CO 1													√
		CO 2	√	√	√	√									
		CO 3	√	√		√									
	CSE 213	CO 1	√	√	√							√			
		CO 2	√	√	√										
		CO 3	√					√							
	CSE 214	CO 1	√	√	√										
		CO 2	√	√	√										
		CO 3	√					√							
	CSE 219	CO 1													
		CO 2	√												
		CO 3	√	√											
	CSE 220	CO 1													

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 2	√				√							
		CO 3	√	√										
	MATH 243	CO 1												
		CO 2												
		CO 3	√											
		CO 4												
L - 3 T - 1	CSE 301	CO 1					√							
		CO 2				√								
		CO 3		√	√		√							
	CSE 309	CO 1	√	√										
		CO 2	√	√	√									
		CO 3			√		√							√
	CSE 310	CO 1												
		CO 2			√		√							
		CO 3				√								√
	CSE 313	CO 1	√	√					√					

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 2			√	√		√							
		CO 3					√								
	CSE 314	CO 1	√	√						√					
		CO 2			√	√			√						
		CO 3						√							
	CSE 315	CO 1	√	√											
		CO 2			√	√									
		CO 3							√						
	CSE 316	CO 1	√	√											
		CO 2			√	√									
		CO 3						√	√						
	CSE 317	CO 1									√				
		CO 2	√												
		CO 3	√												
	CSE 318	CO 1	√		√										
		CO 2		√	√										

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 3	√				√								
L - 3 T - 2	CSE 311	CO 1													
		CO 2		√		√	√								
		CO 3			√				√	√					
	CSE 321	CO 1	√	√							√				
		CO 2	√	√	√			√				√			
		CO 3			√										
	CSE 322	CO 1									√				
		CO 2	√	√	√			√				√			
		CO 3			√									√	
	CSE 325	CO 1		√			√	√						√	
		CO 2	√	√	√	√				√	√				√
		CO 3	√		√								√	√	
	CSE 326	CO 1	√	√	√										
		CO 2	√	√	√										
		CO 3	√					√							

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 4													
	CSE 329	CO 1													
		CO 2	√					√							
		CO 3		√	√				√	√	√				
	CSE 330	CO 1													
		CO 2	√					√							
		CO 3				√	√		√	√	√				
		CO 4										√			√
	CSE 450	CO 1	√	√											
		CO 2					√		√						
		CO 3	√			√				√	√				
		CO 4	√			√		√							
		CO 5			√					√					
		CO 6												√	
		CO 7										√			√
		CO 8											√		

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	HUM 347	CO 1								√	√			√
		CO 2								√				√
		CO 3								√				
		CO 4							√	√	√			
		CO 5							√	√	√			
		CO 6							√	√	√			
L - 4 T - 1	CSE 400	CO 1		√		√								
		CO 2	√	√					√	√	√			
		CO 3			√	√	√				√			
		CO 4			√	√								
		CO 5										√		√
		CO 6											√	
	CSE 401	CO 1	√		√									
		CO 2			√	√								
		CO 3						√						
	CSE 402	CO 1	√		√		√							

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 2	√		√		√							
	CSE 405	CO 1	√	√	√			√	√	√				
		CO 2		√		√								
		CO 3				√	√							
	CSE 406	CO 1	√	√	√				√	√	√			
		CO 2		√		√								
		CO 3				√	√							
		CO 4												
	Option 1													
	Option 2													
	CSE 450	CO 1	√	√										
		CO 2				√			√					
		CO 3	√		√					√	√			
		CO 4	√		√			√						
		CO 5		√						√				

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 6											√		
		CO 7									√			√	
		CO 8										√			
	HUM 475	CO 1													
		CO 2										√			
		CO 3										√			
		CO 4								√				√	√
Option 1 Option 2	CSE 417	CO 1	√		√										
		CO 2		√				√							
		CO 3				√									
	CSE 419	CO 1	√	√											
		CO 2			√	√									
		CO 3							√						
	CSE 421	CO 1													
		CO 2													
		CO 3	√												

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 4		√										
	CSE 423	CO 1	√	√					√					
		CO 2				√		√						
		CO 3			√		√							
	CSE 425	CO 1	√		√									
		CO 2		√					√					
		CO 3				√								
	CSE 429	CO 1							√	√	√			
		CO 2	√	√		√	√							
		CO 3			√		√	√		√				√
	CSE 435	CO 1	√	√										
		CO 2			√	√								
		CO 3							√					
	CSE 441	CO 1												
		CO 2	√		√		√							
		CO 3			√		√							

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	CSE 445	CO 1												
		CO 2		√		√								
		CO 3			√									
	CSE 477	CO 1												
		CO 2		√	√		√							
		CO 3		√	√		√							
	CSE 453	CO 1												
		CO 2	√	√	√		√							
		CO 3	√	√	√		√							
	CSE 455	CO 1												
		CO 2	√	√										
		CO 3			√	√								
	CSE 457	CO 1												
		CO 2		√		√	√							
		CO 3	√		√		√							
CSE 459	CO 1	√	√											

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 2	√	√		√									
		CO 3			√		√							√	
	CSE 463	CO 1													√
		CO 2		√	√	√	√								
		CO 3	√	√	√										√
	CSE 467	CO 1													
		CO 2	√	√		√									
		CO 3	√	√	√	√									
	EEE 463	CO 1	√												
		CO 2	√	√											
		CO 3		√											
		CO 4			√										
	EEE 465	CO 1	√												
		CO 2		√											
		CO 3			√										
	MATH 441	CO 1													

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12			
		CO 2	√														
		CO 3		√													
		MATH 443	CO 1		√												
			CO 2	√													
			CO 3		√	√											
			PHY 405	CO 1	√												
				CO 2	√												
				CO 3	√												
				L - 4 T - 2	CSE 400	CO 1		√	√								
CO 2	√	√						√	√	√							
CO 3			√			√	√			√							
CO 4			√			√											
CO 5												√			√		
CO 6													√				
	Option 3																

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
	Option 3 Sessional														
	Option 4														
	Option 4 Sessional														
	IPE 493	CO 1													
		CO 2													
		CO 3													
	HUM 402	CO 1										√	√		
		CO 2											√		
		CO 3											√		
		CO 4											√		
		CO 5											√		
	HUM 403	CO 1											√		
		CO 2											√		
		CO 3											√		
		CO 4									√		√		√

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 5												√
	HUM 429	CO 1											√	
		CO 2							√	√	√		√	√
		CO 3									√		√	√
		CO 4												
		CO 5							√	√	√			
		CO 6											√	√
Option 3	CSE 409	CO 1		√		√								
		CO 2			√									
		CO 3					√							√
Option 3 Sessional	CSE 410	CO 1			√									
		CO 2			√	√								
Option 4,		CO 3					√							√
Option 4 Sessional	CSE 411	CO 1	√	√										
		CO 2			√	√								
		CO 3							√					

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 1					√							
	CSE 412	CO 2		√	√									
		CO 3			√	√								
		CO 1												
	CSE 413	CO 2	√	√	√		√							
		CO 3		√	√		√							
		CO 1												
	CSE 414	CO 2		√	√		√							
		CO 3		√	√		√							
		CO 1	√	√										
	CSE 415	CO 2			√	√								
		CO 3							√					
		CO 1	√	√										
	CSE 416	CO 2			√	√								
		CO 3							√					
		CO 1	√	√										

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
	CSE 427	CO 1	√			√									
		CO 2	√	√											
		CO 3			√		√								
	CSE 428	CO 1													
		CO 2	√	√											
		CO 3			√		√								
	CSE 431	CO 1	√	√											
		CO 2			√	√									
		CO 3					√								
	CSE 432	CO 1	√	√											
		CO 2			√	√									
		CO 3					√								
	CSE 433	CO 1	√	√											
		CO 2			√	√									

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 3					√								
	CSE 434	CO 1	√	√											
		CO 2			√	√									
		CO 3						√							
	CSE 437	CO 1	√					√							
		CO 2	√				√								
		CO 3		√	√			√							
	CSE 438	CO 1						√							
		CO 2					√								
		CO 3		√	√			√							
		CO 4										√			√
	CSE 439	CO 1													
		CO 2	√	√	√	√									
		CO 3	√	√			√								

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	CSE 440	CO 1												
		CO 2	√	√	√	√	√							
		CO 3	√	√		√	√							
	CSE 447	CO 1	√	√										
		CO 2			√	√								
		CO 3							√					
	CSE 448	CO 1	√	√										
		CO 2			√	√								
		CO 3							√					
	CSE 461	CO 1	√	√										
		CO 2			√									
		CO 3				√								
	CSE 462	CO 1	√	√										
		CO 2			√									

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 3			√										
		CO 4			√										
		CO 5			√										
	CSE 469	CO 1	√	√											
		CO 2				√	√								
		CO 3													
	CSE 470	CO 1													
		CO 2	√	√	√										
		CO 3	√				√								
	CSE 475	CO 1													
		CO 2	√												
		CO 3	√												
	CSE 476	CO 1					√								
		CO 2	√			√									

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		CO 3	√		√									
	CSE 481	CO 1	√	√										
		CO 2			√	√								
		CO 3					√							
	CSE 482	CO 1												
		CO 2			√	√								
		CO 3						√						
	CSE 483	CO 1	√	√										
		CO 2			√	√								
		CO 3						√						
	CSE 484	CO 1	√	√										
		CO 2			√	√								
		CO 3						√						
	CSE 485	CO 1	√	√										

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
		CO 2			√	√									
		CO 3						√							
	CSE 486	CO 1	√	√											
		CO 2			√	√									
		CO 3							√						
	CSE 487	CO 1	√												√
		CO 2		√	√	√			√						
		CO 3			√		√				√		√		
	CSE 488	CO 1	√												√
		CO 2		√	√	√			√						
		CO 3			√		√				√		√		
	EEE 469	CO 1	√												
		CO 2		√											
		CO 3		√											

Level and Term	Courses	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	EEE 470	CO 4			√									
		CO 1				√								
		CO 2					√							
		CO 3		√										
		CO 4									√			

### 19. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
Level -1 Term-1	CSE 101	CO 1		√		√					√							√					
		CO 2		√		√	√	√			√	√						√		√	√		√
		CO 3		√		√		√			√	√									√		
	CSE 102	CO 1		√		√					√	√						√	√				
		CO 2		√		√	√	√			√	√						√		√	√		√
		CO 3		√		√		√			√	√									√		
	CSE 103	CO 1		√							√												

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 2		√			√				√												
		CO 3		√			√	√			√	√											
	MATH 141	CO 1		√	√							√	√						√				
		CO 2		√	√		√					√	√									√	√
		CO 3		√	√							√	√									√	√
		CO 4		√	√							√	√									√	√
Level -1 Term-2	CSE 105	CO 1		√	√		√				√		√						√			√	
		CO 2		√			√			√	√									√			
		CO 3		√	√		√			√	√	√	√						√	√			√
	CSE 106	CO 1		√		√		√			√	√		√						√	√		√
		CO 2		√		√		√			√	√	√						√	√			
		CO 3		√		√		√				√		√	√			√	√	√			√
	CSE 107	CO 1		√		√						√		√							√		
		CO 2		√		√	√					√		√	√						√		√
		CO 3		√		√	√	√				√		√	√			√			√		√
	CSE 108	CO 1		√		√						√		√							√		
		CO 2		√		√	√					√		√	√						√		√

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
		CO 3		√		√	√	√			√		√	√			√			√		√		
	MATH 143	CO 1		√	√							√						√						
		CO 2		√	√		√						√									√		
		CO 3		√	√								√									√		
Level -2 Term-1	CSE 205	CO 1		√	√						√	√						√						
		CO 2		√	√							√	√					√		√				
		CO 3		√	√		√	√				√	√	√							√		√	
	CSE 206	CO 1		√	√			√				√	√						√			√		
		CO 2		√	√							√	√							√				
		CO 3		√	√	√	√	√				√	√		√			√			√	√		
	CSE 207	CO 1		√	√		√				√	√		√			√			√	√		√	
		CO 2		√	√							√	√		√				√					
		CO 3		√							√	√												
	CSE 208	CO 1		√	√		√				√	√			√			√						
		CO 2		√			√	√	√			√		√			√	√			√	√	√	
		CO 3		√	√	√					√	√			√						√			
	CSE 215	CO 1		√	√	√					√	√	√					√						

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 2		√	√	√	√				√	√	√		√			√	√			√	
		CO 3		√	√	√	√				√	√	√		√		√	√	√	√			√
		CO 4		√	√	√			√			√	√	√				√	√				√
	CSE 216	CO 1		√	√		√							√					√				
		CO 2		√		√	√	√				√	√	√	√			√	√				√
		CO 3		√		√	√	√				√	√	√		√	√	√	√	√			√
	MATH 241	CO 1		√																			
		CO 2		√																		√	√
		CO 3		√	√							√	√					√				√	√
Level -2 Term-2	CSE 200	CO 1									√	√						√					
		CO 2																			√		
		CO 3																		√			
		CO 4																		√			
	CSE 209	CO1	√	√	√	√						√							√				
		CO2		√	√	√	√	√	√			√	√	√	√	√		√	√	√	√		√
		CO3		√		√	√	√					√		√	√		√			√	√	√
CSE 211	CO 1		√		√					√													

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 2		√	√		√				√			√			√					√	
		CO 3		√								√		√	√							√	√
	CSE 213	CO 1		√		√	√	√				√	√	√			√	√	√				√
		CO 2		√		√	√	√				√	√		√			√					√
		CO 3		√		√	√	√				√			√			√					√
	CSE 214	CO 1		√		√	√	√				√	√				√		√				√
		CO 2		√		√	√	√				√		√	√			√					√
		CO 3		√		√	√	√				√		√	√	√		√					√
	CSE 219	CO 1		√	√	√	√	√				√	√						√				
		CO 2		√	√	√	√	√				√	√				√			√			
		CO 3		√	√	√	√	√				√	√					√			√		√
	CSE 220	CO 1		√	√	√	√	√				√	√	√	√				√			√	
		CO 2		√	√	√	√	√				√	√	√	√				√	√			
		CO 3			√	√	√	√			√	√	√	√				√	√		√		√
	MATH 243	CO 1		√															√				
		CO 2		√	√								√	√				√				√	√
		CO 3		√	√							√	√					√				√	√

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 4		√	√													√			√	√	
Level -3 Term-1	CSE 301	CO 1		√	√	√	√	√			√	√	√					√		√		√	
		CO 2		√	√	√	√	√			√	√	√	√	√			√	√		√		√
		CO 3		√	√	√	√	√			√	√	√	√	√	√		√	√	√	√		√
	CSE 309	CO 1		√	√	√	√	√				√	√	√					√	√			
		CO 2		√	√	√	√	√				√	√	√					√		√		
		CO 3		√	√	√	√	√				√	√	√				√	√		√		√
	CSE 310	CO 1		√															√	√			
		CO 2		√	√	√						√	√	√					√	√			
		CO 3		√		√	√	√			√	√	√	√					√		√		√
	CSE 313	CO 1		√	√	√	√	√				√	√	√					√				
		CO 2		√	√	√	√	√				√	√	√				√	√	√	√		√
		CO 3		√	√	√	√	√				√	√	√	√			√	√	√	√		√
	CSE 314	CO 1		√	√	√	√	√			√	√	√	√					√				
		CO 2		√	√	√	√	√			√	√	√	√				√	√		√	√	
		CO 3		√	√	√	√	√				√	√	√				√	√		√		√
CSE 315	CO 1		√	√	√	√	√	√		√	√	√	√					√	√				

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 2		√	√	√	√	√	√		√	√	√			√	√	√	√	√			
		CO 3		√	√	√	√	√	√	√		√	√	√				√	√		√		√
	CSE 316	CO 1		√	√	√	√	√	√	√		√	√	√	√				√			√	
		CO 2		√	√	√	√	√	√	√		√	√	√	√				√	√	√		
		CO 3		√	√	√	√	√	√	√	√	√	√	√					√	√		√	√
	CSE 317	CO 1		√	√	√	√	√	√			√							√				
		CO 2		√	√	√	√	√	√		√	√	√	√					√	√	√	√	√
		CO 3		√	√	√	√	√	√		√	√	√	√					√	√	√	√	√
	CSE 318	CO 1		√	√	√	√	√	√			√	√	√					√	√			√
		CO 2		√	√	√	√	√	√		√	√	√	√					√	√	√	√	√
		CO 3		√	√	√	√	√	√		√	√	√	√					√			√	
	Level -3 Term-2	CSE 311	CO 1		√	√	√	√	√			√	√						√				
CO 2				√	√	√	√	√				√	√	√					√	√	√		
CO 3				√	√	√	√	√				√	√	√	√				√	√	√	√	√
CSE 321		CO 1		√	√	√	√	√	√			√	√									√	√
		CO 2		√	√	√	√	√	√			√	√	√						√	√		
		CO 3		√	√	√	√	√	√		√	√				√		√		√	√		√

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
	CSE 322	CO 1		√	√	√	√	√				√												
		CO 2		√	√	√	√	√				√	√	√						√	√			
		CO 3		√	√	√	√	√			√	√				√		√		√	√			√
	CSE 325	CO 1		√	√	√	√	√	√			√	√	√		√	√		√	√				
		CO 2		√	√	√	√	√	√			√	√	√					√					
		CO 3		√	√	√	√	√	√			√	√	√					√					
	CSE 326	CO 1		√	√	√	√	√	√			√	√	√					√	√				
		CO 2		√	√	√	√	√	√			√	√	√	√		√	√	√	√				
		CO 3		√	√	√	√	√	√			√	√	√		√		√	√					√
	CSE 329	CO 1		√	√	√	√	√	√			√											√	
		CO 2		√	√	√	√	√	√		√	√	√	√				√	√	√			√	√
		CO 3		√	√	√	√	√	√	√	√	√	√	√				√	√	√	√	√	√	√
	CSE 330	CO 1		√	√	√	√	√	√			√											√	
		CO 2		√	√	√	√	√	√			√	√	√				√	√	√			√	√
		CO 3		√	√	√	√	√	√	√		√	√	√				√	√	√	√	√	√	√
		CO 4		√	√	√	√	√	√		√	√	√	√	√	√				√	√			√
			CO 1		√	√	√	√	√	√		√	√										√	

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
	CSE 450	CO 2		√	√	√	√	√			√	√				√		√						
		CO 3		√	√	√	√	√				√		√		√		√		√	√	√		
		CO 4		√	√	√	√	√				√		√		√		√	√	√	√			
		CO 5		√	√	√	√	√	√			√	√	√					√			√		
		CO 6																		√			√	
		CO 7											√	√	√	√								
		CO 8										√	√	√	√									
		HUM 347	CO 1								√													
	CO 2									√														
	CO 3									√														
	CO 4									√														
	CO 5									√														
	CO 6									√									√					
Level -4 Term-1	CSE 400	CO 1		√	√	√	√	√		√	√							√						
		CO 2		√	√	√	√	√			√	√		√	√		√				√			
		CO 3		√	√	√	√	√			√	√		√				√	√		√			
		CO 4		√	√	√	√	√			√	√					√		√					

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 5		√	√	√	√	√		√		√	√	√	√								
		CO 6		√	√	√	√	√		√													
	CSE 401	CO1		√	√	√	√	√	√			√	√	√	√				√		√		√
		CO2		√	√	√	√	√	√			√	√	√	√			√	√	√			√
		CO3	√	√	√	√	√	√	√			√	√	√				√	√	√	√		√
	CSE 402	CO1		√	√	√	√	√	√			√	√	√	√				√				√
		CO2		√	√	√	√	√	√			√	√	√	√			√	√		√		√
	CSE 405	CO1		√	√	√	√	√	√			√	√	√					√				
		CO2		√	√	√	√	√	√			√	√	√	√				√	√			√
		CO3		√	√	√	√	√	√		√	√	√	√				√	√				
	CSE 406	CO1		√	√	√	√	√	√			√	√	√					√				
		CO2		√	√	√	√	√	√			√	√	√	√	√			√	√	√	√	√
		CO3		√	√	√	√	√	√	√	√	√	√	√	√			√	√		√		√
		Option 1																					
		Option 2																					

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
	CSE 450	CO 1		√	√	√	√	√	√		√	√									√		
		CO 2		√	√	√	√	√				√	√				√		√				
		CO 3		√	√	√	√	√				√		√		√		√		√	√	√	
		CO 4		√	√	√	√	√				√		√		√		√	√	√	√		
		CO 5		√	√	√	√	√	√			√	√	√					√			√	
		CO 6																		√			√
		CO 7											√	√	√	√							
		CO 8											√	√	√	√							
	HUM 475	CO 1								√													
		CO 2								√												√	√
		CO 3								√												√	
		CO 4								√												√	√
Option 1 Option 2	CSE 417	CO 1		√	√	√	√	√		√	√	√	√		√			√					
		CO 2		√	√	√	√	√	√			√	√	√			√		√	√		√	√
		CO 3		√	√	√	√	√			√	√	√	√				√	√		√		√
	CSE 419	CO 1		√	√	√	√	√			√	√	√	√					√		√		
		CO 2		√	√	√	√	√			√	√	√	√			√	√	√	√	√		√

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 3		√	√	√	√	√			√	√	√				√	√				√	
	CSE 421	CO 1			√	√	√	√											√				
		CO 2			√	√	√	√				√	√	√			√			√			
		CO 3			√	√	√	√				√	√	√				√			√		√
		CO 4			√	√	√	√				√	√	√					√				
	CSE 423	CO 1		√	√	√	√	√				√	√					√				√	
		CO 2		√	√	√	√	√				√	√				√		√	√			
		CO 3		√	√	√	√	√				√		√	√			√			√		√
	CSE 425	CO 1		√	√	√	√	√				√	√									√	
		CO 2		√	√	√	√	√				√	√					√	√	√			
		CO 3		√	√	√	√	√	√			√		√	√						√		√
	CSE 429	CO 1		√	√	√	√	√															
		CO 2		√	√	√	√	√				√	√		√			√	√	√	√		
		CO 3		√	√	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	√
	CSE 435	CO 1		√	√	√	√	√				√	√							√		√	
		CO 2		√	√	√	√	√	√			√		√	√		√		√	√		√	√
		CO 3		√	√	√	√	√		√	√	√		√	√		√						

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
	CSE 441	CO 1		√	√	√	√	√			√							√					
		CO 2		√	√	√	√	√			√	√	√	√	√	√	√		√	√			√
		CO 3		√	√	√	√	√				√	√	√	√		√	√	√	√			√
	CSE 445	CO 1		√	√	√	√	√					√						√				
		CO 2		√	√	√	√	√				√	√	√			√		√	√			
		CO 3		√	√	√	√	√			√	√	√	√				√	√		√		√
	CSE 477	CO 1		√	√	√	√	√															
		CO 2		√	√	√	√	√				√	√	√	√	√		√		√			
		CO 3		√	√	√	√	√				√	√	√	√	√		√		√			
	CSE 453	CO 1		√		√	√	√															
		CO 2		√		√	√	√				√	√	√	√	√		√		√			
		CO 3		√		√	√	√				√	√	√	√	√		√		√			
	CSE 455	CO 1		√	√	√	√	√					√			√				√			
		CO 2		√	√	√	√	√				√	√							√			
		CO 3		√	√	√	√	√				√	√	√							√		√
	CSE 457	CO 1		√	√	√	√	√															
		CO 2		√	√	√	√	√				√	√	√	√			√		√			√

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 3		√	√	√	√	√			√	√	√	√	√		√			√		√	
	CSE 459	CO 1		√	√	√	√	√				√	√						√	√			
		CO 2		√	√	√	√	√				√	√								√		
		CO 3		√	√	√	√	√				√	√										√
	CSE 463	CO 1	√	√	√	√	√	√				√											
		CO 2		√	√	√	√	√				√		√				√			√		√
		CO 3		√	√	√	√	√			√	√		√				√			√		√
	CSE 467	CO 1	√		√								√						√				
		CO 2			√			√				√	√				√			√			
		CO 3			√		√	√				√	√					√			√		√
	MATH 441	CO 1		√	√							√			√			√	√				
		CO 2		√	√			√				√		√				√				√	√
		CO 3		√	√							√		√				√				√	√
	MATH 443	CO 1		√	√							√	√					√	√			√	√
		CO 2		√	√		√					√	√					√	√			√	√
		CO 3		√	√		√					√	√					√	√			√	√
	Level -4	CSE 400	CO 1		√	√	√	√	√		√	√							√				

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
Term-2		CO 2		√	√	√	√	√		√	√		√	√		√				√			
		CO 3		√	√	√	√	√		√	√		√					√	√		√		
		CO 4		√	√	√	√	√		√	√						√		√				
		CO 5		√	√	√	√	√		√		√	√	√	√	√							
		CO 6		√	√	√	√	√		√													
	Option 3																						
	Option 3 Sessional																						
	Option 4																						
	Option 4 Sessional																						
	HUM 402	CO 1								√													
		CO 2								√													
		CO 3								√													
		CO 4								√													
		CO 5								√													

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
	HUM 403	CO 1							√															
		CO 2								√														
		CO 3								√														
		CO 4								√														
		CO 5								√														
	HUM 429	CO 1								√														
		CO 2								√														
		CO 3								√														
		CO 4								√														
		CO 5								√														
		CO 6								√														
Option 3, Option 3 Sessional, Option 4, Option 4 Sessional	CSE 409	CO 1		√	√	√	√	√			√	√	√					√						
		CO 2		√	√	√	√	√				√	√	√					√	√				
		CO 3		√	√	√	√	√			√	√	√	√					√				√	
	CSE 410	CO 1		√	√	√	√	√				√	√	√					√					
		CO 2		√	√	√	√	√				√	√	√					√					
		CO 3		√	√	√	√	√			√	√	√	√					√	√			√	

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
	CSE 411	CO 1		√	√	√	√	√			√						√		√			√		
		CO 2		√	√	√	√	√			√		√	√								√	√	
		CO 3		√	√	√	√	√			√													
	CSE 412	CO 1		√	√	√	√	√				√		√				√			√		√	
		CO 2		√	√	√	√	√				√			√									√
		CO 3		√	√	√	√	√				√			√									√
	CSE 413	CO 1		√	√	√	√	√																
		CO 2		√	√	√	√	√				√	√	√	√	√		√		√				
		CO 3		√	√	√	√	√				√	√	√	√	√		√		√				
	CSE 414	CO 1		√	√	√	√	√																
		CO 2		√	√	√	√	√				√	√	√	√	√		√		√				
		CO 3		√	√	√	√	√				√	√	√	√	√		√		√				
	CSE 415	CO 1		√	√	√	√	√				√	√			√			√					
		CO 2		√	√	√	√	√	√			√	√	√			√			√			√	√
		CO 3		√	√	√	√	√					√						√					
			CO 1		√	√	√	√	√			√	√			√			√					
			CO 2		√	√	√	√	√	√			√	√	√			√			√			√

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
	CSE 416	CO 3		√	√	√	√	√				√						√						
	CSE 427	CO 1		√	√	√	√	√						√				√		√				
		CO 2		√	√	√	√	√			√	√	√	√					√	√	√		√	
		CO 3		√	√	√	√	√	√			√	√	√			√	√	√	√			√	
	CSE 428	CO 1		√	√	√	√	√	√						√				√		√			
		CO 2		√	√	√	√	√	√			√	√	√	√				√	√	√		√	
		CO 3		√	√	√	√	√	√			√	√	√	√			√	√	√	√			
	CSE 431	CO 1		√	√	√	√	√	√			√	√	√					√					
		CO 2		√	√	√	√	√	√			√	√	√	√				√	√	√	√		√
		CO 3		√	√	√	√	√	√			√	√	√	√				√	√		√		√
	CSE 432	CO 1		√	√	√	√	√	√			√	√	√					√					
		CO 2		√	√	√	√	√	√			√	√	√	√	√			√	√	√	√		√
		CO 3		√	√	√	√	√	√			√	√	√	√				√	√		√		√
	CSE 433	CO 1		√	√	√	√	√	√			√	√	√					√					
		CO 2		√	√	√	√	√	√			√	√	√	√				√	√	√	√		√
		CO 3		√	√	√	√	√	√			√	√	√	√				√	√		√		√
	CSE 434	CO 1		√	√	√	√	√			√	√	√						√					

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 2		√	√	√	√	√		√	√	√	√				√	√	√	√		√	
		CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√	
	CSE 437	CO 1		√	√	√	√	√			√		√								√		√
		CO 2		√	√	√	√	√		√	√		√	√				√			√		√
		CO 3		√	√	√	√	√		√	√		√	√	√		√				√		√
	CSE 438	CO 1		√	√	√	√	√			√		√								√		√
		CO 2		√	√	√	√	√		√	√		√	√				√			√		√
		CO 3		√	√	√	√	√		√	√		√	√	√		√				√		√
		CO 4		√	√	√	√	√		√	√	√	√	√	√	√							√
	CSE 439	CO 1		√	√	√	√	√															
		CO 2		√	√	√	√	√				√	√							√	√		√
		CO 3		√	√	√	√	√				√	√						√				
	CSE 440	CO 1		√	√	√	√	√															
		CO 2		√	√	√	√	√				√	√							√	√		√
		CO 3		√	√	√	√	√				√	√						√				
	CSE 447	CO 1		√	√	√	√	√				√	√	√			√		√			√	
		CO 2		√	√	√	√	√				√	√	√	√		√		√	√			

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
		CO 3		√	√	√	√	√		√	√	√	√				√	√	√	√		√		
	CSE 448	CO 1		√	√	√	√	√			√	√	√		√			√			√			
		CO 2		√	√	√	√	√			√	√	√	√	√				√	√				
		CO 3		√	√	√	√	√	√		√	√	√	√				√	√	√	√		√	
	CSE 461	CO 1			√	√	√	√			√	√	√	√							√			
		CO 2			√	√	√	√			√	√	√	√				√			√			
		CO 3			√	√	√	√			√	√	√	√							√			
	CSE 462	CO 1			√	√	√	√			√	√	√	√					√		√			
		CO 2			√	√	√	√			√	√	√	√					√		√			
		CO 3			√	√	√	√			√	√	√	√					√		√			
		CO 4			√	√	√	√			√	√	√	√					√		√			
		CO 5			√	√	√	√			√	√	√	√					√		√			
	CSE 469	CO 1		√	√	√	√	√				√	√	√				√	√	√			√	
		CO 2		√	√	√	√	√				√	√	√	√			√	√	√			√	
		CO 3		√	√	√	√	√				√		√		√			√	√				
	CSE 470	CO 1		√		√	√																	
		CO 2					√	√				√			√			√	√					

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5		
		CO 3		√		√	√				√		√		√		√	√				√		
	CSE 475	CO 1		√	√	√	√	√				√							√	√				
		CO 2		√	√	√	√	√			√	√	√	√			√	√	√				√	
		CO 3		√	√	√	√	√	√			√	√	√	√				√	√	√			√
	CSE 476	CO 1		√	√	√	√	√	√			√	√	√					√					
		CO 2		√	√	√	√	√	√			√	√	√					√	√	√			
		CO 3		√	√	√	√	√	√			√	√	√					√	√				√
	CSE 481	CO 1		√	√	√	√	√	√										√					
		CO 2		√	√	√	√	√	√			√	√	√			√			√				
		CO 3		√	√	√	√	√	√			√	√	√				√				√		√
	CSE 482	CO 1		√	√	√	√	√	√			√	√	√					√	√				
		CO 2		√	√	√	√	√	√			√	√				√			√				
		CO 3		√	√	√	√	√	√			√	√	√				√		√	√			√
	CSE 483	CO 1		√	√	√	√	√	√			√	√						√					
		CO 2		√	√	√	√	√	√			√	√				√			√				
		CO 3		√	√	√	√	√	√			√	√					√				√		√
	CSE 484	CO 1		√	√	√	√	√			√	√							√					

Level and Term	Courses	COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5	
		CO 2		√	√	√	√	√			√	√				√		√					
		CO 3		√	√	√	√	√				√	√					√			√		√
	CSE 485	CO 1		√	√	√	√	√				√	√						√				
		CO 2		√	√	√	√	√				√	√				√			√			
		CO 3		√	√	√	√	√				√	√					√			√		√
	CSE 486	CO 1		√	√	√	√	√				√	√	√	√				√			√	
		CO 2		√	√	√	√	√				√	√	√	√				√	√			
		CO 3		√	√	√	√	√			√	√	√	√				√	√		√		√
	CSE 487	CO 1		√	√	√	√	√				√	√	√					√				
		CO 2		√	√	√	√	√				√	√	√			√		√	√			√
		CO 3		√	√	√	√	√				√	√	√				√	√				√
	CSE 488	CO 1		√	√	√	√	√				√	√	√					√				
		CO 2		√	√	√	√	√				√	√	√	√		√		√	√			√
		CO 3		√	√	√	√	√				√	√	√				√	√				√

## 20. Description of all courses of the program

### 20.1 Description of Course CSE 101

#### PART A: General Information

20.1.1 Course Title	: Structured Programming Language
20.1.2 Type of Course	: THEORY
20.1.3 Offered to	: DEPARTMENT OF CSE
20.1.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

##### 20.1.5 Course Content (As approved by the Academic Council)

Data type, variables, operators, expressions, type-casting; Control structure: if-else, switch-case, ternary operator, while/do-while/for loops, nested control structure, break and continue; Function: parameter passing, return type; One-dimensional array: searching and sorting with one-dimensional arrays; Character and String: basic string operations, string related library functions; Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion; Bitwise operations; User-defined data types: structure, union, bitfield, enumeration; Pointers: pointer to string, array, structure, and function, dynamic memory allocation; Input/Output (I/O): Console I/O, Formatted I/O, File I/O, Command Line Arguments; Header files and Preprocessors; Variable argument function; Error handling;.

##### 20.1.6 Course Objectives

The students are expected to:

- Understand the concept of computing problem solving techniques and programming language.
- Develop the programs to solve numerical and computing problems.
- Understand the syntax of the structured programming language.
- Analyze the errors in writing programs.
- Understand the technique of storing data in the file media and manipulate the data to generate formatted results.
- Evaluate the efficiency of a program in solving problems.

##### 20.1.7 Knowledge required

###### Technical

- Introductory knowledge of Computers is required. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

###### Analytical

- None

##### 20.1.8 Course Outcomes (COs)

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Adapt</b> appropriate coding standards with proper documentation to come up with a readable,	-	A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	understandable, and maintainable program				
CO2	<b>Design and implement</b> programs, based on given specification(s), to solve a computing problem with proper code organization	-	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Select and apply</b> appropriate debugging and testing techniques to ensure the correctness of a program and compliance with given specifications to solve a computing problem	-	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.1.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√					√							√				
CO 2		√		√	√	√			√	√					√		√	√		√
CO 3		√		√		√			√	√								√		

### 20.1.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introductory discussion, Motivation behind Programming, hands-on demonstration of a very simple program	CO1 and CO2
Week 2	Data type, variables, operators, expressions, typecasting	CO1 and CO2
Week 3	Control structure: if-else, switch-case, ternary operator	CO1 and CO2
Week 4	while/do-while/for loops, nested control structure, break and continue;	CO1 and CO2
Week 5	Function: parameter passing, return type;	CO1 and CO2

Week	Lecture Topics	Corresponding CO(s)
Week 6	One-dimensional array: searching and sorting with one-dimensional arrays;	CO1 and CO2
Week 7	Character and String: basic string operations, string-related library functions;	CO1 and CO2
Week 8	Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion;	CO1 and CO2
Week 9	Bitwise operations; User-defined data types: structure, union, bitfield, enumeration;	CO1 and CO2
Week 10	Pointers: pointer to string, array, structure, and function	CO1 and CO2
Week 11	dynamic memory allocation	CO1 and CO2
Week 12	Input/Output (I/O): Console I/O, Formatted I/O, File I/O	CO1 and CO2
Week 13	Command Line Arguments; Header files and Preprocessors;	CO1 and CO2
Week 14	Debugging, Variable argument function; Error handling;	CO1, CO2, and CO3

#### 20.1.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.1.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.1.13 Textbook/ Reference

- Teach yourself C, Herbert Schildt (3rd Edition)
- C Programming Language by Brian W. Kernighan and Dennis M. Ritchie (2nd Edition)
- C/C++ Structured Programming by M A H Newton, M. Kaykobad and Md Mostofa Akbar, Voyager Publications

### 20.2 Description of Course CSE 102

#### PART A: General Information

20.2.1 Course Title	: Structured Programming Language Sessional
20.2.2 Type of Course	: SESSIONAL
20.2.3 Offered to	: DEPARTMENT OF CSE
20.2.4 Pre-requisite Course(s)	: NONE

## **PART B: Course Details**

### **20.2.5 Course Content**

Sessional work based on course CSE 101 using the C programming language; A project using C programming language.

### **20.2.6 Course Objectives**

The students are expected to:

- Understand the concept of computing problem solving techniques and programming language.
- Develop the programs to solve numerical and computing problems.
- Understand the syntax of the structured programming language.
- Analyze the errors in writing programs.
- Understand the technique of storing data in the file media and manipulate the data to generate formatted results.
- Evaluate the efficiency of a program in solving problems.

### **20.2.7 Knowledge required**

#### **Technical**

- Introductory knowledge of Computers is required. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

#### **Analytical**

- None

### **20.2.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Adapt</b> appropriate coding standards with proper documentation to come up with a readable, understandable, and maintainable program	PO1 and PO2	A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and implement</b> programs, based on given specification(s), to solve a computing problem with proper code organization	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Select and apply</b> appropriate debugging and testing techniques to ensure the correctness of a program and compliance with given specifications to solve a computing problem	PO5	P7	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### **20.2.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√					√	√					√	√				
CO 2		√		√	√	√			√	√					√		√	√		√
CO 3		√		√		√			√	√								√		

### 20.2.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	<b>Type:</b> Lecture/Demonstration Introduction rules and regulations overview, tools demonstration, writing your first C program!	CO1, CO2, and CO3
Week 2	<b>Type:</b> Hands-on Data type, variables, operators, expressions, typecasting, Control structure: if-else, switch-case, ternary operator.	CO1, CO2, and CO3
Week 3	<b>Type:</b> Lab. Assignment Data type, variables, operators, expressions, type-casting, Control structure: if-else, switch-case, ternary operator	CO1, CO2, and CO3
Week 4	<b>Type:</b> Lab. Assignment Control structure: if-else, switch-case, ternary operator	CO1, CO2, and CO3
Week 5	<b>Type:</b> Lab. Assignment while/do-while/for loops, nested control structure, break and continue;	CO1, CO2, and CO3
Week 6	<b>Type:</b> Lab. Assignment Function: parameter passing, return type;	CO1, CO2, and CO3
Week 7	<b>Type:</b> Hands-on One-dimensional array: searching and sorting with one-dimensional arrays;	CO1, CO2, and CO3
Week 8	<b>Type:</b> Lab. Assignment Character and String: basic string operations, string-related library functions;	CO1, CO2, and CO3
Week 9	<b>Type:</b> Home Assignment Multi-dimensional array: matrix operations with multi-dimensional arrays; Recursion;	CO1, CO2, and CO3
Week 10	<b>Type:</b> Lab. Assignment Bitwise operations; User-defined data types: structure, union, bitfield, enumeration;	CO1, CO2, and CO3
Week 11	<b>Type:</b> Hands-on Pointers: pointer to string, array, structure, and function	CO1, CO2, and CO3
Week 12	<b>Type:</b> Home Assignment Pointers: pointer to string, array, structure, and function , Dynamic memory allocation	CO1, CO2, and CO3

Week	Lecture Topics	Corresponding CO(s)
Week 13	Quiz	CO3
Week 14	<b>Type:</b> Hands-on Input/Output (I/O): Console I/O, Formatted I/O, File I/O; Command Line Arguments	CO1, CO2, and CO3

### 20.2.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Lab and Home Assignments: There will be several assignments given. The students will have to solve some of the assignments in the lab. within a short period of time. Other assignments will be take-home.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

### 20.2.12 Distribution of Marks

Attendance:	10 %
Lab and Home Assignments:	60%
Quiz Exam:	30%
Total:	100%

### 20.2.13 Textbook/ Reference

- Teach yourself C, Herbert Schildt (3rd Edition)
- C Programming Language by Brian W. Kernighan and Dennis M. Ritchie (2nd Edition)
- C/C++ Structured Programming by M A H Newton, M. Kaykobad and Md Mostofa Akbar, Voyager Publications

## 20.3 Description of Course CSE 103

### PART A: General Information

20.3.1 Course Title : DISCRETE MATHEMATICS

20.3.2 Type of Course : THEORY

20.3.3 Offered to : DEPARTMENT OF CSE

20.3.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.3.5 Course Content (As approved by the Academic Council)

Sets, functions, sequences, sums; Relations and partial ordered sets; Mathematical logic: propositional calculus and predicate calculus; Mathematical reasoning and proof techniques: induction; Counting: permutations, combinations, principles of inclusion and exclusion, generating functions; Discrete probability; Recurrence relations and recursive algorithms; Graph theory: graphs, paths, and trees; Introduction to number theory and algebraic structures.

#### 20.3.6 Course Objectives

The students are expected to:

- study the concept and relevant tools of mathematical logic and reasoning
- learn how to apply different proof techniques to prove propositions

- learn how to do counting and enumeration through combinatorial analysis
- develop problem solving and modeling skills using discrete structures (e.g., graphs)

### 20.3.7 Knowledge required

#### Technical

- None

#### Analytical

- Basic Mathematics (HSC Level)

### 20.3.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>understand</b> and <b>apply</b> the theory, constructs and concepts of mathematical logic and reasoning and <b>derive</b> proof using those	-	C3	Lecture, exercise	Class Tests or Assignments and Final Exam
CO 2	Combinatorically <b>analyze</b> various counting problems	-	C5	Lecture, exercise	Class Tests or Assignments and Final Exam
CO 3	<b>Analyze</b> problems and <b>develop</b> models thereof using discrete structures	-	C5	Lecture, exercise	Class Tests or Assignments and Final Exam

### 20.3.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√							√											
CO 2		√			√				√											
CO 3		√			√	√			√	√										

### 20.3.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction, Motivation; Set Theory	CO1
Week 2	propositional calculus	CO1
Week 3	predicate calculus	CO1

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 4	sequences, sums, function	CO1
Week 5	function, relations	CO1
Week 6	Mathematical reasoning and proof techniques	CO1
Week 7	Mathematical reasoning and proof techniques	CO1
Week 8	Number theory and algebraic structures	CO1
Week 9	Counting	CO2
Week 10	Counting	CO2
Week 11	Discrete Probability	CO2
Week 12	Recurrence relations and recursive algorithms	CO3
Week 13	Graph Theory: graphs, paths, and trees	CO3
Week 14	Revision	CO1, CO2, and CO3

#### **20.3.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.3.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.3.13 Textbook/ Reference**

- a. Kenneth. H. Rosen, "Discrete mathematics and its applications", Tata McGraw- Hill Publishing Company, New Delhi
- b. Susanna S. Epp, "Discrete mathematics and its applications", Brooks/Cole-Thomas Learning, USA.

## **20.4 Description of Course CSE 105**

### **PART A: General Information**

**20.4.1 Course Title** : DATA STRUCTURES AND ALGORITHMS I

**20.4.2 Type of Course** : THEORY

**20.4.3 Offered to** : DEPARTMENT OF CSE

**20.4.4 Pre-requisite Course(s)** : CSE 101, CSE 103

### **PART B: Course Details**

#### **20.4.5 Course Content (As approved by the Academic Council)**

Introduction to algorithms; Asymptotic analysis: growth of functions,  $O$ ,  $\Omega$ ,  $\Theta$ ,  $o$ ,  $\omega$  notations; Correctness proof of algorithms; Analysis of algorithms: Master theorem, etc.; Elementary data structures: arrays, linked lists, stacks, queues, trees and tree traversals, graphs and graph representations, heaps, binary search trees; Graph traversals: DFS, BFS, applications of DFS and BFS; Methods for the design of efficient algorithms: divide and conquer, greedy methods, dynamic programming; Sorting: sorting algorithms, sorting in linear time; Lower bound theory; Data structures for set operations.

#### **20.4.6 Course Objectives**

The students are expected to:

- Understand algorithmic behavior in terms of time and space,
- Design, analyze, and implement various data structures,
- Assess and compare data structure impacts on the performance of an application,
- Formulate problems and solve them using appropriate data structures and algorithms.

#### **20.4.7 Knowledge required**

##### **Technical**

- Structured Programming language

#### **20.4.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO 1	<b>Understand and analyze</b> performance of data structures in algorithms in terms of time and space	PO1 and PO2	C4, A5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 2	<b>Evaluate</b> the correctness and complexity of algorithms	PO1 and PO4	C6	Lecture, Hands-on and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 3	<b>Construct</b> appropriate data structures and algorithms to <b>solve</b> real world problems	PO3, PO5, PO6 and PO12	C3, A5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

#### **20.4.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√		√				√		√						√			√
CO 2		√			√			√	√									√		
CO 3		√	√		√			√	√	√	√					√	√			√

#### 20.4.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Fundamentals of data structures, abstract data types	CO1
Week 2	Asymptotic analysis, arrays, linked lists	CO1
Week 3	Stacks, queues	CO1
Week 4	Trees and tree traversals	CO1
Week 5	Binary search trees, heaps	CO1, CO3
Week 6	Graphs and graph representations	CO1, CO3
Week 7	Introduction to algorithms: correctness and complexity	CO1, CO2
Week 8	Graph traversals: DFS, BFS, and their applications	CO3
Week 9	Sorting algorithms	CO1, CO2, CO3
Week 10	Divide and conquer, master theorem	CO2, CO3
Week 11	Greedy algorithms	CO2, CO3
Week 12	Dynamic programming (Basics)	CO1, CO3
Week 13	Dynamic programming (Application)	CO3
Week 14	Data structures for set operations, sorting in linear time	CO1, CO3

#### 20.4.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.4.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.4.13 Textbook/ Reference

- Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press, 3rd Edition
- Algorithm Design, by Jon Kleinberg and Eva Tardos, Pearsons Publishers
- Data Structures and Algorithm Analysis, Edition 3.2 (C++ Version) by Clifford A. Shaffer
- Data Structures and Algorithms in C++, Second Edition by Michael T., Roberto Tamassia and David M. Mount
- Algorithms, by Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani

## 20.5 Description of Course CSE 106

### PART A: General Information

<b>20.5.1 Course Title</b>	:DATA STRUCTURES AND ALGORITHMS I SESSIONAL
<b>20.5.2 Type of Course</b>	: SESSIONAL
<b>20.5.3 Offered to</b>	: DEPARTMENT OF CSE
<b>20.5.4 Pre-requisite Course(s)</b>	: N/A

### PART B: Course Details

#### 20.5.5 Course Content (As approved by the Academic Council)

Laboratory works based on the following topics. Introduction to algorithms; Asymptotic analysis: growth of functions,  $O$ ,  $\Omega$ ,  $\Theta$ ,  $o$ ,  $\omega$  notations; Correctness proof of algorithms; Analysis of algorithms: Master theorem, etc.; Elementary data structures: arrays, linked lists, stacks, queues, trees and tree traversals, graphs and graph representations, heaps, binary search trees; Graph traversals: DFS, BFS, applications of DFS and BFS; Methods for the design of efficient algorithms: divide and conquer, greedy methods, dynamic programming; Sorting: sorting algorithms, sorting in linear time; Lower bound theory; Data structures for set operations.

#### 20.5.6 Course Objectives

The students are expected to:

- understand algorithmic behaviour in terms of time and space,
- design, analyze, and implement various data structures,
- assess and compare data structure impacts on the performance of an application,
- formulate problems and solve them using appropriate data structures and algorithms.

#### 20.5.7 Knowledge required

##### Technical

- Structured Programming language

### 20.5.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand and analyze</b> performance of algorithms in terms of time and space and <b>evaluate</b> their correctness	PO1, PO2, PO4 and PO9	C4, A5, P4	Lecture, exercise, hands-on, coding and development	Assignments or Projects, Viva, Quiz
CO2	<b>Implement and utilize</b> appropriate data structures and algorithms in various algorithmic problems	PO2, PO3, PO5 and PO12	C5, A2, P3	Lecture, exercise, coding and development	Assignments or Projects, Viva, Quiz
CO3	<b>Solve</b> real world problems using various data structures and algorithms	PO3 and PO6	C3, P5	Lecture, exercise, coding and development	Assignments or Projects, Viva, Quiz

### 20.5.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√		√		√	√		√						√	√		√
CO 2		√		√		√		√	√	√						√	√			
CO 3		√		√		√			√		√	√			√	√	√			√

### 20.5.10 Lecture/ Activity Plan

Week	Topics	Corresponding CO(s)
Week 1, 2	Introduction and Practice	CO1
Week 3	Array, linked list	CO2
Week 4	Stack	CO2
Week 5	Queue	CO2
Week 6	Binary search tree	CO1, CO2

Week	Topics	Corresponding CO(s)
Week 7	Heap	CO1, CO2
Week 8	Graph: Problem formulation and representation	CO1, CO2
Week 9	Graph traversals: DFS, BFS, and their applications	CO1, CO2, CO3
Week 10	Sorting algorithms	CO2, CO3
Week 11	Divide and conquer	CO2, CO3
Week 12	Greedy algorithm	CO2, CO3
Week 13	Dynamic programming	CO2, CO3
Week 14	Quiz / Final Evaluation	CO1, CO2, CO3

### 20.5.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Offline/Online Assignments and Project and Viva: Offline/Online assignments will be given regularly. A project may also be included. Viva may be taken to assess knowledge and skill of the students. All these will be considered in final evaluation.
- Quiz: One or more comprehensive quizzes will be held as per the institutional ordinance.

### 20.5.12 Distribution of Marks

Attendance:	5-10 %
Offline/Projects and Viva:	30-50%
Online:	20-30%
Quiz:	20-30%
Total:	100%

### 20.5.13 Textbook/ Reference

- Introduction to Algorithms, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, MIT Press, 3rd Edition
- Algorithm Design, by Jon Kleinberg and Eva Tardos, Pearsons Publishers
- Data Structures and Algorithm Analysis, Edition 3.2 (C++ Version) by Clifford A. Shaffer
- Data Structures and Algorithms in C++, Second Edition by Michael T., Roberto Tamassia and David M. Mount
- Algorithms, by Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani

## 20.6 Description of Course: CSE 107

### PART A: General Information

20.6.1 Course Title	: Object Oriented Programming Language
20.6.2 Type of Course	: THEORY
20.6.3 Offered to	: DEPARTMENT OF CSE
20.6.4 Pre-requisite Course(s)	: CSE 101

## **PART B: Course Details**

### **20.6.5 Course Content (As approved by the Academic Council)**

Philosophy of object oriented programming (OOP); Basic principles of OOP: abstraction, encapsulation, polymorphism, inheritance; Advantages of OOP over structured programming; C++: Classes and objects: specifying a class, access specifiers; Functions: inline functions, friend functions; Constructors and destructors; Operator overloading and type conversions; Inheritance: single inheritance, multilevel inheritance, multiple inheritance; Polymorphism: function overloading, virtual functions, pure virtual functions; Templates: class templates, function templates, introduction to the standard template library (STL); Java: Nested and Inner classes; Local variable type inference; Strings: String, StringBuffer, StringBuilder; Inheritance: abstract class and anonymous subclasses, object class; Access protection with package; Interface; Exception; Thread: multithreading, Introduction to Java concurrency utilities; Generics and collections; Stream API and lambda expressions; Networking: ServerSocket, Socket;

### **20.6.6 Course Objectives**

The students are expected to:

- Understand the fundamentals of object-oriented programming.
- Demonstrate analytical and technical skills required to write codes in object-oriented programming languages (C++ and Java)
- Develop/Engineer new solutions and algorithms in object-oriented programming languages (C++ and Java) to solve real-life problems.

### **20.6.7 Knowledge required**

#### **Technical**

- Knowledge on C programming language is required.

#### **Mathematics**

- None

### **20.6.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO 1	Understand the fundamentals of object-oriented programming	PO12	C2, A1	Lecture, Group Discussion	Class Tests or Assignments and Final Exam
CO 2	Demonstrate analytical and technical skills required to write codes in object-oriented programming languages (C++ and Java)	PO1, PO2, and PO3	C5, A2	Lecture and Live Coding, Problem Solving	Class Tests or Assignments and Final Exam
CO 3	Develop/Engineer new solutions and algorithms in object-oriented programming languages (C++ and Java) to solve real-life problems	PO3, PO4, PO5, PO6, and PO12	C6, A5	Lecture and Live Coding, Problem Solving	Class Tests or Assignments and Final Exam

### 20.6.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√					√		√							√		
CO 2		√		√	√				√		√	√						√		√
CO 3		√		√	√	√			√		√	√			√			√		√

### 20.6.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Overview of Object-Oriented Programming Language, Overview of C++, Class	CO1
2	Array, Pointer, Reference, and Function Overloading	CO1
3	Operator Overloading	CO2
4	Inheritance, Virtual Function	CO2
5	Virtual Function, Basic C++ I/O	CO2
6	Templates, Introduction to the standard template library (STL)	CO3
7	Advanced C++	CO3
8	Introduction to Java, Console I/O, String, Arrays	CO1
9	Inheritance, Interface, Exceptions, Package	CO2
10	Threading, Introduction to Java concurrent library	CO3
11	Collections, Generics, Java Modules	CO3
12	Networking, Java I/O	CO3
13	Enumeration, Type Wrappers, Auto boxing	CO3
14	Lambda Expressions, Stream API	CO3

### 20.6.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.6.12 Distribution of Marks

Attendance:	10%
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.6.13 Textbook/ Reference

- Herbert Schildt, Teach Yourself C++, 3rd Edition.
- Herbert Schildt, Java: The Complete Reference, 12th Edition (covers Java 17)

### 20.7 Description of Course: CSE 108

#### PART A: General Information

20.7.1 Course Title : Object Oriented Programming Language

20.7.2 Type of Course : SESSIONAL

20.7.3 Offered to : DEPARTMENT OF CSE

20.7.4 Pre-requisite Course(s) :

#### PART B: Course Details

##### 20.7.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 107; A project using Java programming language.

##### 20.7.6 Course Objectives

The students are expected to:

- Understand the fundamentals of object-oriented programming.
- Demonstrate analytical and technical skills required to write codes in object-oriented programming languages (C++ and Java)
- Develop/Engineer new solutions and algorithms in object-oriented programming languages (C++ and Java) to solve real-life problems.

##### 20.7.7 Knowledge required

###### Technical

- Knowledge on C programming language is required.

###### Mathematics

- None

##### 20.7.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Understand the fundamentals of object-oriented programming	PO12	C2, A1, P1	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO2	Demonstrate analytical and technical skills required to write codes in object-oriented programming languages (C++ and Java)	PO1, PO3	C5, A2, P3	Lecture, Demonstration, and hands-on	Assignments, Quiz and Project

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO3	Develop/Engineer new solutions and algorithms in object-oriented programming languages (C++ and Java) to solve real-life problems	PO3, PO4, PO5, PO6, and PO12	C6, A5, P6	Lecture, Demonstration, and hands-on	Assignments and Project

### 20.7.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√					√		√							√		
CO 2		√		√	√				√		√	√						√		√
CO 3		√		√	√	√			√		√	√			√			√		√

### 20.7.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Lecture on Introduction to OOP, Structure vs. Class, Encapsulation	CO1
2	Online assignment on C++: Constructor and Destructor functions and function overloading Offline assignment on C++: Constructor and Destructor functions, function overloading	CO2
3	Offline assignment evaluation (C++)	CO2
4	Practice on C++: Dynamic allocation of objects, Function Overloading: Overloading Constructor functions, Copy Constructors, passing objects to and returning objects from functions Offline assignment on C++: Dynamic allocation of objects, Function Overloading: Overloading Constructor functions, Copy Constructors, Passing objects to and returning objects from functions	CO2
5	Offline assignment evaluation (C++) Offline assignment of C++: Operator Overloading	CO2
6	Offline assignment evaluation (C++)	CO2
7	Practice on C++: Inheritance; Function Overriding, Advanced Topics	CO3
8	Practice on Java: Introduction to Java, Java simple program, scanner, array, command line argument. Offline assignment on Java: class, scanner, array, command line argument	CO1
9	Offline assignment evaluation (Java)	CO2

Week	Topic	Course Outcomes
	Lecture on Java FX and Java Project Assignment	
10	Practice on Java: Inheritance, Interface, Exception	CO2
11	Practice on Java: Threading & Networking Project evaluation (Part 1)	CO2, CO3
12	Practice on Java: Collections & Generics	CO2
13	Quiz	CO1, CO2
14	Project evaluation (Part 2)	CO3

#### 20.7.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.7.12 Distribution of Marks

Attendance:	10%
Assignments/Projects:	70%
Quiz:	20%
Total:	100%

#### 20.7.13 Textbook/ Reference

- Herbert Schildt, Teach Yourself C++, 3rd Edition.
- Herbert Schildt, Java: The Complete Reference, 12th Edition (covers Java 17)

### 20.8 Description of Course CSE 200

#### PART A: General Information

20.8.1 Course Title : Technical Writing and Presentation

20.8.2 Type of Course : SESSIONAL

20.8.3 Offered to : DEPARTMENT OF CSE

20.8.4 Pre-requisite Course(s) :

#### PART B: Course Details

##### 20.8.5 Course Content (As approved by the Academic Council)

Issues of technical writing and effective oral presentation in Computer Science and Engineering; Writing styles of definitions, propositions, theorems and proofs; Preparation of reports, research papers, theses and books: abstract, preface, contents, bibliography and index; Writing of book reviews and referee reports; Writing tools: \LaTeX, etc.; Diagram drawing software; presentation tools.

### 20.8.6 Course Objectives

The students are expected to:

- i. The rules for scientific, mathematical and technical writing,
- ii. The best practice for technical presentation,
- iii. The use of modern software and tools for technical writing and presentation,
- iv. How to write research paper and theses, and
- v. Work individually and in groups.

### 20.8.7 Knowledge required

**Technical**

•

**Analytical**

### 20.8.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Use</b> modern tools for technical and mathematical writing and presentation	PO5	C3	Lectures, Lab Practice	Online Test
CO2	<b>Work</b> individually and in a team	PO9		Team work	Presentation & Assignment
CO3	<b>Write</b> technical report, research papers and theses	PO10	C6	Lecture	Assignment
CO4	<b>Present</b> scientific, technical and mathematical contents effectively	PO10	C3	Lecture	Presentation

### 20.8.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1									√	√						√				
CO 2																		√		
CO 3																	√			
CO 4																	√			

### 20.8.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1-2	Latex Tutorial	CO1
Week 3-4	Lecture of Technical Writing, Latex Tutorial	CO1, CO3
Week 5-6	Lecture on research paper and thesis writing, Tutorial on Drawing Tools	CO1, CO3
Week 7-8	Lecture on good presentation, Tutorial on Beamer	CO1, CO4
Week 9-10	Online on Latex & Beamer	CO1
Week 11-12	Presentation	CO2, CO4
Week 13-14	Quiz & Final Report Submission	CO1, CO2, CO3, CO4

### 20.8.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final QUIZ: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.
- Final Term Report: The students will be required to submit a final term report.

### 20.8.12 Distribution of Marks

Class Participation	10%
Use of modern technical writing and presentation tools	20%
Knowledge of technical and mathematical writing	15%
Presentation of research papers (Group Wise)	20%
Report Writing (Group Wise)	15%
Quiz	20%
Total	100%

### 20.8.13 Textbook/ Reference

- D. E. Knuth, T. Larrabee and P. M. Roberts, Mathematical Writing, The Mathematical Association of America, MAA Notes, 14, 1989.
- S. G. Krantz, A Primer of Mathematical Writing, American Mathematical Society, 1997.

## 20.9 Description of Course CSE 205

### PART A: General Information

20.9.1 Course Title	: DIGITAL LOGIC DESIGN
20.9.2 Type of Course	: THEORY
20.9.3 Offered to	: DEPARTMENT OF CSE
20.9.4 Pre-requisite Course(s)	: NONE

**PART B: Course Details**

**20.9.5 Course Content (As approved by the Academic Council)**

Digital logic: Boolean algebra, theorems and properties, logic gates and their truth tables, canonical and standard forms, Boolean functions, minimization techniques; Combinational logic: arithmetic and data handling logic, decoder and encoders, multiplexer and demultiplexers; Asynchronous and synchronous logic design: flip-flops and latches, race around problems, modes of asynchronous sequential circuits, clocked sequential circuits, state diagram, Mealy and Moore machines; state minimizations and assignments; Registers; Counters: asynchronous and synchronous counters and their applications; Memory and Programmable logic: internal construction of RAM and ROM, address multiplexing, PLA design.

**20.9.6 Course Objectives**

The students are expected to:

- Understand and formulate different number systems, binary logic, and circuits.
- Design combinational and sequential circuits.
- Develop state-machines circuits with flip-flops.

**20.9.7 Knowledge required**

**Technical**

- N/A

**Analytical**

- N/A

**20.9.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> and <b>formulate</b> different number systems, binary logic, and circuits.	PO1 and PO2	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design</b> combinational and sequential circuits.	PO3 and PO4	A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Develop</b> state-machines circuits with flip-flops.	PO2 and PO3	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

**20.9.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√						√	√						√				
CO 2		√	√						√	√					√		√			

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 3		√	√		√	√			√	√	√							√		√

### 20.9.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to Digital Logic Design Boolean Algebra and Logic Gates De Morgan's Theorems Logic gates and their truth tables	CO1
Week 2	Number System Canonical forms Minimization techniques	CO1
Week 3	Combinational Logic Arithmetic and data handling logic circuits	CO1 and CO2
Week 4	Decoders and Encoders	CO1 and CO2
Week 5	Multiplexers and Demultiplexers	CO1 and CO2
Week 6	PLA Design	CO1 and CO2
Week 7	Synchronous Sequential Logic	CO3
Week 8	Synchronous Sequential Logic (contd.)	CO3
Week 9	Registers and Counters	CO3
Week 10	Registers and Counters	CO3
Week 11	Asynchronous Sequential Logic	CO3
Week 12	Asynchronous Sequential Logic	CO3
Week 13	Asynchronous Sequential Logic	CO3
Week 14	Wrap up	CO1, CO2, and CO3

### 20.9.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.9.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.9.13 Textbook/ Reference

- Digital Design (5th edition), M. Morris Mano, Michael D. Ciletti
- Digital Design: A Pragmatic Approach, Everett L. Johnson, Mohammad A. Karim

### 20.10 Description of Course CSE 206

#### PART A: General Information

20.10.1 Course Title	: DIGITAL LOGIC DESIGN SESSIONAL
20.10.2 Type of Course	: SESSIONAL
20.10.3 Offered to	: DEPARTMENT OF CSE
20.10.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

##### 20.10.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 205 including 4-bit ALU design and implementation.

##### 20.10.6 Course Objectives

The students are expected to:

- Construct and analyze combinational and sequential circuits.
- Apply Boolean algebra techniques to digital circuit analysis.
- Experiment and develop laboratory reports based on experimental data.

##### 20.10.7 Knowledge required

###### Technical

- N/A

###### Analytical

- N/A

##### 20.10.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Construct</b> and <b>analyze</b> combinational and sequential circuits.	PO1 and PO2	C3	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO2	<b>Apply</b> Boolean algebra techniques to digital circuit analysis.	PO3 and PO4	A5	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO3	<b>Experiment</b> and <b>develop</b> laboratory reports based on experimental data.	PO6	P7	Lecture, Demonstration, and hands-on	Assignments and Quiz

**20.10.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√			√			√	√						√			√	
CO 2		√	√						√	√							√			
CO 3		√	√	√	√	√			√	√		√			√			√	√	

**20.10.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to Logisim and IC Series - 74XX	CO2
Week 2	Implementing circuits with basic gates	CO2
Week 3	Truth tables and simplification using Boolean Algebra	CO1
Week 4	Truth tables and K-maps	CO1
Week 5	Arithmetic circuit design	CO2
Week 6	Follow-up of previous topics	CO1 and CO2
Week 7	Circuit design using IC 7483	CO2
Week 8	Encoder and Decoder Circuits	CO2 and CO3
Week 9	Design using Multiplexers	CO2 and CO3
Week 10	Flip-Flops and Registers	CO2 and CO3
Week 11	Flip-Flops and Registers	CO2 and CO3
Week 12	Counter	CO1, CO2, and CO3
Week 13	Quiz	CO1, CO2, and CO3
Week 14	Follow-up	CO1, CO2, and CO3

### 20.10.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments: There will be ten Assignments
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

### 20.10.12 Distribution of Marks

Attendance:	10 %
Assignments:	60%
Quiz Exam:	30%
Total:	100%

### 20.10.13 Textbook/ Reference

- a. Microprocessor Data Handbook.
- b. Digital Logic and Computer Design by M. Morris Mano
- c. Digital Design by E. L. Johnson and M. A. Karim
- d. Digital Fundamentals by Thomas L. Floyd
- e. Switching and Finite Automata Theory by ZVI Kohavi

## 20.11 Description of Course CSE 207

### PART A: General Information

20.11.1 Course Title	: DATA STRUCTURES AND ALGORITHMS II
20.11.2 Type of Course	: THEORY
20.11.3 Offered to	: DEPARTMENT OF CSE
20.11.4 Pre-requisite Course(s)	: CSE 105

### PART B: Course Details

#### 20.11.5 Course Content (to be approved by the Academic Council)

Graph algorithms: minimum spanning tree algorithms, shortest path algorithms, maximum flow and maximum bipartite matching; Advanced data Structures: balanced binary search trees (AVL trees, red-black trees, splay trees), skip list, advanced heaps (Fibonacci heaps, binomial heaps); Hashing; NP-completeness; NP-hard and NP-complete problems; Coping with hardness: backtracking, branch and bound, approximation algorithms; String matching algorithms.

#### 20.11.6 Course Objectives

The students are expected to:

- understand and analyze performance of algorithms in terms of time and space,
- evaluate the correctness of algorithms,
- formulate various algorithmic problems and design efficient algorithms to solve those problems,
- solve real world problems using various data structures and algorithms,
- utilize advanced data structures for efficient implementations of algorithms,
- understand various complexity classes of algorithmic problems and compare between them, and
- design backtracking, branch and bound and efficient approximation algorithms to cope with hard combinatorial problems.

#### 20.11.7 Knowledge required

##### Technical

- Programming language

##### Mathematics

- Discrete mathematics

### 20.11.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> performance of algorithms in terms of time and space and <b>evaluate</b> the correctness of algorithms	PO1, PO2, PO4	C6, A5	Lecture, Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Formulate</b> various algorithmic problems and <b>utilize</b> efficient data structures and algorithms to solve real world problems	PO2, PO3, PO5, PO6, PO12	C5, A2	Lecture, Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Understand</b> various complexity classes of algorithmic problems and <b>compare</b> between them	PO4, PO9, PO12	C4, A3	Lecture, Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam

### 20.11.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√		√			√	√		√			√			√	√		√
CO 2		√	√						√	√		√				√				
CO 3		√						√	√											

### 20.11.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Overview of BFS and DFS and their applications	CO1, CO2
Week 2	Minimum spanning tree	CO1, CO2
Week 3	Single source shortest paths	CO1, CO2
Week 4	All pair shortest paths	CO1, CO2

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 5	Maximum flow and maximum bipartite matching	CO1
Week 6	Binomial heap and fibonacci heap	CO3
Week 7	AVL tree, skip list	CO3
Week 8	Red-black tree	CO3
Week 9	Splay tree	CO3
Week 10	Hashing	CO3
Week 11	NP, NP-complete and NP-hard problems	CO1, CO3
Week 12	Branch and bound, backtracking	CO1, CO2
Week 13	Approximation algorithms	CO1, CO2
Week 14	String matching algorithms	CO2

#### **20.11.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.11.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.11.13 Textbook/ Reference**

- Introduction to Algorithms by Thomas H. Cormen, Charles Leiserson, Ron Rivest, and Cliff Stein
- Data Structures and Algorithms in C++ by Michael T. Goodrich, Roberto Tamassia, and David M. Mount
- Algorithm Design by Jon Kleinberg and Eva Tardos

### **20.12 Description of Course CSE 208**

#### **PART A: General Information**

**20.12.1 Course Title** : DATA STRUCTURES AND ALGORITHMS II SESSIONAL

**20.12.2 Type of Course** : SESSIONAL

**20.12.3 Offered to** : DEPARTMENT OF CSE

**20.12.4 Pre-requisite Course(s)** : N/A

## **PART B: Course Details**

### **20.12.5 Course Content (to be approved by the Academic Council)**

Graph algorithms: minimum spanning tree algorithms, shortest path algorithms, maximum flow and maximum bipartite matching; Advanced data Structures: balanced binary search trees (AVL trees, red-black trees, splay trees), skip list, advanced heaps (Fibonacci heaps, binomial heaps); Hashing; NP-completeness; NP-hard and NP-complete problems; Coping with hardness: backtracking, branch and bound, approximation algorithms; String matching algorithms.

### **20.12.6 Course Objectives**

The students are expected to:

- understand and analyze performance of algorithms in terms of time and space, and evaluate the correctness of algorithms,
- formulate various algorithmic problems and design efficient algorithms to solve those problems,
- solve real world problems using various data structures and algorithms,
- utilize advanced data structures for efficient implementations of algorithms,
- understand various complexity classes of algorithmic problems and compare between them, and
- design backtracking, branch and bound and efficient approximation algorithms to cope with hard combinatorial problems.

### **20.12.7 Knowledge required**

#### **Technical**

- Programming language

#### **Mathematics**

- Discrete mathematics

### **20.12.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand and analyze</b> performance of algorithms in terms of time and space and <b>evaluate</b> the correctness of algorithms	PO1, PO2, PO4	C4, A5	Lecture, problem solving, coding and development	Assignments or Projects, Viva, Quiz
CO2	<b>Formulate</b> various algorithmic problems and <b>utilize</b> efficient data structures and algorithms to solve real world problems	PO2, PO3, PO5, PO6, PO12	C5, A2, P5	Lecture, problem solving, coding and development	Assignments or Projects, Viva, Quiz
CO3	<b>Understand</b> various complexity classes of algorithmic problems and <b>compare</b> between them	PO4, PO9, PO12	C4, A3, P3	Lecture, problem solving, and hands-on	Assignments or Projects, Viva, Quiz

### 20.12.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√		√			√	√			√			√					
CO 2		√			√	√	√		√		√			√	√			√	√	√
CO 3		√	√	√				√	√			√						√		

### 20.12.10 Lecture/ Activity Plan

Week	Topics	Corresponding CO(s)
Week 1	Introduction - Basic Graph Algorithms	CO1
Week 2	Applications of BFS and DFS	CO2
Week 3	Minimum Spanning Tree	CO1, CO2
Week 4	Single Source Shortest Paths	CO1, CO2
Week 5	All-Pair Shortest Paths	CO1, CO2
Week 6	Maximum Flow and Maximum Bipartite Matching	CO1, CO2
Week 7	Applications of graph algorithms	CO1, CO2, CO3
Week 8	Advanced Data Structure I – Binomial Heaps and/or Fibonacci Heaps	CO1, CO2
Week 9	Advanced Data Structure II–AVL Tree and/or Red Black Tree	CO1, CO2
Week 10	Hashing	CO1, CO2
Week 11	NP, NP-complete and NP-hard problems	CO1, CO2, CO3
Week 12	Branch and bound, backtracking	CO1, CO2
Week 13	Approximation algorithms and/or String matching algorithms	CO1, CO2
Week 14	Quiz	CO1, CO2, CO3

### 20.12.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Offline/Online Assignments and Project: Offline/Online assignments will be given in every class. A project may also be included. All these will be considered in final evaluation.
- Quiz: A comprehensive quiz will be held on the last week of the semester as per the institutional ordinance.

### 20.12.12 Distribution of Marks

Attendance:	5-10 %
Offline/Projects and Viva:	25-40%
Online and Viva:	25-40%
Quiz:	20-40%
Total:	100%

### 20.12.13 Textbook/ Reference

- Introduction to Algorithms by Thomas H. Cormen, Charles Leiserson, Ron Rivest, and Cliff Stein
- Data Structures and Algorithms in C++ by Michael T. Goodrich, Roberto Tamassia, and David M. Mount
- Algorithm Design by Jon Kleinberg and Eva Tardos

### 20.13 Description of Course CSE 209

#### PART A: General Information

20.13.1 Course Title : COMPUTER ARCHITECTURE

20.13.2 Type of Course : THEORY

20.13.3 Offered to : DEPARTMENT OF CSE

20.13.4 Pre-requisite Course(s) : CSE 205

#### PART B: Course Details

#### 20.13.5 Course Content (As approved by the Academic Council)

Information representation; Measuring computer performance; Instruction set architectures: MIPS/ ARM, operations and operands of computer hardware, representing Instructions in machine instructions; Computer Arithmetic: Integer and floating point operations; Processor design: single cycle datapath and control, pipelined datapath and control, Hazards, Exceptions; Instruction-Level Parallelism: multiple issue, speculation, superscalar and dynamic pipelining, out-of-order execution, register renaming; Memory organization: cache, cache performance, cache optimization techniques, virtual memory; Multiprocessors: introduction to SISD, MIMD, SIMD, SPMD, vector; Parallel architectures: data level parallelism, performance, GPU architecture.

#### 20.13.6 Course Objectives

The students are expected to:

- Investigate different aspects of MIPS and ARM instruction set
- Understand the details of the processor design.
- Study computer memory organizations in depth.
- Compare and analyze different types of multi processors and parallel processors.

#### 20.13.7 Knowledge required

##### Technical

- System design and development
- Language Programming

##### Analytical

- None

### 20.13.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the basics of instruction set architectures.	-	C2	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design</b> different parts of a computer processor and <b>compare</b> the aspects of different multiprocessors	PO3 and PO5	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Apply</b> parallelism to single and parallel processors.	PO1 and PO7	P6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.13.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1	√	√	√	√					√							√				
CO 2		√	√	√	√	√			√	√	√	√	√		√	√	√	√		√
CO 3		√		√	√	√				√		√	√		√			√	√	√

### 20.13.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Information representation; Measuring computer performance;	CO1
Week 2	Instruction set architectures: MIPS/ ARM, operations and operands of computer hardware	CO1
Week 3	Representing Instructions in machine instructions	CO1
Week 4	Computer Arithmetic: Integer operations	CO1
Week 5	Computer Arithmetic: Floating point operations	CO1
Week 6	Processor design: single cycle datapath and control	CO2
Week 7	Processor design: pipelined datapath and control, Hazards, Exceptions	CO2
Week 8	Instruction-Level Parallelism: multiple issue, speculation, superscalar and dynamic pipelining, out-of-order execution, register renaming	CO2 and CO3

Week	Lecture Topics	Corresponding CO(s)
Week 9	Memory organization: cache, cache performance, cache optimization techniques, virtual memory	CO2
Week 10	Multiprocessors: SISD, MIMD	CO2
Week 11	Multiprocessors: SIMD, SPMD, vector	CO2
Week 12	Parallel architectures: data level parallelism	CO3
Week 13	Parallel architectures: GPU architecture	CO3
Week 14	Revision	CO1, CO2, and CO3

#### 20.13.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.13.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.13.13 Textbook/ Reference

- Computer Organization and Design by David A. Patterson and John L. Hennessy
- Computer Organization and Design ARM Edition by David A. Patterson and John L. Hennessy

### 20.14 Description of Course CSE 210

#### PART A: General Information

20.14.1 Course Title	: COMPUTER ARCHITECTURE SESSIONAL
20.14.2 Type of Course	: SESSIONAL
20.14.3 Offered to	: DEPARTMENT OF CSE
20.14.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

#### 20.14.5 Course Content (As approved by the Academic Council)

Sessional based on CSE209; A short project work will be included such as the following: Booth Multiplier Design and Implementation, Small Microprocessor Design and Implementation, FPGA programming

### 20.14.6 Course Objectives

The students are expected to:

- Investigate different aspects of MIPS and ARM instruction set
- Understand the details of the processor design.
- Study computer memory organizations in depth.
- Compare and analyze different types of multi processors and parallel processors.

### 20.14.7 Knowledge required

#### Technical

- System design and development
- Language Programming

#### Analytical

- None

### 20.14.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> and <b>apply</b> MIPS programming.	PO1 and PO2	C3	Lecture, Demonstration, and hands-on	Quiz
CO2	<b>Implement</b> hardware systems applying the basics of logical design.	PO3 and PO4	C3, A5	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO3	<b>Design</b> and <b>develop</b> different processing components.	PO6	C6, P7	Lecture, Demonstration, and hands-on	Project and Quiz

### 20.14.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1	√	√	√	√					√	√	√					√				
CO2		√	√	√	√	√			√	√	√	√			√	√	√	√		√
CO3		√		√	√	√			√	√	√	√	√		√	√		√	√	√

### 20.14.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1-2	Introductory lecture on course overview.	CO1
Week 3-4	Demonstration class on MIPS programming. Lecture on Assignment 1.	CO1 and CO2

Week	Lecture Topics	Corresponding CO(s)
Week 5-6	Evaluation of Assignment 1. Lecture on Assignment 2.	CO2
Week 7-8	Evaluation of Assignment 2.	CO2
Week 9-10	Lecture class on Project.	CO3
Week 11-12	Evaluation of the Project.	CO3
Week 13-14	Discussion and Revision Class;	CO1, CO2, and CO3

#### 20.14.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.14.12 Distribution of Marks

Attendance:	10 %
Assignments and Projects:	70%
Quiz Exam:	20%
Total:	100%

#### 20.14.13 Textbook/ Reference

- Computer Organization and Design by David A. Patterson and John L. Hennessy
- Computer Organization and Design ARM Edition by David A. Patterson and John L. Hennessy

### 20.15 Description of Course CSE 211

#### PART A: General Information

20.15.1 Course Title : THEORY OF COMPUTATION

20.15.2 Type of Course : THEORY

20.15.3 Offered to : DEPARTMENT OF CSE

20.15.4 Pre-requisite Course(s) : NONE

#### PART B: Course Details

##### 20.15.5 Course Content (As approved by the Academic Council)

Regular languages; Finite automata: deterministic finite automata, nondeterministic finite automata, equivalence and conversion between deterministic and nondeterministic finite automata; Regular expressions: equivalence with finite automata; Nonregular languages: pumping lemma for regular languages; Context free languages: context free grammars, ambiguity, Chomsky normal form, pumping lemma for context free grammars; Pushdown automata: equivalence with context-free grammar; Turing machines: basic machines, variants of Turing machines, computing with Turing machines; Computability: Church-Turing thesis, Hilbert's problems, diagonalization language; Decidability: decidable languages, undecidability, halting problem, reducibility; Complexity: time complexity, class P, class NP, NP-completeness, Cook's theorem, space complexity, Savitch's theorem.

##### 20.15.6 Course Objectives

The students are expected to:

- Study of abstract (mathematical) machines and the computation problems solvable by the automaton.
- Learn formal languages, their formulation, usage of these languages to specify computable problems.
- Learn the mathematical abstraction of computation using a Turing Machine.
- Develop proof techniques to find computability and complexity of problems.
- Analyse the fundamental capabilities and limitations of computers.

### 20.15.7 Knowledge required

#### Technical

- None

#### Mathematics

- Basic Mathematics (HSC Level)

### 20.15.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand and analyze</b> underlying notions of types of languages, computability, and complexity	PO12	C2, A4	Lecture, exercise	Class Tests or Assignments, and Final Exam
CO2	<b>Analyze</b> languages using regular expression and context-free grammar and <b>evaluate</b> different ways to compute them through automata and Turing machine.	PO1, PO2, PO3 and PO4	C4, A5	Lecture, exercise	Class Tests or Assignments, and Final Exam
CO3	<b>Develop</b> methodologies to prove computability and assess complexity of problems.	PO1, PO2 and PO4	C3	Lecture, exercise	Class Tests or Assignments, and Final Exam

### 20.15.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√					√											
CO 2		√	√		√				√			√			√					√
CO 3		√							√		√	√							√	√

### 20.15.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to Automata theory, Finite Automata	CO1, CO2, CO3

Week	Lecture Topics	Corresponding CO(s)
Week 2	Finite Automata	CO1, CO2, CO3
Week 3	Finite Automata	CO1, CO2, CO3
Week 4	Regular Expression	CO1, CO2, CO3
Week 5	Context-Free Grammars and Languages	CO1, CO2, CO3
Week 6	Context-Free Grammars and Languages	CO1, CO2, CO3
Week 7	Context-Free Grammars and Languages	CO1, CO2, CO3
Week 8	Push Down Automata	CO1, CO2, CO3
Week 9	Push Down Automata	CO1, CO2, CO3
Week 10	Turing Machines	CO1, CO2, CO3
Week 11	Turing Machines	CO1, CO2, CO3
Week 12	Turing Machines	CO1, CO2, CO3
Week 13	Undecidability	CO1, CO2, CO3
Week 14	Complexity	CO1, CO2, CO3

#### 20.15.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.15.12 Distribution of Marks

Attendance:	10%
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.15.13 Textbook/ Reference

- Introduction to the Theory of Computation (by Michael Sipser)
- Introduction to Automata Theory, Languages, and Computation (by John E. Hopcroft, Rajeev Motwani, and Jeffrey D. Ullman)
- Elements of the Theory of Computation (by Harry R. Lewis and Christos H. Papadimitriou)

### 20.16 Description of Course CSE 213

#### PART A: General Information

**20.16.1 Course Title** : Software Engineering  
**20.16.2 Type of Course** : THEORY  
**20.16.3 Offered to** : DEPARTMENT OF CSE  
**20.16.4 Pre-requisite Course(s)** : None

**PART B: Course Details**

**20.16.5 Course Content (As approved by the Academic Council)**

Software engineering: professional software development, ethics; Software development life cycle; Requirements analysis: functional and non-functional requirements, requirement elicitation and specification, use cases, requirement validation; System modelling and design: unified modelling language (UML) diagrams, user interface design; Design patterns: Creational, Structural, and Behavioural Patterns; Development: Code smell, code review and documentation, version control; Testing and debugging: unit testing, test doubles, integration testing, regression testing, white box and black box testing, Performance and Security Testing, A/B testing, bug reporting;

**20.16.6 Course Objectives**

The students are expected to:

- Learn software requirement analysis and design techniques and Design software.
- Learn and apply software design patterns in appropriate scenarios.
- Learn and apply software testing techniques and tools.

**20.16.7 Knowledge required**

**Technical**

- Databases and Object-Oriented Programming.

**Analytical**

- Problem analysis.

**20.16.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Learn</b> software requirement analysis and design techniques and <b>Design</b> software maintaining ethics	PO1, PO2, PO3, PO8	C6	Lecture	Class test, assignment, final exam
CO2	<b>Learn and apply</b> software design patterns in appropriate scenarios	PO1, PO2, PO3	C3	Lecture	Class test, assignment, final exam
CO3	<b>Learn and apply</b> software testing techniques and tools	PO1, PO5	C3	Lecture	Class test, assignment, final exam

**20.16.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√	√	√			√	√	√			√	√	√				√
CO 2		√		√	√	√			√	√		√			√					√
CO 3		√		√	√	√			√			√			√					√

#### 20.16.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Professional software development, ethics; Software development life cycle; Requirements analysis: functional and non-functional requirements	CO1
2	Requirement elicitation and specification, use cases, requirement validation	
3	Unified modeling language (UML) diagrams: Class and Collaboration Diagram	CO1
4	Sequence diagram, State diagram, user interface design	CO1
5	Intro to Design Pattern (DP), Creational DP: Factory, Abstract Factory, Singleton, Builder, etc.	CO2
6	Structural DP: Adapter, Decorator, Façade, Composite, etc.	CO2
7	Behavioral DP: State, Strategy, Observer, etc.	CO2
8	Behavioral DP: Chain of Responsibility, Mediator, etc.	CO2
9	Additional design patterns and review of previously studied patterns	CO2
10	Code Smell and Code review	CO3
11	Documentation and Version control	CO3
12	Software Testing Basics, Different types of software white and black box testing methods	CO3
13	Equivalence Partitioning, Unit testing and other Methods/concepts	CO3
14	Automated Testing, Security and Performance Testing	CO3

#### 20.16.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.16.12 Distribution of Marks

Attendance: 10 %

Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.16.13 Textbook/ Reference

- Software Engineering at Google: Lessons Learned from Programming Over Time by Titus Winters, Tom Manshreck, Hyrum Wright
- Engineering Software as a Service: An Agile Approach Using Cloud Computing by Armando Fox, David Patterson
- Software Engineering: A Practitioner’s Approach by Roger S. Pressman, Bruce Maxim
- Software Engineering by Ian Sommerville
- The Unified Modeling Language User Guide by Booch, Rumbaugh, and Jacobson
- Design Patterns: Elements of Reusable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

### 20.17 Description of Course CSE 214

#### PART A: General Information

20.17.1 Course Title : Software Engineering Sessional

20.17.2 Type of Course : SESSIONAL

20.17.3 Offered to : DEPARTMENT OF CSE

20.17.4 Pre-requisite Course(s) : None

#### PART B: Course Details

20.17.5 Course Content (As approved by the Academic Council)  
Sessional based on CSE 213 (Software Engineering).

#### 20.17.6 Course Objectives

The students are expected to

- Design software applying requirement analysis and design techniques
- Apply software design patterns in appropriate scenarios
- Apply software testing techniques and tools

#### 20.17.7 Knowledge required

##### Technical

- Databases and Object Oriented Programming.

##### Analytical

#### 20.17.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Design</b> software applying requirement analysis and design techniques	PO1, PO2, PO3	C3	Lecture and demonstration	Assignment, Quiz

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO2	<b>Apply</b> software design patterns in appropriate scenarios	PO1, PO2, PO3	C3	Lecture and demonstration	Assignment, Quiz
CO3	<b>Apply</b> software testing techniques and tools	PO1, PO5	C3	Lecture and demonstration	Assignment, Quiz

### 20.17.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√	√	√			√	√				√		√				√
CO 2		√		√	√	√			√		√	√			√					√
CO 3		√		√	√	√			√		√	√	√		√					√

### 20.17.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Discussion on UML design techniques and tools and distribution of assignments (specific software module) to all the groups.	CO1
2	Presentation on UML design (BPMN, Use case, Class, Collaboration, Sequence, State diagrams) of a software module.	CO1
3	Lab on creational design pattern.	CO2
4	Lab on structural design pattern.	CO2
5	Lab on behavioral design pattern.	CO2
6	Lab on Unit testing.	CO3
7	Lab on automated functional and load testing.	CO3

### 20.17.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester..

### 20.17.12 Distribution of Marks

Attendance:	10 %
Assignments/Projects:	60%
Final Quiz:	30%
Total:	100%

### 20.17.13 Textbook/ Reference

- Software Engineering at Google: Lessons Learned from Programming Over Time by Titus Winters, Tom Manshreck, Hyrum Wright
- Engineering Software as a Service: An Agile Approach Using Cloud Computing by Armando Fox, David Patterson
- Software Engineering: A Practitioner's Approach by Roger S. Pressman, Bruce Maxim
- Software Engineering by Ian Sommerville
- The Unified Modeling Language User Guide by Booch, Rumbaugh, and Jacobson
- Design Patterns: Elements of Reusable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

## 20.18 Description of Course CSE 215

### PART A: General Information

20.18.1 Course Title	: DATABASE
20.18.2 Type of Course	: THEORY
20.18.3 Offered to	: DEPARTMENT OF CSE
20.18.4 Pre-requisite Course(s)	: NONE

### PART B: Course Details

#### 20.18.5 Course Content (As approved by the Academic Council)

Concepts of database systems; Introduction to the relational model; Database design using the Entity-Relationship model; Functional dependencies and normalization; Query Languages: Relational algebra, SQL; Constraints, functions and procedures, triggers; Functional dependencies and normalization; Data storage architectures; Indexing: primary and secondary indices, B+ tree index, hash indices; Query processing and optimization; Transaction management; Concurrency control; Recovery system; Introduction to parallel and distributed databases; Introduction to Big data analytics; NoSQL databases.

#### 20.18.6 Course Objectives

The students are expected to:

- Understand the concept of Database Systems as a persistent storage of data
- Design of database consisting of tables, indexes and relationships
- Understand the syntax of the database query language
- Analyse whether the design of the database or the query is optimal in terms redundancy
- Understand the necessity of managing concurrent transactions and its support in database management system
- Analyse the application of different types of databases such as relational/non-relational database, centralized/parallel/distributed database
- Understand the concept and technique of state of the Big Data Analytics

#### 20.18.7 Knowledge required

##### Technical

- Introductory knowledge on Computer Programming is required.

##### Mathematics

- Discrete Mathematics

### 20.18.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the concept of Database Systems as a persistent storage of data and <b>analyze</b> the application of different types of databases such as relational/non-relational database, centralized/parallel/distributed database.	PO1, PO2, PO4	C3, A1	Lecture	Class Tests or Assignments and Projects in CSE 216, and Final Exam
CO2	<b>Analyze</b> the design of database and understand the syntax of Structured Query Language for creating, manipulating, and querying database.	PO1, PO2, PO3, PO5	C5, A2	Lecture, Demonstration, and hands-on	Class Tests or Assignments and Projects in CSE 216, and Final Exam
CO3	<b>Evaluate</b> the optimality of the design of the database or the query.	PO1, PO2, PO7	C4, A2	Lecture	Class Tests or Assignments and Projects in CSE 216, and Final Exam
CO4	<b>Understand</b> the concept of transaction and apply it for different problems.	PO1, PO2, PO3	C4, A2	Lecture, Demonstration	Class Tests or Assignments and Projects in CSE 216, and Final Exam

### 20.18.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√					√	√	√					√				
CO 2		√	√	√	√				√	√	√		√			√	√			√
CO 3		√	√	√	√				√	√	√		√		√	√	√			√
CO 4		√	√	√		√			√	√	√				√	√				√

### 20.18.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Concepts of database systems; Introduction to the relational model;	CO1
2	Database design using the Entity-Relationship model;	CO1, CO2
3	Functional dependencies and normalization;	CO3
4	Query Languages: Relational algebra, SQL;	CO2
5	Constraints, functions and procedures, triggers;	CO1, CO2
6	Data storage architectures	CO1
7	Indexing: primary and secondary indices	CO1, CO2, CO3
8	B+ tree index, hash indices	CO3
9	Query processing and optimization	CO3
10	Transaction management; Concurrency control;	CO1, CO4
11	Recovery system	CO1, CO4
12	Introduction to parallel and distributed databases	CO1
13	Introduction to Big data analytics	CO1
14	NoSQL databases	CO1

#### 20.18.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.18.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.19 Description of Course CSE 216

##### PART A: General Information

20.19.1 Course Title : DATABASE SESSIONAL

20.19.2 Type of Course : SESSIONAL

20.19.3 Offered to : DEPARTMENT OF CSE

20.19.4 Pre-requisite Course(s) : NONE

##### PART B: Course Details

### 20.19.5 Course Content

Oracle SQL: Selection, Aggregation, Join, Sub-query; Oracle DML and DDL Statements; Oracle PL/SQL: Functions, Triggers, and Procedures; Design of a Database; Designing and Implementing multi-platform Database.

### 20.19.6 Course Objectives

The students are expected to:

- Understand the design of database for different use cases.
- Design databases and queries with focus on optimality and standard engineering practice.
- Develop software systems that utilize a database.

### 20.19.7 Knowledge required

#### Technical

- Computer Programming

### 20.19.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the design of database for different use cases.	-	C2	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam
CO2	<b>Design</b> databases and queries with focus on optimality and standard engineering practice.	PO4, PO5	C4	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam
CO3	<b>Develop</b> software systems that utilize a database.	PO6, PO9, PO10, PO11	C6	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam

### 20.19.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√		√						√					√				
CO 2		√		√	√	√			√	√	√	√			√	√				√
CO 3		√		√	√	√			√	√	√		√	√	√	√	√			√

### 20.19.10 Lecture/ Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	ERD Practice, Oracle database installation	CO1
Week 2	ERD Online	CO1
Week 3	Project group formation, Basic SQL Lecture	CO1, CO2, CO3
Week 4	Basic SQL Online, Project Finalization	CO1, CO2
Week 5	Advanced SQL Lecture and Practice	CO1, CO2
Week 6	Advanced SQL Online, ERD Lecture	CO1, CO2
Week 7	Project Design Review and Presentation	CO1, CO3
Week 8	PL/SQL Lecture	CO1, CO2
Week 9	Project Update 1	CO1, CO3
Week 10	PL/SQL Function and Procedure Online	CO1, CO2
Week 11	Project Update 2	CO1, CO3
Week 12	PL/SQL Triggers Online	CO1, CO2
Week 13	Final Project Submission	CO1, CO3
Week 14	Final Quiz	CO1, CO2, CO3

#### 20.19.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Online/ Offline Assignments: There will be 3/4 online or offline assignments
- Projects: There will be a project related to topics covered in the sessional
- Final Quiz: A comprehensive Final Quiz will be held at the end of the semester as per the institutional ordinance.

#### 20.19.12 Distribution of Marks

Attendance:	10%
Online Assignment:	25%
Offline Assignment	25%
Final Project:	20%
Final Quiz:	20%
<b>Total:</b>	<b>100%</b>

#### 20.20 Description of Course CSE 219

##### PART A: General Information

**20.20.1 Course Title** : SIGNALS AND LINEAR SYSTEMS

**20.20.2 Type of Course** : THEORY

**20.20.3 Offered to** : DEPARTMENT OF CSE

**20.20.4 Pre-requisite Course(s)** : MATH 141

## **PART B: Course Details**

### **20.20.5 Course Content (As approved by the Academic Council)**

Introduction to signals and systems: continuous and discrete-time signals, basic operation on signals, unit impulse and unit step function, systems and their properties; Linear time invariant (LTI) systems: continuous and discrete-time LTI systems, convolution integral and convolution sum, properties of LTI systems; Time domain analysis of LTI systems: differential and difference equations; Frequency domain analysis of LTI systems: Fourier series representation of continuous and discrete-time periodic signals, properties of continuous and discrete-time Fourier series, Fourier series and LTI systems; Continuous and discrete-time Fourier transform: representation of aperiodic signals, Fourier transform for periodic signals, properties, duality; Time and frequency characterization of signals and systems; Sampling: the sampling theorem, interpolation, aliasing; Laplace transform: properties, inverse Laplace transform, analysis and characterization of LTI systems; Z-transform: properties, inverse Z-transform, analysis of LTI systems.

### **20.20.6 Course Objectives**

The students are expected to:

1. Learn continuous and discrete-time signals, linear systems and their properties.
2. Learn Fourier, DFT, Laplace and Z transforms
3. Apply the principles of Fourier DFT, Laplace and Z transforms for analyzing signals and linear systems.

### **20.20.7 Knowledge required**

#### **Technical**

- Basic of calculus and differential equations

### **20.20.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> continuous and discrete-time signals, linear systems, their properties, and the sampling process	-	C2	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Apply</b> mathematical concepts for analysis of signals and linear systems	PO1	C3	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Analyze</b> continuous and discrete-time signals, and linear systems in time and frequency domains	PO1, PO2	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

**20.20.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√						√				
CO 2		√	√	√	√	√			√	√				√			√			
CO 3		√	√	√	√	√			√	√					√			√		√

**20.20.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to continuous and discrete-time signals and linear systems	CO1
Week 2	Basic operation on signals, unit impulse and unit step function, systems and their properties	CO1
Week 3	Linear time invariant (LTI) systems: continuous and discrete-time LTI systems, convolution integral and convolution sum	CO1, CO2
Week 4	Properties of LTI systems, representation by differential and difference equations	CO1, CO2
Week 5	Continuous-time Fourier series and Fourier transform, properties	CO2
Week 6	Continuous-time Fourier series and Fourier transform, properties	CO2
Week 7	Discrete-time Fourier transform and properties	CO2
Week 8	Time and frequency characterization of signals and systems	CO2, CO3
Week 9	Time and frequency characterization of signals and systems	CO2, CO3
Week 10	Sampling: the sampling theorem	CO1, CO3
Week 11	Interpolation, aliasing	CO1, CO3
Week 12	Laplace transform: properties, inverse Laplace transform, analysis and characterization of LTI systems	CO2, CO3
Week 13	Z-transform: properties, inverse Z-transform, analysis of LTI systems	CO2, CO3
Week 14	Review	CO1, CO2, CO3

**20.20.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.

- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.20.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.20.13 Textbook/ Reference

- Oppenheim, Alan V., and A. S. Willsky. Signals and Systems.

### 20.21 Description of Course CSE 220

#### PART A: General Information

20.21.1 Course Title	: SIGNALS AND LINEAR SYSTEMS SESSIONAL
20.21.2 Type of Course	: SESSIONAL
20.21.3 Offered to	: DEPARTMENT OF CSE
20.21.4 Pre-requisite Course(s)	: None

#### PART B: Course Details

#### 20.21.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 219.

#### 20.21.6 Course Objectives

The students are expected to:

- Learn continuous and discrete-time signals, linear systems and their properties.
- Learn Fourier, DFT, Laplace and Z transforms
- Apply the principles of Fourier DFT, Laplace and Z transforms for analyzing signals and linear systems.

#### 20.21.7 Knowledge required

##### Technical

- Basic of calculus and differential equations

**20.21.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> continuous and discrete-time signals, linear systems, their properties, and the sampling process	-	C2	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO2	<b>Apply</b> mathematical concepts and tools for analysis of signals and linear systems	PO1, PO5	C3	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO3	<b>Analyze</b> continuous and discrete-time signals, and linear systems in time and frequency domains	PO1, PO2	C4	Lecture, Demonstration, and hands-on	Assignments and Quiz

**20.21.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√	√				√				√
CO 2		√	√	√	√	√			√	√	√	√				√	√			
CO 3			√	√	√	√		√	√	√	√				√	√		√		√

**20.21.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1-2	Course Overview + Continuous-time and Discrete-time representation of basic signals	CO1
Week 3-4	Convolution, difference equation	CO1 and CO2
Week 5-6	Fourier series and transform	CO1, CO2 and CO3
Week 7-8	Discrete-time Fourier transform	CO1 and CO2
Week 9-10	Filtering, Sampling	CO1 and CO2
Week 11-12	Laplace, Z transform	CO1 and CO2
Week 13-14	Quiz	CO1, CO2 and CO3

**20.21.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Assignments: There will be some online and offline assignments
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.21.12 Distribution of Marks

Attendance:	10 %
Assignments:	70%
Quiz Exam:	20%
Total:	100%

#### 20.21.13 Textbook/ Reference

- Oppenheim, Alan V., and A. S. Willsky. Signals and Systems.

### 20.22 Description of Course CSE 301

#### PART A: General Information

20.22.1 Course Title : MATHEMATICS FOR COMPUTING AND DATA SCIENCE

20.22.2 Type of Course : THEORY

20.22.3 Offered to : DEPARTMENT OF CSE

20.22.4 Pre-requisite Course(s) : MATH 243

#### PART B: Course Details

#### 20.22.5 Course Content (As approved by the Academic Council)

Advanced counting and discrete probability: recurrences and sums, binomial coefficients, special numbers, generating functions, probability generating function; Random variables: discrete and continuous random variables, multivariate distributions, moment generating functions; Conditional probability and conditional expectation; Probability bounds: Markov and Chebyshev inequalities, Chernoff bound, Cauchy-Schwarz and Jensen inequalities; Convergence of random variables: law of large numbers, central limit theorem; Statistical inference: parametric and nonparametric models, point estimation, confidence intervals, bootstrapping; Parametric inference: maximum likelihood estimation; Bayesian inference: maximum a posteriori estimation; Hypothesis testing: permutation test, likelihood ratio test, multiple testing; Stochastic processes: Poisson process, Gaussian process; Markov chains: discrete-time, continuous-time, birth-death process; Queuing theory: exponential models, open and closed queuing network, applications of queuing models.

#### 20.22.6 Course Objectives

Students are expected to:

- Apply data science and mathematical techniques methods to various computing problems
- Analyze computing problems from different domains using mathematical tools and techniques
- Develop data science, data engineering and mathematical models for real life problems.

#### 20.22.7 Knowledge required

##### Technical

- Probability and Statistics

##### Analytical

- Problem formulation and solving.

#### 20.22.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Apply</b> data science and mathematical techniques methods to various computing problems	PO5	C3	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Analyze</b> computing problems from different domains using mathematical tools and techniques	PO4	C4	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO3	<b>Develop</b> data science, data engineering and mathematical models for real life problems	PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

#### 20.22.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√		√		√
CO 2		√	√	√	√	√		√	√	√	√	√			√	√		√		√
CO 3		√	√	√	√	√		√	√	√	√	√	√		√	√	√	√		√

#### 20.22.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Advanced counting and discrete probability: recurrences and sums, binomial coefficients, special numbers	CO1, CO2, CO3
Week 2	generating functions, probability generating function	CO1, CO2, CO3
Week 3	Random variables: discrete and continuous random variables, multivariate distributions, moment generating functions	CO1, CO2
Week 4	Conditional probability and conditional expectation	CO1, CO2
Week 5	Probability bounds: Markov and Chebyshev inequalities, Chernoff bound, Cauchy-Schwarz and Jensen inequalities	CO1, CO2
Week 6	Convergence of random variables: law of large numbers, central limit theorem	CO1, CO2

Week	Lecture Topics	Corresponding CO(s)
Week 7	Statistical inference: parametric and nonparametric models, point estimation, confidence intervals, bootstrapping	CO1, CO2
Week 8	Parametric inference: maximum likelihood estimation; Bayesian inference: maximum a posteriori estimation	CO1, CO2
Week 9	Hypothesis testing: permutation test, likelihood ratio test, multiple testing	CO2, CO3
Week 10	Stochastic processes: Poisson process, Gaussian process	CO2, CO3
Week 11	Markov chains: discrete-time, continuous-time, birth-death process	CO1, CO2, CO3
Week 12	Queuing theory: exponential models	CO1, CO2, CO3
Week 13	Queuing theory: open and closed queuing network	CO2, CO3
Week 14	Queuing theory: applications of queuing models	CO1, CO2, CO3

#### 20.22.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.22.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.22.13 Textbook/ Reference

- Concrete Mathematics: A Foundation for Computer Science by Ronald Graham, Donald Knuth, Oren Patashnik
- All of Statistics by Larry Wasserman
- Introduction to Probability, Statistics, and Random Processes by Hossein Pishro-Nik
- An Introduction to Statistical Learning - Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani,
- Introduction to Probability Models (12th Edition), by Sheldon M. Ross

### 20.23 Description of Course CSE 309

#### PART A: General Information

20.23.1 Course Title	: COMPILER
20.23.2 Type of Course	: THEORY
20.23.3 Offered to	: DEPARTMENT OF CSE
20.23.4 Pre-requisite Course(s)	: CSE 211

## **PART B: Course Details**

### **20.23.5 Course Content (to be approved by the Academic Council)**

Basic issues, compiler structure, front end, optimizer, back end; Lexical Analysis: Tokens, patterns, and lexemes, transition diagrams, lexical-analyzer generator; Syntax Analysis: Top-down parsing, bottom-up parsing, LR parsing, parser generators; Syntax-Directed Translation: Syntax-directed definitions, dependency graphs, syntax trees, syntax-directed translation schemes; Intermediate-Code Generation: Directed acyclic graphs for expressions, three-address Code, quadruples, triples, static single-assignment form, types and declarations, type checking, control flow; Run-Time Environments: Storage organization, static versus dynamic storage allocation, activation trees, activation records, heap management and garbage collection; Code Generation: Basic blocks and flow graphs, optimization of basic blocks, peephole optimization, register allocation and assignment, instruction selection; Machine-Independent Optimizations: Principal sources of optimization; Interprocedural Analysis: Call graphs, pointer analysis.

### **20.23.6 Course Objectives**

The students are expected to:

- Understand the basic components of a compiler and the interactions among them
- Analyze various code optimization techniques
- Design and develop a novel compiler

### **20.23.7 Knowledge required**

- Data structures and algorithms
- Programming language

### **20.23.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> the basic components of a compiler and the interaction among them	PO1, PO2	C4, A3	Lecture and problem solving	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Analyze</b> various code optimization techniques	PO1, PO2, PO3	C3, A3	Lecture, demonstration, and problem solving	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Design and develop</b> a novel compiler	PO3, PO5 PO12	C5, A4	Lecture and problem solving	Class Tests or Assignments or Projects, and Final Exam

**20.23.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√	√			
CO 2		√	√	√	√	√			√	√	√					√		√		
CO 3		√	√	√	√	√			√	√	√				√	√		√		√

**20.23.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Basic issues, compiler structure, front end, optimizer, back end	CO1, CO3
Week 2	Lexical Analysis: Tokens, patterns, and lexemes, transition diagrams	CO1, CO3
Week 3	Lexical-analyzer generator	CO1, CO3
Week 4	Syntax Analysis	CO1, CO3
Week 5	Top-down parsing	CO1, CO3
Week 6	Bottom-up parsing	CO1, CO3
Week 7	LR parsing, parser generators	CO1, CO3
Week 8	Syntax-Directed Translation: Syntax-directed definitions, dependency graphs, syntax trees	CO1, CO3
Week 9	Syntax-directed translation schemes	CO1, CO3
Week 10	Intermediate-Code Generation: Directed acyclic graphs for expressions, three-address Code, quadruples, triples, static single-assignment form	CO2, CO3
Week 11	ICG for types and declarations, type checking, control flow	CO2, CO3
Week 12	Run-Time Environments: Storage organization, static versus dynamic storage allocation, activation trees, activation records, heap management and garbage collection	CO2, CO3
Week 13	Code Generation: Basic blocks and flow graphs, optimization of basic blocks, peephole optimization, register allocation and assignment, instruction selection;	CO2, CO3
Week 14	Machine-Independent Optimizations: Principal sources of optimization; Interprocedural Analysis: Call graphs, pointer analysis.	CO2, CO3

**20.23.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.23.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.23.13 Textbook/ Reference**

- Compilers: Principles, Techniques & Tools by ALFRED V. AHO, MONICA S. LAM, RAVI SETHI AND JEFFREY D. ULLMAN
- Engineering A Compiler by LINDA TORCZON AND KEITH COOPER

### **20.24 Description of Course CSE 310**

#### **PART A: General Information**

**20.24.1 Course Title** : COMPILER SESSIONAL

**20.24.2 Type of Course** : Sessional

**20.24.3 Offered to** : DEPARTMENT OF CSE

**20.24.4 Pre-requisite Course(s)** : N/A

#### **PART B: Course Details**

#### **20.24.5 Course Content (to be approved by the Academic Council)**

Laboratory works based on Basic issues, compiler structure, front end, optimizer, back end; Lexical Analysis: Tokens, patterns, and lexemes, transition diagrams, lexical-analyzer generator; Syntax Analysis: Top-down parsing, bottom-up parsing, LR parsing, parser generators; Syntax-Directed Translation: Syntax-directed definitions, dependency graphs, syntax trees, syntax-directed translation schemes; Intermediate-Code Generation: Directed acyclic graphs for expressions, three-address Code, quadruples, triples, static single-assignment form, types and declarations, type checking, control flow; Run-Time Environments: Storage organization, static versus dynamic storage allocation, activation trees, activation records, heap management and garbage collection; Code Generation: Basic blocks and flow graphs, optimization of basic blocks, peephole optimization, register allocation and assignment, instruction selection; Machine-Independent Optimizations: Principal sources of optimization; Interprocedural Analysis: Call graphs, pointer analysis.

#### **20.24.6 Course Objectives**

The students are expected to:

- Understand the basic components of a compiler and the interaction among them.
- Use automated tools for lexical, syntax and semantic analysis.
- Construct a simple compiler.

### 20.24.7 Knowledge required

- Data structures and algorithms
- Programming language

### 20.24.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Understand</b> the basic components of a compiler and the interaction among them	-	C2, A1, P1	Lecture, problem solving, coding and development	Online, offline assignments, viva, quiz
CO 2	<b>Use</b> automated tools for lexical analysis, syntax analysis, and semantics analysis.	PO3, PO5	C3, A2, P3	Lecture, problem solving, coding and development	Online, offline assignments, viva, quiz
CO 3	<b>Design and construct</b> a simple compiler	PO4, PO12	C5, A4, P5	Lecture, problem solving, coding and development	Online, offline assignments, viva

### 20.24.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√														√				
CO 2		√	√	√					√	√	√					√	√			
CO 3		√		√	√	√		√	√	√	√					√		√		√

### 20.24.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1, 2	Lecture on 'symbol table' assignment	CO1
Week 3, 4	Evaluation of 'symbol table' assignment Lecture on 'lexical analysis' assignment	CO1, CO3
Week 5, 6	Evaluation of 'lexical analysis' assignment Lecture on 'syntax and semantic analysis' assignment	CO2, CO3
Week 7, 8	Evaluation of 'syntax and semantic analysis' assignment	CO2, CO3

Week	Lecture Topics	Corresponding CO(s)
	Lecture on 'code generation and optimization' assignment	
Week 9, 10	Evaluation of 'code generation and optimization' assignment – progress 1	CO3
Week 11, 12	Evaluation of 'code generation and optimization' assignment – final	CO3
Week 13, 14	Quiz	CO1, CO2

#### 20.24.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Offline and online coding assignments: There will be four offline and online coding assignments on various phases and components of a compiler.
- Viva: Viva will be taken during evaluation of each assignment.
- Final quiz exam: A comprehensive written quiz exam will be held at the end of the semester.

#### 20.24.12 Distribution of Marks

Offline and Online:	60-70%
Attendance:	5%
Quiz:	25-35%
Total:	100%

#### 20.24.13 Textbook/ Reference

- Compilers: Principles, Techniques & Tools by ALFRED V. AHO, MONICA S. LAM, RAVI SETHI AND JEFFREY D. ULLMAN
- Flex & Bison, John R. Levine
- A Compact Guide to Lex & YACC, Thomas Niemann

### 20.25 Description of Course CSE 311

#### PART A: General Information

20.25.1 Course Title : DATA COMMUNICATION

20.25.2 Type of Course : THEORY

20.25.3 Offered to : DEPARTMENT OF CSE

20.25.4 Pre-requisite Course(s) : CSE 219

#### PART B: Course Details

#### 20.25.5 Course Content (As approved by the Academic Council)

Introduction to analog and digital communication: bandwidth, signal-to-noise ratio, capacity; Analog modulation: amplitude modulation (AM), DSB-SC, SSB, VSB, frequency modulation (FM), phase modulation (PM); Analog-to-digital conversion: sampling, quantization, pulse code modulation (PCM), DPCM, ADPCM, delta modulation, digital telephony and video compression; Line coding, pulse shaping, intersymbol interference; Digital modulation: amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), differential, binary and M-ary PSK, quadrature AM (QAM), binary and M-ary FSK, minimum shift keying (MSK), Gaussian

minimum shift keying (GMSK); Multiplexing and multiple access: time division multiplexing (TDM), frequency division multiplexing (FDM), orthogonal frequency domain multiplexing (OFDM), spread spectrum, code division multiple access (CDMA); Noise in communication, additive white Gaussian noise (AWGN), errors due to noise; Information theory: entropy, mutual information, Huffman and Lempel-Ziv source coding, Shannon's information capacity theorem; Error control coding: linear block codes, cyclic codes, convolutional codes, Viterbi decoding; Introduction to modern communication systems: cellular, satellite, optical fiber and power-line carrier communication.

### 20.25.6 Course Objectives

The students are expected to:

- Study the fundamental concepts of data communication.
- Investigate the concepts of modulation, multiplexing and multiple access.
- Understand how modern communication systems work and explore different types of communication concepts and methodologies.

### 20.25.7 Knowledge required

#### Technical

- None

#### Mathematics

- Calculus, Fourier Transform

### 20.25.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand and analyze</b> underlying notions of analog and digital communication systems.	-	C2, P7	Lecture	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Evaluate and analyze</b> different modulation, multiplexing and multiple access principals, practices and measures.	PO2, PO4, PO5	C6, A5	Lecture	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Develop</b> different new techniques for solutions of real-world problems	PO3, PO6, PO7	C5	Lecture	Class Tests or Assignments or Projects, and Final Exam

### 20.25.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√						√				
CO 2		√	√	√	√	√			√	√	√					√	√	√		

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 3		√	√	√	√	√			√	√	√	√			√	√	√	√		√

#### 20.25.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to Analog and Digital Communication Systems, Signals, and Fourier Transform	CO1
Week 2	Sampling Theorem, Quantization	CO1
Week 3	Line Coding	CO1
Week 4	Pulse Modulation and Shaping	CO1
Week 5	Multiple Access Techniques	CO1, CO3
Week 6	Multiple Access Techniques, Error Rate	CO1, CO3
Week 7	Information Theory, Channel Coding and Capacity	CO1
Week 8	Analog Modulation: Amplitude Modulation	CO1, CO2
Week 9	Analog Modulation: Carrier Acquisition	CO2, CO3
Week 10	Analog Modulation: Phase and Frequency Modulation	CO2, CO3
Week 11	Digital Modulation: ASK, PSK, FSK	CO2, CO3
Week 12	Digital Modulation: M-ary Modulation	CO2, CO3
Week 13	Applications	CO3
Week 14	Revision	CO1, CO2, and CO3

#### 20.25.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.25.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.25.13 Textbook/ Reference

- Modern Analog and Digital Communication Systems [Oxford University Press] B.P. Lathi, Zhi Ding

### 20.26 Description of Course CSE 313

#### PART A: General Information

20.26.1 Course Title : OPERATING SYSTEMS

20.26.2 Type of Course : THEORY

20.26.3 Offered to : DEPARTMENT OF CSE

20.26.4 Pre-requisite Course(s) : NONE

#### PART B: Course Details

#### 20.26.5 Course Content (As approved by the Academic Council)

Operating system concepts: its role in computer systems, operating system structures, multiuser and multitasking OS; Process: process concepts, user and kernel threads, synchronization, inter-process communication, communication in client-server systems; CPU scheduling: scheduling criteria and algorithms, thread scheduling; Process synchronization: critical-section problem, semaphores, monitors; Deadlock: resource allocation and deadlock, deadlock detection, prevention and recovery; Memory management: swapping, paging, segmentation, virtual memory; Input/ Output: hardware, software, disk, terminals, clocks; File Systems: files, directories, security, protection; Multi Processor System: Multiprocessor OS types, multiprocessor synchronization and scheduling, case study of a multiprocessor system; Case study of some operating systems.

#### 20.26.6 Course Objectives

The students are expected to:

- Study different types of Process Management, Memory management and File management.
- Investigate reliability analysis of different types of systems and understand how to avoid and circumvent defects.
- Explore different types of methodologies of hardening systems.

#### 20.26.7 Knowledge required

##### Technical

- System design and development

##### Mathematics

- Probability theory

#### 20.26.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand and analyze</b> underlying notions of different components of Operating Systems	PO1, PO2, and PO7	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO2	<b>Develop</b> methodologies and <b>evaluate</b> different approaches used for Process, File and Memory management.	PO3, PO4 and PO6	C6, A3	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Analyze</b> different techniques used for page replacement, Deadlock prevention, memory and file management.	PO5	C4	Lecture, and hands-on	Class Tests or Assignments or Projects, and Final Exam

### 20.26.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√	√			√	√	√	√		√
CO 3		√	√	√	√	√			√	√	√				√	√	√			√

### 20.26.10 Lecture/ Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	Introduction to Operating System	CO1
Week 2	Process and Threads	CO1
Week 3	Inter Process Communication	CO1
Week 4	Scheduling, Case Study on Process and Threads	CO1 and CO2
Week 5	File Systems	CO2
Week 6	Case Study on File Systems	CO2
Week 7	Deadlocks	CO2
Week 8	Case Study on Deadlocks	CO2
Week 9	Memory Management	CO3
Week 10	Case Study on Memory Management	CO3
Week 11	Input/Output	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 12	Multiple Processor System	CO2
Week 13	Case Study on Multiple Processor System	CO3
Week 14	Revision and Summary	CO1, CO2, and CO3

#### 20.26.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.26.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.26.13 Textbook/ Reference

- Modern Operating System, 4<sup>th</sup> Edition (by Andrew S Tanenbaum)

### 20.27 Description of Course CSE 314

#### PART A: General Information

20.27.1 Course Title	: OPERATING SYSTEMS SESSIONAL
20.27.2 Type of Course	: THEORY
20.27.3 Offered to	: DEPARTMENT OF CSE
20.27.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

##### 20.27.5 Course Content (As approved by the Academic Council)

Operating system concepts: its role in computer systems, operating system structures, multiuser and multitasking OS; Process: process concepts, user and kernel threads, synchronization, inter-process communication, communication in client-server systems; CPU scheduling: scheduling criteria and algorithms, thread scheduling; Process synchronization: critical-section problem, semaphores, monitors; Deadlock: resource allocation and deadlock, deadlock detection, prevention and recovery; Memory management: swapping, paging, segmentation, virtual memory; Input/ Output: hardware, software, disk, terminals, clocks; File Systems: files, directories, security, protection; Multi Processor System: Multiprocessor OS types, multiprocessor synchronization and scheduling, case study of a multiprocessor system; Case study of some operating systems.

##### 20.27.6 Course Objectives

The students are expected to:

- Study different types of Process Management, Memory management and File management.
- Investigate reliability analysis of different types of systems and understand how to avoid and circumvent defects.
- Explore different types of methodologies of hardening systems.

##### 20.27.7 Knowledge required

**Technical**

- Programming Language

**Mathematics**

- Programming Language

**20.27.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Understand and analyze</b> underlying notions of different components of Operating Systems	PO1, PO2, and PO7	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 2	<b>Develop</b> methodologies and <b>evaluate</b> different approaches used for Process, File and Memory management.	PO3, PO4 and PO6	C6, A3	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO 3	<b>Analyze</b> different techniques used for page replacement, Deadlock prevention, memory and file management.	PO5	C4, P6	Lecture, and hands-on	Class Tests or Assignments or Projects, and Final Exam

**20.27.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√		√	√	√	√					√				
CO 2		√	√	√	√	√		√	√	√	√				√	√		√	√	
CO 3		√	√	√	√	√			√	√	√				√	√		√		√

**20.27.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Lectures on Shell Commands	CO1
Week 2	Lectures on Shell Script and Offline 1	CO1
Week 3	Offline 1 evaluation and Online	CO1 and CO2
Week 4	Lecture on pthread and Offline 2	CO1 and CO2
Week 5	Lecture on fork	CO2
Week 6	Offline 2 evaluation and Online	CO1 and CO2

Week	Lecture Topics	Corresponding CO(s)
Week 7	Lecture on Linux Kernel Compilation and System Call Implementation	CO2
Week 8-14	XV6/ NACHOS	CO1, CO2, and CO3

#### 20.27.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Online/ Offline Assignments: There will be 3/4 online or offline assignments
- Projects: There will be a project related to topics covered in the sessional
- Final Quiz: A comprehensive Final Quiz will be held at the end of the semester as per the institutional ordinance.

#### 20.27.12 Distribution of Marks

Attendance:	10%
Online Assignment:	26%
Offline Assignment	26%
Final Project:	20%
Final Quiz:	20%
<b>Total:</b>	<b>100%</b>

#### 20.27.13 Textbook/ Reference

- Modern Operating System, 4<sup>th</sup> Edition (by Andrew S Tanenbaum)

### 20.28 Description of Course CSE 315

#### PART A: General Information

20.28.1 Course Title	:MICROPROCESSORS, MICROCONTROLLERS, AND EMBEDDED SYSTEMS
20.28.2 Type of Course	: THEORY
20.28.3 Offered to	: DEPARTMENT OF CSE
20.28.4 Pre-requisite Course(s)	: CSE 205

#### PART B: Course Details

#### 20.27.14 Course Content (As approved by the Academic Council)

Introduction to embedded systems: microprocessors and microcontrollers, applications; Microprocessors and computers: architecture, addressing modes, x86 instruction set, arithmetic co-processor, evolution of microprocessors, multitasking, virtual memory; Microcontrollers: architecture, ARM/AVR instruction set, single-board microcontrollers; Assembly language programming; Memory architectures: von Neuman and Harvard architecture, memory hierarchy, DMA; I/O modes: memory mapped I/O, general purpose I/O; Interfaces and peripherals; Interrupts and timers; Bus interfaces: UART, SPI, I2C, USB; Sampling and pulse width modulation (PWM); Interfacing with stepper motor, liquid-crystal display (LCD), analog-to-digital converter (ADC), digital-to-analog converter (DAC), sensors and actuators; Wireless communication; Embedded systems design: design flow, specifications and modeling; Power management; Distributed embedded systems and the Internet of Things (IoT); Embedded and real time OS.

### 20.28.5 Course Objectives

The students are expected to:

- Identify and adapt architectures and operations of different types of microprocessors and microcontrollers.
- Distinguish and combine different types of memories and peripheral interfacing for microprocessors, microcontrollers, and embedded systems.
- Design and create different microprocessor and microcontroller-based systems having sensors and actuators.

### 20.28.6 Knowledge required

#### Technical

- System design and development

#### Analytical

- Logic design

### 20.28.7 Course Outcomes (COs)

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	After undergoing this course, students should be able to: <b>Analyze</b> architectures and operations of different types of microprocessors and microcontrollers.	PO1 and PO2	C4, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and develop</b> memory and peripheral interfacing for microprocessors, microcontrollers, and embedded systems.	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Create and evaluate</b> microprocessor, microcontrollers-based systems encompassing sensors and actuators.	PO6	C6, P7	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.28.8 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√	√		√	√	√	√				√	√			
CO 2		√	√	√	√	√	√		√	√	√			√	√	√	√	√		

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 3		√	√	√	√	√	√		√	√	√				√	√		√		√

### 20.28.9 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to embedded systems: microprocessors and microcontrollers, applications;	CO1
Week 2	Microprocessors and computers: architecture, addressing modes, x86 instruction set, Assembly language programming;	CO1
Week 3	Microprocessors and computers: architecture, addressing modes, x86 instruction set, Assembly language programming;	CO1
Week 4	Arithmetic co-processor, evolution of microprocessors, multitasking	CO1 and CO2
Week 5	Virtual memory; Microcontrollers: architecture, ARM/AVR instruction set, single-board microcontrollers;	CO1 and CO3
Week 6	Memory architectures: von Neuman and Harvard architecture, memory hierarchy, DMA;	CO1 and CO3
Week 7	I/O modes: memory mapped I/O, general purpose I/O;	CO1
Week 8	Interfaces and peripherals; Interrupts and timers;	CO1 and CO2
Week 9	Bus interfaces: UART, SPI, I2C, USB;	CO1 and CO2
Week 10	Sampling and pulse width modulation (PWM); Interfacing with stepper motor, liquid-crystal display (LCD),	CO1 and CO2
Week 11	Analog-to-digital converter (ADC), digital-to-analog converter (DAC), sensors and actuators;	CO1 and CO2
Week 12	Wireless communication	CO3
Week 13	Embedded systems design: design flow, specifications and modeling; Power management;	CO3
Week 14	Distributed embedded systems and the Internet of Things (IoT); Embedded and real time OS.	CO3

### 20.28.10 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.28.11 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.28.12 Textbook/ Reference

- Embedded Systems Architecture by Daniele Lacamera  
<https://www.amazon.com/Embedded-Systems-Architecture-architectural-pragmatic/dp/1788832607/>
- Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers by Jonathan W Valvano  
<https://www.amazon.com/Embedded-Systems-Introduction-CortexTM-M-Microcontrollers/dp/1477508996>
- Embedded Systems with ARM Cortex-M Microcontrollers by Yifeng Zhu  
<https://web.eece.maine.edu/~zhu/book/>
- Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A CyberPhysical Systems Approach  
[https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia\\_DigitalV2\\_2.pdf](https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia_DigitalV2_2.pdf)

## 20.29 Description of Course CSE 316

### PART A: General Information

20.29.1 Course Title	: MICROPROCESSORS, MICROCONTROLLERS, AND EMBEDDED SYSTEMSSESSIONAL
20.29.2 Type of Course	: SESSIONAL
20.29.3 Offered to	: DEPARTMENT OF CSE
20.29.4 Pre-requisite Course(s)	: NONE

### PART B: Course Details

#### 20.29.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 315 including assembly language programming and experiments using microprocessor/microcontroller.

#### 20.29.6 Course Objectives

The students are expected to:

- Understand and adapt Assembly language
- Implement hardware systems through interfacing different computing and memory components
- Design and develop digital systems with a microcontroller, sensors, and/or actuators

#### 20.29.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Logic design

### 20.29.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> and <b>apply</b> Assembly language	PO1 and PO2	C3	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO2	<b>Implement</b> hardware systems through interfacing different computing and memory components.	PO3 and PO4	C3, A5	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO3	<b>Design</b> and <b>develop</b> digital systems with a microcontroller, sensors, and/or actuators.	PO5 and PO6	C6, P7	Lecture, Demonstration, and hands-on	Project and Quiz

### 20.29.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√	√		√	√	√	√				√			√	
CO 2		√	√	√	√	√	√		√	√	√	√			√	√	√			
CO 3		√	√	√	√	√	√	√	√	√	√				√	√		√		√

### 20.29.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1-2	Lab Assignment on Assembly (Basic IO and arithmetic ops)	CO1
Week 3-4	Assignment on Assembly (Branching and Loops)	CO1
Week 5-6	Experiment on microcontroller: Basic IO and interrupt	CO2
Week 7-8	Experiment on microcontroller: ADC and LCD Display	CO2
Week 9-10	Experiment on microcontroller: TIMER	CO2
Week 11-12	Experiment on microcontroller: Serial communication	CO2
Week 13-14	Demonstration on building embedded systems	CO1, CO2 and CO3

### 20.29.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Project: There will be six Assignments and one Term Project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

### 20.29.12 Distribution of Marks

Attendance:	10 %
Assignments:	70%
Quiz Exam:	20%
Total:	100%

### 20.29.13 Textbook/ Reference

- Embedded Systems Architecture by Daniele Lacamera  
<https://www.amazon.com/Embedded-Systems-Architecture-architectural-pragmatic/dp/1788832607/>
- Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers by Jonathan W Valvano  
<https://www.amazon.com/Embedded-Systems-Introduction-CortexTM-M-Microcontrollers/dp/1477508996>
- Embedded Systems with ARM Cortex-M Microcontrollers by Yifeng Zhu  
<https://web.eece.maine.edu/~zhu/book/>
- Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A CyberPhysical Systems Approach  
[https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia\\_DigitalV2\\_2.pdf](https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia_DigitalV2_2.pdf)

### 20.30 Description of Course CSE 317

#### PART A: General Information

20.30.1 Course Title	: Artificial Intelligence
20.30.2 Type of Course	: Theory
20.30.3 Offered to	: Department of CSE
20.30.4 Pre-requisite Course(s)	: None

#### PART B: Course Details

##### 20.30.5 Course Content (As approved by the Academic Council)

Introduction to AI, intelligent agents; Solving problems by searching: informed search strategies, greedy best-first search, A\* search, inadmissible heuristics and weighted A\*, heuristic functions; Local search and optimization problems: hill-climbing search, simulated annealing, local beam search, evolutionary algorithms; Adversarial search and games: alpha-beta tree search, Monte Carlo tree search; Constraint satisfaction problems (CSP): backtracking and local search for CSPs; Knowledge, reasoning, and planning: logical agents, inference in first-order logic, knowledge representation, automated planning; Learning from examples: forms of learning, supervised learning, learning decision trees, model selection and optimization, theory of learning; parametric models: linear regression and classification; Nonparametric models: nearest-neighbour models, support vector machines (SVM); Ensemble learning: bagging, random forests, stacking, boosting, gradient boosting, online learning; Markov decision process (MDP), partially observable MDP, learning from rewards, passive and active reinforcement learning, Q-learning, policy search; Robotics: robotic perception, planning and control, reinforcement learning in robotics; Ethics and future of AI.

##### 20.30.6 Course Objectives

The students are expected to:

- To make students understand the fundamental knowledge of AI and machine learning
- To teach the students how the knowledge of AI and machine learning can be applied to solve real-world problems

### 20.30.7 Knowledge required

#### Technical

- Probability theory, linear algebra, multivariate calculus, good programming knowledge of C/C++/Java/Python

#### Analytical

- Problem solving and creating thinking

### 20.30.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the basic principles, techniques, ethical aspects, and applications of AI	PO8	C2	Lecture and demonstration	Class tests and final exam
CO2	<b>Apply</b> techniques of AI in knowledge representation, logic, inference, game theory, and in problems that require search algorithms including constraint satisfaction problems	PO1	C3	Lecture and demonstration	Class tests and final exam
CO3	<b>Understand and apply</b> machine learning techniques for solving problems by supervised and unsupervised learning, reinforcement learning, Q-learning, and planning.	PO1	C3	Lecture and demonstration	Class tests and final exam

### 20.30.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√							√				
CO 2		√	√	√	√	√		√	√	√	√				√	√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√				√	√	√	√		√

### 20.30.10 Lecture/Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to AI, intelligent agents; Solving problems by searching: informed search strategies, greedy best-first search, A* search, inadmissible heuristics and weighted A*, heuristic functions	CO1-CO2
Week 2	Local search and optimization problems: hill-climbing search, simulated annealing, local beam search, evolutionary algorithms	CO1-CO2
Week 3	Adversarial search and games: alpha-beta tree search, Monte Carlo tree search	CO1-CO2
Week 4	Constraint satisfaction problems (CSP): backtracking and local search for CSPs	CO1-CO2
Week 5	Knowledge, reasoning, and planning: logical agents, inference in first-order logic	CO1-CO2
Week 6	Knowledge representation, automated planning	CO1-CO2
Week 7	Learning from examples: forms of learning, supervised learning, learning decision trees, model selection and optimization, theory of learning	CO3
Week 8	Parametric models: linear regression and classification	CO3
Week 9	Nonparametric models: nearest-neighbor models, support vector machines (SVM)	CO3
Week 10	Ensemble learning: bagging, random forests, stacking, boosting, gradient boosting, online learning	CO3
Week 11	Markov decision process (MDP), partially observable MDP, learning from rewards	CO3
Week 12	Passive and active reinforcement learning, Q-learning, policy search	CO3
Week 13	Robotics: robotic perception, planning and control, reinforcement learning in robotics	CO3
Week 14	Ethics and future of AI	CO1

### 20.30.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.30.12 Distribution of Marks

Attendance:	10%
Class tests:	20%
Final quiz:	70%
Total:	100%

**20.30.13 Textbook/ Reference**

- “Artificial Intelligence: A Modern Approach” by Stuart Russel and Peter Norvig
- “Machine Learning” by Tom M. Mitchell

**20.31 Description of Course CSE 318****PART A: General Information**

**20.31.1 Course Title** : Artificial Intelligence Sessional

**20.31.2 Type of Course** : Sessional

**20.31.3 Offered to** : Department of CSE

**20.31.4 Pre-requisite Course(s)** : None

**PART B: Course Details****20.31.5 Course Content (As approved by the Academic Council)**

Sessional based on contents of the theory course CSE317 (Artificial Intelligence)

**20.31.6 Course Objectives**

The students are expected to

- To teach the students how to design and implement programs to solve real-world AI and machine learning problems.
- To teach the students how to evaluate the performance of machine learning techniques in real-world applications.

**20.31.7 Knowledge required****Technical**

- Probability theory, linear algebra, multivariate calculus, good programming knowledge of C/C++/Java/Python

**Analytical**

- Problem solving and creating thinking

**20.31.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Develop</b> programs for search algorithms (heuristic and adversarial) and constraint satisfaction problems.	PO1 and PO3	C6	Program design for real-world problem solving	Assignment, viva, final quiz
CO2	<b>Design and implement</b> techniques to solve real-world machine learning	PO2 and PO3	C6, P7	Program design for real-world	Assignment, viva, final quiz

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
	problems (supervised and unsupervised).			problem solving	
CO3	<b>Compare and evaluate</b> different machine learning algorithms in real-world problems.	PO1 and PO5	C5, A4	Program design for real-world problem solving	Assignment, viva, final quiz

### 20.31.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√			√	√	√				√	√				√
CO 2		√	√	√	√	√		√	√	√	√				√	√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√					√			√	

### 20.31.10 Lecture/Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Weeks 1 & 2	Assignment on A* search	CO1
Weeks 3 & 4	Assignment on adversarial search	CO1
Week 5 & 6	Assignment on constraint satisfaction problem	CO1
Week 7 & 8	Assignment on probabilistic modeling (hidden Markov models)	CO2
Week 8 & 10	Assignment on supervised learning (decision tree algorithms)	CO2
Weeks 11 & 12	Assignment on supervised learning (linear regression/logic regression/support vector machine) and ensemble learning (bagging/boosting/stacking)	CO2
Weeks 13	Assignment on evaluating several machine learning techniques on a real-world problem	CO3
Week 14	Final quiz	CO1 – CO3

### 20.31.11 Assessment Strategy

- Assignment: There will be four to six assignments. Some assignments may have sub-problems covering multiple topics.
- Viva: There will be a short viva examination on every assignment.
- Final quiz: A final quiz will be held at the end of the semester.

### 20.31.12 Distribution of Marks

Assignments:	50-60%
Viva:	10-20%
Final quiz:	20-30%
Total:	100%

### 20.31.13 Textbook/ Reference

- Textbooks referred in the respective theory course CSE317 (Artificial Intelligence).

## 20.32 Description of Course CSE 321

### PART A: General Information

20.32.1 Course Title : COMPUTER NETWORKS

20.32.2 Type of Course : THEORY

20.32.3 Offered to : DEPARTMENT OF CSE

20.32.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.32.5 Course Content (As approved by the Academic Council)

Introduction to Computer Networks; Protocol hierarchies; Data link control: Link layer and services; Multiple access protocol: Standards IEEE 802.\*; Hubs, Bridges, and Switches, Fast Ethernet; Routing architecture and algorithms; IPV4, IPV6, ARP, RARP, DHCP, BGP; Introduction to transport layer: UDP, TCP; Principles of Reliable data transfer, Principles of congestion control, TCP, Congestion control; Application layer services: Web, HTTP, FTP, SMTP, DNS architecture; IoT fundamentals: Edge devices, Wireless communication, Routing, IoT applications; IoT advanced: Edge-cloud IoT platforms, Load balancing, Energy management, IoT security; Datacenter topology.

#### 20.32.6 Course Objectives

The students are expected to:

- i. Study and analyze architectures of different types of computer networks.
- ii. Create different types of computer networks with evaluation of standard and newly design protocols.
- iii. Classify applications of computer networks with determining suitable alternatives of the networks

#### 20.32.7 Knowledge required

##### Technical

- Data Communication

##### Mathematics

- Number system and conversions

### 20.32.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Study</b> and <b>analyze</b> architectures of different types of computer networks	PO1, PO2 and PO8	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Create</b> types of computer networks with <b>evaluation</b> of standard and newly <b>design</b> protocols	PO1, PO2, PO3, PO5, PO9	C6, A5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Classify</b> applications of computer networks with <b>determining</b> suitable alternatives of the networks	PO3	C5, P6	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam

### 20.32.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√									√	√
CO 2		√	√	√	√	√			√	√	√						√	√		
CO 3		√	√	√	√	√		√	√				√		√		√	√		√

### 20.32.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to computer networks, OSI reference model and TCP/IP	CO1
Week 2	Transmission media: Wired and Wireless transmission	CO1
Week 3	Data Link layer design issues and DL protocols	CO1
Week 4	Multiple Access protocols, Ethernet	CO1 and CO2
Week 5	Wireless LANs	CO2
Week 6	Data Link layer switching	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 7	Network devices, Circuit and Packet switching	CO2
Week 8	Flooding, IPv4 and IPv6 addressing	CO2
Week 9	Routing Algorithms, DV and LS routing algorithms	CO2
Week 10	OSPF, RIP algorithms and its issues	CO3
Week 11	ARP, DHCP, Introduction to TCP	CO3
Week 12	TCP flow control, Congestion control, UDP	CO3
Week 13	Application layer protocols: HTTP, DNS, DNS, SMTP, IMAP, POP3	CO2
Week 14	Summary and Revision	CO1, CO2, and CO3

### 20.32.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.32.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.32.13 Textbook/ Reference

Computer Networks, 6<sup>th</sup> Edition (by Andrew S. Tanenbaum)

## 20.33 Description of Course CSE 322

### PART A: General Information

20.33.1 Course Title : COMPUTER NETWORKS SESSIONAL

20.33.2 Type of Course : SESSIONAL

20.33.3 Offered to : DEPARTMENT OF CSE

20.33.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.33.5 Course Content (As approved by the Academic Council)

Computer Networks; Protocol hierarchies; Data link control: Link layer and services; Multiple access protocol: Standards IEEE 802.\*; Hubs, Bridges, and Switches, Fast Ethernet; Routing architecture and algorithms; IPV4, IPV6, ARP, RARP, DHCP, BGP; Introduction to transport layer: UDP, TCP; Principles of Reliable data transfer, Principles of congestion control, TCP, Congestion control; Application layer services: Web, HTTP, FTP, SMTP,

DNS architecture; IoT fundamentals: Edge devices, Wireless communication, Routing, IoT applications; IoT advanced: Edge cloud IoT platforms, Load balancing, Energy management, IoT security; Datacenter topology.

### 20.33.6 Course Objectives

The students are expected to:

- i. Understand architectures of different types of computer networks.
- ii. Develop contemporary and new protocols of computer networks.
- iii. Identify applications of computer networks with determining suitable alternatives of the networks.

### 20.33.7 Knowledge required

#### Technical

- Socket Programming

### 20.33.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> architectures of different types of computer networks.	PO8	C2, P1	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam
CO2	<b>Design and Analyze</b> contemporary and new protocols of computer networks.	PO1, PO2, PO3, PO5, and PO9	C6, A5	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam
CO3	<b>Evaluate</b> computer networks with determining suitable alternatives of the networks	PO3, PO11	C5, P7	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam

### 20.33.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√				√										
CO 2		√	√	√	√	√			√	√	√						√	√		
CO 3		√	√	√	√	√		√	√				√		√		√	√		√

### 20.33.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Lecture on Socket Programming and Declaration of Assignment 1 on Socket Programming	CO1
Week 2	Demonstration of Packet Tracer	CO1
Week 3	Assignment 1 Evaluation	CO1
Week 4	Packet Tracer Practice Session	CO1
Week 5	Online on Packet Tracer	CO1
Week 6	Declaration of Assignment 2 on Routing protocol	CO2
Week 7	Evaluation of Assignment 2	CO2
Week 8	Demonstration on NS3 and Project topic finalization	CO3
Week 9	Assignment 3 on reliable protocol implementation (TCP)	CO2
Week 10	Demonstration on Network related commands and Wireshark and in class evaluation	CO1
Week 11	Project Update (NS3)	CO3
Week 12	Assignment 3 Evaluation	CO2
Week 13	Final Project (NS3) Submission	CO3
Week 14	Final Quiz	CO1, CO2, and CO3

### 20.33.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Online/ Offline Assignments: There will be 3/4 online or offline assignments
- Projects: There will be a project related to topics covered in the sessional
- Final Quiz: A comprehensive Final Quiz will be held at the end of the semester as per the institutional ordinance.

### 20.33.12 Distribution of Marks

Attendance:	10%
Online Assignment:	26%
Offline Assignment	26%
Final Project:	20%
Final Quiz:	20%
<b>Total:</b>	<b>100%</b>

### 20.33.13 Textbook/ Reference

Computer Networks by Andrew S. Tanenbaum (5<sup>th</sup> edition)

## 20.34 Description of Course CSE 326

### PART A: General Information

20.34.1 Course Title : Software Project Management

20.34.2 Type of Course : THEORY

20.34.3 Offered to : DEPARTMENT OF CSE

20.34.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.34.5 Course Content (As approved by the Academic Council)

Project management: risk management, stakeholder management, team management, issue management; Project planning: software pricing, project scheduling, estimation techniques, COCOMO cost modelling; Software development methodologies: Agile, Waterfall; Agile software development: Scrum, Kanban; Software quality assurance: software measurement, metrics, static analysis; Delivery management: acceptance criteria, continuous integration and continuous delivery (CI/CD); Software architecture: software as a service (SaaS), service oriented architecture (SOA), microservices, model-view-controller (MVC), n-tier; Deployment: cloud computing, distributed system architecture, containerization/virtualization; Monitoring and maintenance: metrics, APM (application performance monitoring), refactoring.

#### 20.34.6 Course Objectives

The students are expected to:

- Understand the concept of Management in Developing Software Projects
- Develop schedule and plan of the software project
- Develop the effort and price estimates for software projects
- Analyse the financial and technical feasibility of the software projects
- Understand the necessity of software process models and develop tailor made software process for software projects
- Understand the concept of software quality and develop management techniques to achieve quality in each and every step of software development life cycle
- Develop measurement techniques for monitoring software projects

#### 20.34.7 Knowledge required

##### Technical

- knowledge on Computer Programming and Software Engineering

##### Mathematics

- None

#### 20.34.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> the financial and technical feasibility of the software projects and <b>develop</b> the effort and price estimates for software projects	PO2, PO4, PO5, PO11	C6, A3	Lecture, Demonstration	Class Tests or Assignments or Projects, and Final Exam

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO2	<b>Understand</b> the necessity of software process models and <b>develop</b> tailor made software process for software projects	PO1, PO2, PO3, PO4, PO7, PO8, PO12	C5, A5	Lecture	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Understand</b> the concept of software quality and <b>develop</b> management and measurement techniques to achieve quality in each and every step of software development life cycle	PO1, PO3, PO10, PO11	C3, A4	Lecture	Class Tests or Assignments or Projects, and Final Exam

#### 20.34.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√			√	√	√	√			
CO 2		√	√	√	√	√			√	√	√					√				
CO 3		√	√	√	√	√			√	√	√					√				

#### 20.34.10 Lecture/ Activity Plan

<b>Week</b>	<b>Topic</b>	<b>Course Outcomes</b>
1	Project management: risk management	CO1
2	stakeholder management	CO1
3	team management, issue management	CO1
4	Project planning, project scheduling	CO1, CO2, CO4
5	software pricing, estimation techniques, COCOMO cost modeling	CO3, CO4
6	Software development methodologies: Agile, Waterfall;	CO5
7	Agile software development: Scrum, Kanban	CO5
8	Software quality assurance	CO6
9	software measurement, metrics, static analysis	CO7

Week	Topic	Course Outcomes
10	Delivery management: acceptance criteria, continuous integration and continuous delivery (CI/CD)	CO1, CO2
11	Software architecture: software as a service (SaaS), service-oriented architecture (SOA), microservices, model-view-controller (MVC), n-tier; Deployment	CO5
12	cloud computing, distributed system architecture, containerization/virtualization	CO5
13	Monitoring and maintenance metrics	CO7
14	APM (application performance monitoring), refactoring	CO7

#### 20.34.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.34.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.34.13 Textbook/ Reference

Information Technology Project Management, 8<sup>th</sup> Edition, by Kathy Schwalbe, Cengage Learning.

### 20.35 Description of Course CSE 326

#### PART A: General Information

20.35.1 Course Title : Software Project Management

20.35.2 Type of Course : SESSIONAL

20.35.3 Offered to : DEPARTMENT OF CSE

20.35.4 Pre-requisite Course(s) : None

#### PART B: Course Details

#### 20.35.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 326 (Software Project Management).

### 20.35.6 Course Objectives

After undergoing this course, students should be able to:

- Design a simple software applying software engineering knowledge.
- Develop a simple software full stack and deploy that in cloud, browser and Mobile with UML modelling.
- Apply agile project management principles to software development projects.

### 20.35.7 Knowledge required

#### Technical

- Databases, Object Oriented Programming, Design Patterns, Software Engineering Fundamentals.

#### Analytical

### 20.35.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Design</b> a simple software applying software engineering knowledge.	PO1, PO2, PO3	C6, P7	Lecture and demonstration	Assignment, Quiz
CO2	<b>Develop</b> a simple software full stack and deploy that in cloud, browser and Mobile with UML modelling.	PO1, PO2, PO3	C6	Lecture and demonstration	Assignment, Quiz
CO3	<b>Apply</b> agile project management principles to software development projects.	PO1, PO5	C3	Lecture and demonstration	Assignment, Quiz

### 20.35.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√	√			
CO 2		√	√	√	√	√			√	√	√	√		√	√	√	√			
CO 3		√	√	√	√	√			√	√	√		√		√	√				√

### 20.35.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Discussion on software projects.	CO1
2	Formulating the design principles and understanding core	CO1

Week	Topic	Course Outcomes
3	Problem formulation and design	CO1
4	Reserved	CO2
5	Update – 1	CO2
6	Reserved	CO2
7	Update - 2	CO2
8	Online	CO2
9	Discussion on Project Deployment	CO3
10	Discussion on deployment related issues	CO3
11	Update -3	CO2
12	Quiz	CO1, CO2, CO3
13	Report Submission & Industry Demonstration	CO2, CO3

#### 20.35.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.35.12 Distribution of Marks

Attendance:	10 %
Assignments/Projects:	60%
Final Quiz:	30%
Total:	100%

#### 20.35.13 Textbook/ Reference

- Software Engineering at Google: Lessons Learned from Programming Over Time by Titus Winters, Tom Manshreck, Hyrum Wright
- Engineering Software as a Service: An Agile Approach Using Cloud Computing by Armando Fox, David Patterson
- Software Engineering: A Practitioner’s Approach by Roger S. Pressman, Bruce Maxim
- Software Engineering by Ian Sommerville
- The Unified Modeling Language User Guide by Booch, Rumbaugh, and Jacobson
- Design Patterns: Elements of Reusable Object-Oriented Software by Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

#### 20.36 Description of Course CSE 329

##### PART A: General Information

20.36.1 Course Title : MACHINE LEARNING

20.36.2 Type of Course : THEORY

20.36.3 Offered to : DEPARTMENT OF CSE

#### 20.36.4 Pre-requisite Course(s)

: CSE 317 (Artificial Intelligence)

### **PART B: Course Details**

#### **20.36.5 Course Content (As approved by the Academic Council)**

Developing machine learning systems: problem formulation, data collection, manipulation and preprocessing, exploratory data analysis and visualization; Deep learning: linear regression as a neural network, simple feedforward networks, forward propagation, backward propagation, computation graphs, numerical stability and initialization; Optimization: batch and stochastic gradient descent (SGD); Convolutional neural networks (CNN): convolution, padding, stride, pooling, modern CNNs (AlexNet, VGG, GoogLeNet, ResNet), batch normalization; Recurrent neural networks (RNN): language modeling with RNNs, modern RNNs, long short-term memory (LSTM), gated recurrent units (GRU), recursive neural networks, sequence-to-sequence (seq2seq) models; Generalization in deep learning: designing neural network architectures, weight decay, dropout; Probabilistic modeling and reasoning: Bayesian networks, exact inference, variable elimination algorithm, approximate inference, direct sampling methods, inference by Markov chain simulation, Gibb's sampling; Probabilistic reasoning over time, inference in temporal models, hidden Markov model, Kalman filters; Learning probabilistic models: learning with complete data, Bayesian learning, naive Bayes models, generative and discriminative models, generalized linear model; Learning with hidden variables: expectation-maximization (EM) algorithm, mixture models, learning mixtures of Gaussians, K-means clustering, learning hidden Markov models; Dimensionality reduction: principal component analysis (PCA); Recommender systems: collaborative filtering using matrix factorization.

#### **20.36.6 Course Objectives**

The students are expected to:

- Understand the basic concepts of machine learning
- Apply different machine learning algorithms and models to different tasks
- Develop machine learning models for different applications

#### **20.36.7 Knowledge required**

##### **Technical**

- Introductory knowledge of probability, statistics, and linear algebra is recommended. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

##### **Analytical**

- None

#### **20.36.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> the basic concepts of machine learning	-	C2	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Apply</b> different machine learning algorithms and models to different tasks	PO1, PO5	C3	Lecture, Demonstration, and hands-on	Class Tests or Assignments, and Final Exam
CO3	<b>Develop</b> machine learning models for different applications within the boundaries of	PO2, PO3, PO6, PO7, PO8	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	the ethical and societal obligations of engineers				

### 20.36.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√										√	
CO 2		√	√	√	√	√		√	√	√	√				√	√	√		√	√
CO 3		√	√	√	√	√	√	√	√	√	√				√	√	√	√	√	√

### 20.36.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Developing machine learning systems: problem formulation, data collection, manipulation and preprocessing,	CO1
Week 2	Exploratory data analysis and visualization	CO1
Week 3	Neural networks	CO1, CO2, CO3
Week 4	Optimization	CO1, CO2, CO3
Week 5	Convolutional neural networks (CNN)	CO1, CO2
Week 6	Recurrent neural networks (RNN)	CO1, CO2
Week 7	Generalization in deep learning	CO1, CO2, CO3
Week 8	Probabilistic modeling and reasoning	CO1
Week 9	Approximate inference	CO1
Week 10	Hidden Markov model, Kalman filters	CO1, CO3
Week 11	Learning probabilistic models	CO1
Week 12	Expectation–maximization (EM) algorithm, mixture models	CO1, CO2, CO3
Week 13	Dimensionality reduction	CO1, CO2
Week 14	Recommender systems	CO1, CO2, CO3

### 20.36.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

**20.36.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

**20.36.13 Textbook/ Reference**

- Artificial Intelligence: A Modern Approach (4th Edition) by Stuart Russel and Peter Norvig
- Dive into Deep Learning (Online Edition) by Alex J. Smola et al.
- Probabilistic Machine Learning: An Introduction by Kevin P. Murphy
- Probabilistic Machine Learning: Advanced Topics by Kevin P. Murphy

**20.37 Description of Course CSE 330**

**PART A: General Information**

- 20.37.1 Course Title** : MACHINE LEARNING SESSIONAL
- 20.37.2 Type of Course** : SESSIONAL
- 20.37.3 Offered to** : DEPARTMENT OF CSE
- 20.37.4 Pre-requisite Course(s)** : NONE

**PART B: Course Details**

**20.37.5 Course Content (As approved by the Academic Council)**

Sessional based on CSE 329 (Machine learning)

**20.37.6 Course Objectives**

The students are expected to:

- Understand the basic concepts of machine learning
- Apply different machine learning algorithms and models to different tasks
- Develop machine learning models for different applications
- Engage in lifelong learning and independent & team work

**20.37.7 Knowledge required**

**Technical**

- Introductory knowledge of probability, statistics, and linear algebra is recommended. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

**Analytical**

- None

**20.37.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> the basic concepts of machine learning	-	C2	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Apply</b> different machine learning algorithms and models to different tasks	PO1, PO5	C3	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Develop</b> machine learning models for different applications	PO3, PO4, PO6, PO7, PO8	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO4	<b>Engage</b> in independent learning and independent & team work	PO9, PO12	A5	Independent study, teamwork	Project presentation

**20.37.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√			√										√	
CO 2		√	√	√	√	√			√	√	√				√	√	√		√	√
CO 3		√	√	√	√	√	√		√	√	√				√	√	√	√	√	√
CO 4		√	√	√	√	√		√	√	√	√	√	√				√	√		√

**20.37.10 Lecture/ Activity Plan**

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	Developing machine learning systems	CO1
Week 2	Exploratory data analysis and visualization (Assignment 1)	CO1
Week 3	Neural networks	CO1, CO2, CO3

Week	Lecture Topics	Corresponding CO(s)
Week 4	Optimization (Assignment 2)	CO1, CO2, CO3
Week 5	Convolutional neural networks (CNN)	CO1, CO2
Week 6	Recurrent neural networks (RNN)	CO1, CO2
Week 7	Generalization in deep learning (Assignment 3, project proposal)	CO1, CO2, CO3
Week 8	Probabilistic modeling and reasoning	CO1
Week 9	Approximate inference	CO1
Week 10	Hidden Markov model, Kalman filters (Assignment 4)	CO1, CO3
Week 11	Learning probabilistic models	CO1
Week 12	Expectation–maximization (EM) algorithm, mixture models	CO1, CO2, CO3
Week 13	Dimensionality reduction (Assignment 5)	CO1, CO2
Week 14	Project presentation and report	CO1, CO2, CO3

#### 20.37.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.37.12 Distribution of Marks

Attendance:	10 %
Assignments and Projects:	60%
Quiz Exam:	30%
Total:	100%

#### 20.37.13 Textbook/ Reference

- Artificial Intelligence: A Modern Approach (4th Edition) by Stuart Russel and Peter Norvig
- Dive into Deep Learning (Online Edition) by Alex J. Smola et al.
- Probabilistic Machine Learning: An Introduction by Kevin P. Murphy
- Probabilistic Machine Learning: Advanced Topics by Kevin P. Murphy

### 20.38 Description of Course CSE 400

#### PART A: General Information

20.38.1 Course Title	: Project and Thesis
20.38.2 Type of Course	: SESSIONAL
20.38.3 Offered to	: DEPARTMENT OF CSE
20.38.4 Pre-requisite Course(s)	:

#### PART B: Course Details

#### 20.38.5 Course Content (As approved by the Academic Council)

Study on problems in the field of computer science and engineering.

### 20.38.6 Course Objectives

The students are expected to:

- Identify research problems in computer science and engineering.
- Study and comprehend research literature and identify gaps in present research
- Analyze professional, social, ethical, environmental and sustainability aspects of problems and their solutions
- Develop novel methods or insights to address gaps in literature
- Design experiments or analysis using research based knowledge and research methods to reach valid conclusions
- Engage in independent learning and function effectively as an individual or in teams
- Communicate research findings effectively through written thesis and presentations.

### 20.38.7 Knowledge required

- Foundations on computer science and engineering

### 20.38.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Identify</b> research problems in computer science and engineering	PO2, PO4	C4	Brainstorming, Discussion	Supervisor meeting, presentation, thesis writing
CO2	<b>Critique</b> technical, professional, social, ethical, environmental and sustainability aspects of problems and their solutions through literature review	PO1, PO2, PO6, PO7, PO8	C5, A5	Brainstorming, Discussion, Reading	Supervisor meeting, presentation, thesis writing
CO3	<b>Develop</b> novel methodologies or insights to address gaps in literature	PO3, PO4, PO5, PO8	C6	Brainstorming, Discussion	Supervisor meeting, presentation, thesis writing
CO4	<b>Infer</b> using research based knowledge and research methods	PO3, PO4	C4	Brainstorming, Discussion	Supervisor meeting, presentation, thesis writing
CO5	<b>Engage</b> in independent learning, and individual & teamwork	PO9, PO12	A5	Brainstorming, Discussion	Supervisor meeting
CO6	<b>Summarize</b> research findings effectively through written thesis and presentations	PO10	C6	Thesis writing, presentation	Thesis writing and presentation

**20.38.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√		√	√							√				
CO 2		√	√	√	√	√		√	√		√	√		√				√		
CO 3		√	√	√	√	√		√	√		√				√	√		√		
CO 4		√	√	√	√	√		√	√					√		√				
CO 5		√	√	√	√	√		√		√	√	√	√							
CO 6		√	√	√	√	√		√												

**20.38.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Weeks 1-4	Problem identification	CO1, CO5
Weeks 5-8	Literature review	CO2, CO5
Weeks 9-26	Design and develop solutions/studies/analysis	CO3, CO4, CO5
Weeks 26-28	Thesis writing and presentation	CO5, CO6

**20.38.11 Assessment Strategy**

- Supervisor meeting: Weekly meetings with thesis/project supervisor.
- Presentations: Proposal and defense presentations before boards as well as presentations to the supervisor.
- Thesis writing: Thesis written by students to summarize the research findings.

**20.38.12 Distribution of Marks**

Supervisor meetings and presentations:	40%
Presentations (proposal and defense):	30%
Thesis writing:	30%
Total:	100%

## 20.39 Description of Course CSE 401

### PART A: General Information

- 20.39.1 Course Title : Numerical Analysis, Simulation and Modeling
- 20.39.2 Type of Course : THEORY
- 20.39.3 Offered to : DEPARTMENT OF CSE
- 20.39.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.39.5 Course Content (As approved by the Academic Council)

Introduction to Numerical Analysis, approximations, round-off errors, truncation errors; Visualization and plotting; Root finding: bisection method, false position method, Newton-Raphson method, Bairstow's method; Solution of systems of equations: Gauss elimination method, Gauss-Jordan elimination method, LU decomposition; Eigenvalue decomposition: power method, QR method; Optimization: golden-section search, Newton's method, gradient methods, constrained optimization; Curve fitting, interpolation and approximation: least squares regression, linear interpolation, Lagrange polynomial interpolation, Newton's polynomial interpolation, spline interpolation; Numerical integration and differentiation: Newton-Cotes integration, trapezoidal rule, Simpson's rule, Romberg's integration, Richardson's extrapolation; Solution of ordinary differential equations: Euler's method, Runge-Kutta methods, finite difference methods; Modeling with linear and differential equations; Introduction to simulation and modeling, Discrete event simulation models; Steps in a simulation study; Model validation and verification, Random number generation; Monte Carlo methods: Metropolis-Hastings algorithm

#### 20.39.6 Course Objectives

The students are expected to:

- Apply numerical methods to find solutions of different mathematical and engineering problems.
- Analyze and evaluate the accuracy of numerical method solutions.
- Understand and Apply different techniques of simulation and modeling.

#### 20.39.7 Knowledge required

##### Technical

- Probability and Statistics, Vectors and matrices and Linear Algebra, and Computer programming

##### Analytical

- Problem solving and creative thinking

#### 20.39.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Apply</b> numerical methods to find solutions of different mathematical and engineering problems.	PO1, PO3	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Analyze and evaluate</b> the accuracy of numerical method solutions.	PO2, PO4	C4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO3	<b>Understand and Apply</b> different techniques of simulation and modeling.	PO5	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.39.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√	√				√		√		√
CO 2		√	√	√	√	√			√	√	√	√			√	√	√			√
CO 3	√	√	√	√	√	√			√	√	√				√	√	√	√		√

### 20.39.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to Numerical Analysis	CO1
Week 2	Error Analysis	CO2
Week 3	Root finding and Equation Solving	CO1 and CO2
Week 4	Root finding and Equation Solving	CO1 and CO2
Week 5	Solution of Linear equations	CO1 and CO2
Week 6	Interpolation and Approximation	CO1 and CO2
Week 7	Regression analysis and Curve Fitting	CO1 and CO2
Week 8	Integration	CO1 and CO2
Week 9	Ordinary Differential Equations	CO1 and CO2
Week 10	Different Simulation and Modeling approaches	CO3
Week 11	Different Simulation and Modeling approaches	CO3
Week 12	Monte Carlo methods and Simulation Case studies	CO1 and CO3
Week 13	Random number generation	CO1 and CO3
Week 14	Simulation Output Analysis	CO1 and CO3

### 20.39.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.39.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.39.13 Textbook/ Reference**

- Numerical Methods for Engineers (7th Edition) by Steven Chapra and Raymond Canale
- Simulation Modeling and Analysis (5th Edition) by Averill M. Law

### **20.40 Description of Course CSE 402**

#### **PART A: General Information**

**20.40.1 Course Title** : Numerical Analysis, Simulation and Modeling Sessional

**20.40.2 Type of Course** : Sessional

**20.40.3 Offered to** : DEPARTMENT OF CSE

**20.40.4 Pre-requisite Course(s)** :

#### **PART B: Course Details**

#### **20.40.5 Course Content (As approved by the Academic Council)**

Sessional based on the theory course CSE 401 titled “Numerical methods, Simulation and Modeling”

#### **20.40.6 Course Objectives**

The students are expected to:

- Write computer programs to implement numerical methods to solve mathematical and engineering problems.
- Write computer programs to implement simulation techniques for performing simulation experiments.

#### **20.40.7 Knowledge required**

##### **Technical**

- Probability and Statistics, Vectors and matrices and Linear Algebra, and Computer programming

##### **Analytical**

- Problem solving and creative thinking

#### **20.40.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Write</b> computer programs to implement numerical methods to solve mathematical and engineering problems.	PO1, PO3, PO5	C4	Lecture and Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Write</b> computer programs to implement simulation techniques for performing simulation experiments.	PO1, PO3, PO5	C4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam

#### 20.40.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√	√				√				√
CO 2		√	√	√	√	√			√	√	√	√			√	√		√		√

#### 20.40.10 Lecture/ Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1-2	Introduction to Numerical Algorithms	CO1
Week 2-4	Assignment on Numerical Methods	CO1
Week 5-6	Assignment on Numerical Methods	CO1
Week 7-8	Assignment on Numerical Methods	CO1
Week 9-10	Assignment on Simulation of systems	CO2
Week 11-12	Assignment on Simulation of systems	CO2
Week 13	Assignment on Simulation of systems	CO2
Week 14	Final Quiz/Viva	CO1 and CO2

### 20.40.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.40.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.40.13 Textbook/ Reference

- Numerical Methods for Engineers (7th Edition) by Steven Chapra and Raymond Canale
- Simulation Modeling and Analysis (5th Edition) by Averill M. Law

## 20.41 Description of Course CSE 405

### PART A: General Information

20.41.1 Course Title	: CYBER SECURITY
20.41.2 Type of Course	: THEORY
20.41.3 Offered to	: DEPARTMENT OF CSE
20.41.4 Pre-requisite Course(s)	: CSE 321

### PART B: Course Details

#### 20.41.5 Course Content (As approved by the Academic Council)

Fundamental concepts: confidentiality, integrity and availability, assurance, authenticity and anonymity; threats and attacks, security principles, Ethical issues in security. Cryptographic concepts: encryption, digital signatures, simple attacks on cryptosystems, cryptographic hash functions, digital certificates, Diffie-Hellman Key Exchange Algorithm; Cryptography: symmetric cryptography, public-key cryptography, cryptographic hash functions, digital signatures, details of AES and RSA cryptography. Security: Operating systems concepts, process security, memory and file system security, physical security, application program security, network security concepts, browser security, physical security, applications security, Security Attacks: buffer overflow and other vulnerabilities due to insecure programming, foot printing, social engineering, Trojans and backdoors, sniffing, denial of service, session hijacking, dictionary attack on password protected systems, threats on components like web servers, web applications, mobile platforms, wireless networks; Security Measures: Firewall, Intrusion detection and prevention.

#### 20.41.6 Course Objectives

The students are expected to:

- i. Study the fundamental concepts of cyber security and cryptographic methodologies.
- ii. Investigate the concepts of different security principals.
- iii. Understand how to avoid security attacks and take appropriate security measures.

### 20.41.7 Knowledge required

#### Technical

- Operating system, Networking

#### Mathematics

- Probability theory, Number theory

### 20.41.8 Course Outcomes (COs)

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand and analyze</b> underlying notions of cyber security, cryptographic technologies.	PO1, PO2, PO3, PO6, PO7, PO8	C2, C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Evaluate</b> different security principles and practices.	PO2, PO4	C5, A5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Analyze</b> security computer security measures (Web, OS, Network) and develop preventions.	PO4, PO5	C6	Lecture	Class Tests or Assignments or Projects, and Final Exam

### 20.41.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√	√	√	√	√			√	√	√					√				
CO2		√	√	√	√	√			√	√	√	√				√	√			√
CO3		√	√	√	√	√		√	√	√	√				√	√				

### 20.41.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction of Cyber Security	CO1
Week 2	Cryptographic concepts and methodologies.	CO1

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 3	Cryptographic concepts and methodologies.	CO1
Week 4	Physical Security	CO1
Week 5	Network Security-1	CO1 and CO2
Week 6	OS Security	CO2
Week 7	OS Security	CO2
Week 8	Network Security-II	CO2
Week 9	Network Security-II	CO2, CO3
Week 10	Web Security	CO2, CO3
Week 11	Web Security	CO3
Week 12	Security measures and prevention	CO3
Week 13	Security measures and prevention	CO3
Week 14	Revision	CO1, CO2, and CO3

#### **20.41.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.41.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.41.13 Textbook/ Reference**

- Introduction to Computer Security [Pearson] Michael Goodrich Roberto Tamassia

#### **20.42 Description of Course CSE 406**

##### **PART A: General Information**

**20.42.1 Course Title** : CYBER SECURITY SESSIONAL

**20.42.2 Type of Course** : SESSIONAL

**20.42.3 Offered to** : DEPARTMENT OF CSE

**20.42.4 Pre-requisite Course(s)** :

## **PART B: Course Details**

### **20.42.5 Course Content (As approved by the Academic Council)**

Fundamental concepts: confidentiality, integrity and availability, assurance, authenticity and anonymity; threats and attacks, security principles, Ethical issues in security; Cryptographic concepts: encryption, digital signatures, simple attacks on cryptosystems, cryptographic hash functions, digital certificates, Diffie-Hellman Key Exchange Algorithm; Cryptography: symmetric cryptography, public-key cryptography, cryptographic hash functions, digital signatures, details of AES and RSA cryptography; Security: Operating systems concepts, process security, memory and file system security, physical security, application program security, network security concepts, browser security, physical security, applications security, Security Attacks: buffer overflow and other vulnerabilities due to insecure programming, foot printing, social engineering , Trojans and backdoors, sniffing, denial of service, session hijacking, dictionary attack on password protected systems, threats on components like web servers, web applications, mobile platforms, wireless networks; Security Measures: Firewall, Intrusion detection and prevention.

### **20.42.6 Course Objectives**

The students are expected to:

- Study different types of cryptosystems and relevant security issues.
- Investigate security issues of software and computer systems and security tools.
- Understand how to avoid and circumvent security flaws of software and computer systems.

### **20.42.7 Knowledge required**

#### **Technical**

- Scripting

#### **Mathematics**

- Number theory, and combinatorics

### **20.42.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b>	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand and apply</b> underlying notions of different cryptosystems	PO1, PO2, PO3, PO6, PO7, PO8	C3, P7	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam
CO2	<b>Analyze</b> security issues of software and systems.	PO2, PO4	C4, A5	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam
CO3	<b>Evaluate and design</b> avoidance and circumvention techniques of security flaws	PO4, PO5	C6	Lecture, Demonstration, and hands-on	Assignments or Projects, and Final Exam

**20.42.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√	√	√			√	√	√	√	√
CO 3		√	√	√	√	√	√	√	√	√	√	√			√	√		√		√

**20.42.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Assignment 1 Declaration on Cryptosystem	CO1
Week 2		CO1
Week 3	Assignment 1 Evaluation	CO1
Week 4		CO1
Week 5	Lab Demonstration for Online 1 on Buffer Overflow	CO2
Week 6		CO2
Week 7	Online 1 on Buffer Overflow	CO2
Week 8		CO2
Week 9	Presentation and Demonstration of Security Tool	CO2, and CO3
Week 10		CO2, and CO3
Week 11	Online 2 on Web Security Project Demonstration	CO2, and CO3
Week 12		CO2, and CO3
Week 13	Final Project Submission	CO2, and CO3
Week 14	Final Quiz	CO1, CO2, and CO3

**20.42.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Online/ Offline Assignments: There will be 3/4 online or offline assignments
- Projects: There will be a project related to topics covered in the sessional
- Final Quiz: A comprehensive Final Quiz will be held at the end of the semester as per the institutional ordinance.

**20.42.12 Distribution of Marks**

Attendance:	10%
Online Assignment:	26%
Offline Assignment	26%
Final Project:	20%
Final Quiz:	20%
<b>Total:</b>	<b>100%</b>

### 20.42.13 Textbook/ Reference

- Computer & Internet Security: A Hands-on Approach (by Wenliang Du)  
[<https://www.handsonsecurity.net/files/chapters/edition3/toc-ci.pdf>]
- Introduction to Computer Security (by Michael T. Goodrich and Roberto Tamassia)  
[<https://www.pearson.com/us/higher-education/program/Goodrich-Introduction-to-Computer-Security/PGM218035.html>]

### 20.43 Description of Course CSE 450

#### PART A: General Information

- 20.43.1 Course Title : Capstone Project
- 20.43.2 Type of Course : SESSIONAL
- 20.43.3 Offered to : DEPARTMENT OF CSE
- 20.43.4 Pre-requisite Course(s) :

#### PART B: Course Details

#### 20.43.5 Course Content (As approved by the Academic Council)

Solving complex engineering problems.

#### 20.43.6 Course Objectives

The students are expected to:

- Identify real-world problems that can be solved using innovative engineering and computing systems
- Analyze requirements of diverse stakeholders and conflicting technical and other issues
- Design solutions to complex engineering problems by identifying the components and the processes, and considering health, safety, cultural, social, environmental and ethical aspects
- Manage projects by preparing timeline, budget and through task distribution
- Develop solutions to complex engineering problems by implementing components using modern tools and resources
- Analyze and validate systems and assess their sustainability and environmental impacts
- Function effectively as an individual and in teams, and engage in independent learning
- Communicate project outcomes effectively through reports, presentations and demonstrations

#### 20.43.7 Knowledge required

Foundations of computer science and engineering.

#### 20.43.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Identify</b> real-world problems solvable using engineering and computing systems	PO1, PO2	C4	Discussion, brainstorming	Presentations, supervisor meetings

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO2	<b>Analyze</b> requirements of diverse stakeholders and conflicting technical and other issues	PO4, PO6	C4	Team work, meetings	Presentations, supervisor meetings
CO3	<b>Design</b> solutions to complex engineering problems considering technical, health, safety, cultural, social, environmental and ethical aspects	PO1, PO3, PO7, PO8	C6, A5	Team work, discussion	Presentations, supervisor meetings
CO4	<b>Develop</b> solutions to complex engineering problems using sound engineering practices	PO1, PO3, PO5	C6, P5	Team work, discussion	Presentation, demonstration
CO5	<b>Analyze</b> complex systems and assess their sustainability and environmental impacts	PO2, PO7	C4	Team work, discussion	Presentation, supervisor meetings
CO6	<b>Manage</b> complex engineering projects	PO11	C6, A4	Team work	Presentation, supervisor meetings
CO7	<b>Engage</b> in independent learning and individual and teamwork	PO9, PO12	A5	Team work	Supervisor meetings
CO8	<b>Communicate</b> effectively through presentations and demonstrations	PO10		Demonstration, presentation, report writing	Demonstration, presentation, report

#### 20.43.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√	√		√	√									√	
CO 2		√	√	√	√	√			√	√				√		√				
CO 3		√	√	√	√	√			√		√		√		√		√	√	√	
CO 4		√	√	√	√	√			√		√		√		√	√	√	√		

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 5		√	√	√	√	√	√		√	√	√					√			√	
CO 6																	√			√
CO 7										√	√	√	√							
CO 8									√	√	√	√								

#### 20.43.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Discussion on Motivation of the Capstone Project	
Week 2-3	Team Formation, Project Ideation	CO1, CO2
Week 4-5	Presentation on the idea and probable solution strategy (i)	CO6
Week 6-7	Presentation on the idea and probable solution strategy (ii)	CO6
Week 8-9	Deliverables (i)	CO3, CO4, CO5
Week 10-11	Discussion with Supervisors (i)	CO7, CO8,
Week 12-13	Deliverables (ii)	CO3, CO4, CO5
Week 15-16	Discussion with Supervisors (ii)	CO7, CO8,
Week 17-18	Deliverables (iii)	CO3, CO4, CO5
Week 19-20	Discussion with Supervisors (iii)	CO7, CO8
Week 21-22	Online Assessment	CO3, CO4
Week 23-26	Project Demo (i)	CO8
Week 26-26	Submission of Final Report	CO8
Week 27-28	Presentation, Project Demo (ii)	CO8

#### 20.43.11 Assessment Strategy

- Supervisor meeting: Meetings with project supervisor.
- Presentations: Presentations before the evaluators and the project supervisor.
- Demonstration: Live and video demonstration of the solution by the students.
- Report: Final report on the project

#### 20.43.12 Distribution of Marks

Supervisor meetings and presentations:	40%
Presentation, demonstration and report:	60%
Total:	100%

## 20.44 Description of Course CSE 409

### PART A: General Information

- 20.44.1 Course Title : Computer Graphics
- 20.44.2 Type of Course : THEORY
- 20.44.3 Offered to : DEPARTMENT OF CSE
- 20.44.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.44.5 Course Content (As approved by the Academic Council)

Basics of computer graphics and its applications; Raster graphics: images and colours; 3D rasterization pipeline: modelling, viewing, projection and viewport transformations; Visible surface detection and hidden surface removal methods: back-face detection, depth buffer method, scan-line algorithm, depth-sorting method, BSP trees method; Scan conversion and antialiasing; Direct illumination; Global illumination: radiosity, shadows; Shading and textures; Ray casting and ray tracing; Fractals; 3D modeling: parametric curves and surfaces using B-spline and Bezier curves and surfaces, polygonal meshes; Graphics hardware and computer games; Computer animation and computer-generated imagery (CGI).

#### 20.44.6 Course Objectives

The students are expected to:

- Know the basics and terminologies of computer graphics
- Understand the different stages of rasterization pipeline,
- Apply ray tracing and illumination techniques to generate realistic images,
- Use advanced technologies in computer graphics.

#### 20.44.7 Knowledge required

##### Technical

- Structured Programming language

#### 20.44.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Distinguish</b> the input, output and tasks of rasterization pipeline stages	PO2 and PO4	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Generate</b> realistic images with suitable technologies	PO3	C5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Use</b> state-of-the-art computer graphics technologies	PO5 and PO12	C3, A5	Lecture, Hands-on and Demonstration	Class Tests or Assignments or Projects, and Final Exam

**20.44.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√					√	√			
CO 3		√	√	√	√	√		√	√	√	√					√				√

**20.44.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to computer graphics	CO1
Week 2	Classical computer graphics technologies	CO3
Week 3	Rasterization pipeline: Modeling transformation	CO1
Week 4	Rasterization pipeline: Modeling transformation	CO1
Week 5	Rasterization pipeline: View, projection and viewport transformation	CO1
Week 6	Rasterization pipeline : Scan conversion and antialiasing	CO1, CO2
Week 7	Visible surface detection	CO1, CO2
Week 8	Visible surface detection	CO1, CO2
Week 9	Ray casting and ray tracing	CO2
Week 10	Illumination	CO2
Week 11	Shading, texture and shadows	CO2
Week 12	Fractals	CO2
Week 13	Parametric curves and surfaces	CO2
Week 14	Advanced computer graphics technologies	CO2, CO3

**20.44.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.44.12 Distribution of Marks

Attendance:	10%
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.44.13 Textbook/ Reference

- Fundamentals of Computer Graphics by Peter Shirley, Steve Marschner et al.
- Computer Graphics: Principles and Practice in C by James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes
- Computer Graphics using OpenGL by Francis S Hill, Jr.
- Schaum's Outline of Computer Graphics by Zhigang Xiang, Roy A. Plastock

#### 20.45 Description of Course CSE 410

##### PART A: General Information

20.45.1 Course Title : Computer Graphics Sessional

20.45.2 Type of Course : SESSIONAL

20.45.3 Offered to : DEPARTMENT OF CSE

20.45.4 Pre-requisite Course(s) :

##### PART B: Course Details

##### 20.45.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 409.

##### 20.45.6 Course Objectives

The students are expected to:

- Implement the different stages of rasterization pipeline,
- Apply ray tracing and illumination techniques to generate realistic images,
- Use advanced technologies in computer graphics.

##### 20.45.7 Knowledge required

###### Technical

- Structured Programming language

##### 20.45.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Demonstrate</b> the different stages of rasterization graphics pipeline	PO3	C3	Lecture, coding and development	Assignments or Projects, Viva, Quiz

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO2	<b>Construct</b> realistic images with ray tracing and illumination	PO3 and PO4	C5, P1	Lecture, coding and development	Assignments or Projects, Viva, Quiz
CO3	<b>Solve</b> graphical problems with classical and modern technologies	PO5 and PO12	C3, A5, P3	Lecture, exercise, hands-on, coding and development	Assignments or Projects, Viva, Quiz

#### 20.45.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√					√				
CO 3		√	√	√	√	√		√	√	√	√					√	√			√

#### 20.45.10 Lecture/ Activity Plan

Week	Topics	Corresponding CO(s)
Week 1, 2	Classical computer graphics technologies	CO3
Week 3, 4	Classical computer graphics technologies	CO3
Week 5, 6, 7	Rasterization pipeline	CO1
Week 8, 9	Ray tracing and illumination: Realistic image construction	CO2
Week 10, 11	Ray tracing and illumination: Realistic image construction	CO2
Week 12, 13	Modern computer graphics technologies	CO3
Week 14	Quiz / Final evaluation	CO1, CO2, CO3

#### 20.45.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Offline/Online Assignments and Viva: Offline/Online assignments will be given regularly. Viva may be taken to assess knowledge and skill of the students.
- Quiz / Final evaluation: A quiz or some other type of final evaluation will be held as per the institutional ordinance.

### 20.45.12 Distribution of Marks (Tentative)

Attendance:	0-10%
Offline and Viva:	40-60%
Online:	15-26%
Quiz:	15-26%
Total:	100%

### 20.45.13 Textbook/ Reference

- Fundamentals of Computer Graphics by Peter Shirley, Steve Marschner et al.
- Computer Graphics: Principles and Practice in C by James D. Foley, Andries van Dam, Steven K. Feiner, John F. Hughes
- Computer Graphics using OpenGL by Francis S Hill, Jr.
- Schaum's Outline of Computer Graphics by Zhigang Xiang, Roy A. Plastock

## 20.46 Description of Course CSE 411

### PART A: General Information

20.46.1 Course Title	: Simulation and Modeling
20.46.2 Type of Course	: THEORY
20.46.3 Offered to	: DEPARTMENT OF CSE
20.46.4 Pre-requisite Course(s)	:

### PART B: Course Details

#### 20.46.5 Course Content (As approved by the Academic Council)

Systems, models, and simulation: The nature of Simulation, Discrete and Continuous Systems, Simulation Software, Areas of Application, Advantages and Disadvantages of Simulation; Agent-Based Simulation and System Dynamics, Spreadsheet Simulation; Input Modeling: Selecting Input Probability Distributions; Generating Random Variates: Inverse-Transform Method, Acceptance-Rejection, Composition, Convolution; Output analysis, Variance-Reduction Techniques, Experimental Design and Optimization; Building Valid, Credible, and Appropriately Detailed Simulation Models; Analysis and Modeling of some practical systems.

#### 20.46.6 Course Objectives

The students are expected to:

- Create a mathematical model for simulating a real-world process or system.
- Learn how to select appropriate probability distributions for input modeling and evaluate simulation output data by proper statistical measures.
- Learn common approaches to generate random variates in a statistically reliable way.

#### 20.46.7 Knowledge required

##### Technical

- Probability and Statistics, Computer programming

##### Analytical

- System design and evaluation

### 20.46.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Create a mathematical model for simulating a real-world process or system.	PO1, PO2	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	Learn how to select appropriate probability distributions for input modeling and evaluate simulation output data by proper statistical measures.	PO3, PO4	C6	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	Learn common approaches to generate random variates in a statistically reliable way.	PO6	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.46.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√						√		√			√
CO 2		√	√	√	√	√			√		√	√							√	√
CO 3		√	√	√	√	√			√											

### 20.46.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Simulation and Modeling Basics	CO1
Week 2	Discreet Event Simulation	CO1
Week 3	Discreet Event Simulation	CO1
Week 4	Other Types of Simulation	CO1 and CO2
Week 5	Review of Basic Probability and Statistics	CO2
Week 6	Input Modeling	CO2
Week 7	Input Modeling	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 8	Input Modeling	CO2
Week 9	Random Variable Generation	CO2
Week 10	Random Variable Generation	CO3
Week 11	Random Variable Generation	CO3
Week 12	Output Analysis	CO3
Week 13	Experimental design and optimization	CO1, CO2, and CO3
Week 14	Experimental design and optimization	CO1, CO2, and CO3

#### 20.46.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.46.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.46.13 Textbook/ Reference

- Simulation Modeling and Analysis (5th Edition) by Averill M. Law
- Discrete-Event System Simulation (5th Edition) by Jerry Banks, John Carson, Barry Nelson
- Simulation (5th Edition) by Sheldon M. Ross

#### 20.47 Description of Course CSE 412

##### PART A: General Information

20.47.1 Course Title : Simulation and Modeling

20.47.2 Type of Course : Sessional

20.47.3 Offered to : DEPARTMENT OF CSE

20.47.4 Pre-requisite Course(s) :

##### PART B: Course Details

#### 20.47.5 Course Content (As approved by the Academic Council)

Sessional based on the theory course CSE 411 titled “Simulation and Modeling”

### 20.47.6 Course Objectives

The students are expected to:

- **Demonstrate** the knowledge to write programs for simulating a real-world process or system.
- **Develop** programs for generating random variates from different probability distributions to run various simulation models and problems.
- **Utilize** output analysis techniques to improve the quality of estimates obtained from simulation runs.

### 20.47.7 Knowledge required

#### Technical

- Probability and Statistics, Computer programming

#### Analytical

- System design and evaluation

### 20.47.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Demonstrate</b> the knowledge to write programs for simulating a real-world process or system.	PO5	C3	Program design for real-world problem solving	Lab assignment, viva, final quiz
CO2	<b>Develop</b> programs for generating random variates from different probability distributions to run various simulation models and problems.	PO2 and PO3	C4	Program design for real-world problem solving	Lab assignment, viva, final quiz
CO3	<b>Utilize</b> output analysis techniques to improve the quality of estimates obtained from simulation runs.	PO3 and PO4	C6	Program design for real-world problem solving	Lab assignment, viva, final quiz

### 20.47.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√	√	√	√	√			√		√				√			√		√
CO2		√	√	√	√	√			√			√								√
CO3		√	√	√	√	√			√			√								√

### 20.47.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Weeks 1-4	Assignment on simulation and modeling of basic queueing systems.	CO1
Week 5-6	Assignment on simulation and modeling of basic inventory models.	CO1
Week 7-8	Assignments on generating random variates from the uniform distribution.	CO2
Week 9-11	Assignments on generating random variates from the various probability distributions.	CO2
Week 12-13	Assignments on Output Data Analysis for a Single System and Comparing Alternative System Configurations	CO3
Week 14	Final quiz	CO1 - CO3

### 20.47.11 Assessment Strategy

- Assignment: There will be four to six assignments. Some assignments may have sub-problems covering multiple topics.
- Viva: There will be a short viva examination on every assignment.
- Final quiz: A final quiz will be held at the end of the semester.

### 20.47.12 Distribution of Marks

Assignment:	50-60%
Viva:	10-20%
Final quiz:	20-30%
Total:	100%

### 20.47.13 Textbook/ Reference

- Simulation Modeling and Analysis (5th Edition) by Averill M. Law
- Discrete-Event System Simulation (5th Edition) by Jerry Banks , John Carson , Barry Nelson
- Simulation (5th Edition) by Sheldon M. Ross

## 20.48 Description of Course CSE 413

### PART A: General Information

20.48.1 Course Title : High Performance Computing

20.48.2 Type of Course : THEORY

20.48.3 Offered to : DEPARTMENT OF CSE

20.48.4 Pre-requisite Course(s) : CSE 209 Computer Architecture

## **PART B: Course Details**

### **20.48.5 Course Content (As approved by the Academic Council)**

Introduction to high performance computing: motivation, applications, challenges; Multi-processor computer organization: architecture, memory hierarchy, and pipelines; Performance measures and analysis: speedup, efficiency and scalability; Program optimization and vectorization; Parallelization strategies: task parallelism, data parallelism, and work sharing techniques; Parallel algorithms: algorithmic techniques, problem decomposition, partitioning and load balancing; High performance parallel programming: shared memory and message passing models, OpenMP and MPI programming; High performance computing with graphics processing unit (GPU): GPU architecture, GPU programming model, GPU languages; High performance cloud and cluster computing: MapReduce programming model, Apache Hadoop.

### **20.48.6 Course Objectives**

Students are expected to:

- Understand high performance computing (HPC), multi-processor computer architecture, issues and strategies in HPC
- Design parallel algorithms and programs for HPC
- Develop parallel and optimized programs for HPC

### **20.48.7 Knowledge required**

#### **Technical**

- Programming and computer architecture.

#### **Analytical**

- Problem formulation and solving.

### **20.48.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> high performance computing (HPC), multi-processor computer architecture, issues and strategies in HPC	-	C2	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Design</b> parallel algorithms and programs for HPC	PO1, PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO3	<b>Develop</b> parallel and optimized programs for HPC	PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

**20.48.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√														
CO 2		√	√	√	√	√			√	√	√	√	√		√		√			
CO 3		√	√	√	√	√			√	√	√	√	√		√		√			

**20.48.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to high performance computing	CO1
Week 2	Multi-processor computer organization	CO1
Week 3	Performance measures and analysis Program optimization and vectorization	CO1
Week 4	Parallelization strategies	CO1, CO2
Week 5	Parallel algorithms	CO1, CO2
Week 6	Shared-memory parallel programming with OpenMP	CO2, CO3
Week 7	Efficient OpenMP programming Locality optimizations	CO2, CO3
Week 8	Distributed-memory parallel programming with MPI	CO2, CO3
Week 9	Efficient MPI programming Hybrid parallelization	CO2, CO3
Week 10	High performance computing with GPUs	CO1, CO2, CO3
Week 11	GPU programming model	CO2, CO3
Week 12	GPU languages	CO2, CO3
Week 13	High performance cloud and cluster computing	CO1, CO2, CO3
Week 14	High performance cloud and cluster computing	CO2, CO3

**20.48.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Assignments: There will be online and offline assignments
- Project: There will be a project involving analytics of data from a domain of choice by the students
- Quiz: A final quiz will be held at the end of the semester

#### 20.48.12 Distribution of Marks

Attendance:	10 %
Assignments:	70%
Quiz:	20%
Total:	100%

#### 20.48.13 Textbook/ Reference

- Parallel and High Performance Computing by Robert Robey, Yuliana Zamora
- Introduction to High Performance Computing for Scientists and Engineers by Georg Hager, Gerhard Wellein
- Parallel Computer Architecture: A Hardware/Software Approach by David Culler, J.P. Singh, Anoop Gupta

#### 20.49 Description of Course CSE 414

##### PART A: General Information

20.49.1 Course Title : High Performance Computing Sessional

20.49.2 Type of Course : SESSIONAL

20.49.3 Offered to : DEPARTMENT OF CSE

20.43.4 Pre-requisite Course(s) : CSE 209 Computer Architecture

##### PART B: Course Details

##### 20.49.5 Course Content (As approved by the Academic Council)

Sessional based on the theory course.

##### 20.49.6 Course Objectives

Students are expected to:

- Understand high performance computing (HPC), multi-processor computer architecture, issues and strategies in HPC
- Design parallel algorithms and programs for HPC
- Develop parallel and optimized programs for HPC

##### 20.49.7 Knowledge required

###### Technical

- Programming and computer architecture.

###### Analytical

- Problem formulation and solving.

### 20.49.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> high performance computing (HPC), multi-processor computer architecture, issues and strategies in HPC	-	C2	Demonstration, individual/team work	Assignments, Quiz
CO2	<b>Design</b> parallel algorithms and programs for HPC	PO2, PO3, PO5	C6	Demonstration, individual/team work	Assignments, Quiz
CO3	<b>Develop</b> parallel and optimized programs for HPC	PO2, PO3, PO5	C6	Demonstration, individual/team work	Assignments, Quiz

### 20.49.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√														
CO 2		√	√	√	√	√			√	√	√	√	√		√		√			
CO 3		√	√	√	√	√			√	√	√	√	√		√		√			

### 20.49.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	High performance computing (HPC) environment demonstration	CO1
Week 2-3	Program optimization and vectorization	CO1, CO3
Week 4-5	Parallel algorithms	CO1, CO2
Week 6-7	Shared-memory parallel programming with OpenMP programming	CO2, CO3
Week 8-9	Distributed-memory parallel programming with MPI	CO2, CO3
Week 10-11	GPU programming	CO2, CO3
Week 12-13	High performance cloud and cluster computing	CO1, CO2, CO3
Week 14	Quiz	CO1, CO2, CO3

#### 20.49.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.49.12 Distribution of Marks

Attendance:	10 %
Assignments and Projects:	60%
Quiz Exam:	30%
Total:	100%

#### 20.49.13 Textbook/ Reference

- a. Parallel and High Performance Computing by Robert Robey, Yuliana Zamora
- b. Introduction to High Performance Computing for Scientists and Engineers by Georg Hager, Gerhard Wellein
- c. Parallel Computer Architecture: A Hardware/Software Approach by David Culler, J.P. Singh, Anoop Gupta

### 20.50 Description of Course CSE 415

#### PART A: General Information

20.50.1 Course Title	: REAL-TIME EMBEDDED SYSTEMS
20.50.2 Type of Course	: THEORY
20.50.3 Offered to	: DEPARTMENT OF CSE
20.50.4 Pre-requisite Course(s)	: N/A

#### PART B: Course Details

#### 20.50.5 Course Content (As approved by the Academic Council)

Embedded architectures: 16/32/64-bit embedded processors; Interaction with devices: buses, memory architectures, memory management, device drivers; Concurrency: software and hardware interrupt, timers; Real-time principles: synchronization, scheduling, multi-tasking; Real-time task scheduling: schedulability analysis, rate, and deadline monotonic scheduling, fixed and dynamic priority scheduling; Feed-back control theory and application; Profiling and code optimization; Embedded software systems: exception handling, loading, mode-switching, programming embedded systems.

#### 20.50.6 Course Objectives

The students are expected to:

- i. Analyze and design different real-time embedded systems.
- ii. Differentiate and select appropriate principles of real-time embedded systems.
- iii. Apply proper concepts in building real-time embedded systems

#### 20.50.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Logic design

### 20.50.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Analyze</b> and design different real-time embedded systems	PO1 and PO2	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 2	<b>Differentiate and select</b> appropriate principles of real-time embedded systems.	PO3 and PO4	A5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO 3	<b>Apply</b> proper concepts in building real-time embedded systems	PO6	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.50.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√			√			√				
CO 2		√	√	√	√	√	√		√	√	√			√			√		√	√
CO 3		√	√	√	√	√				√						√				

### 20.50.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to embedded systems	CO1
Week 2	16/32/64-bit embedded processors	CO1
Week 3	Interaction with devices: buses, memory architectures	CO1
Week 4	Interaction with devices: memory management, device drivers;	CO1
Week 5	Concurrency: software and hardware interrupts, timers	CO2
Week 6	Real-time principles: synchronization	CO2
Week 7	Real-time principles: scheduling, multitasking	CO2
Week 8	Real-time task scheduling: schedulability analysis, rate, and deadline	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 9	Monotonic scheduling, fixed and dynamic priority scheduling;	CO2
Week 10	Feedback control theory and application;	CO2
Week 11	Profiling and code optimization;	CO3
Week 12	Embedded software systems: exception handling, loading	CO3
Week 13	Mode-switching, programming embedded systems.	CO3
Week 14	Wrap up;	CO1, CO2, and CO3

#### 20.50.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.50.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.50.13 Textbook/ Reference

- “Real-Time Embedded Systems: Design Principles and Engineering Practices” 1st Edition, by Xiaocong Fan

### 20.51 Description of Course CSE 416

#### PART A: General Information

20.51.1 Course Title : REAL-TIME EMBEDDED SYSTEMS Sessional

20.51.2 Type of Course : SESSIONAL

20.51.3 Offered to : DEPARTMENT OF CSE

20.51.4 Pre-requisite Course(s) : N/A

#### PART B: Course Details

##### 20.51.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 415

##### 20.51.6 Course Objectives

The students are expected to:

- Analyze and design different real-time embedded systems.
- Differentiate and select appropriate principles of real-time embedded systems.
- Apply proper concepts in building real-time embedded systems

### 20.51.7 Knowledge required

#### Technical

- System design and development

#### Analytical

- Logic design

### 20.51.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> and design different real-time embedded systems	PO1 and PO2	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Differentiate</b> and <b>select</b> appropriate principles of real-time embedded systems.	PO3 and PO4	A5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Apply</b> proper concepts in building real-time embedded systems	PO6	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.51.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√			√			√				
CO 2		√	√	√	√	√	√		√	√	√			√			√		√	√
CO 3		√	√	√	√	√				√						√				

### 20.51.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1/2	Introduction to real-time embedded systems, project discussion	CO1
Week 3/4	Team Formation for Projects, Project Ideation	CO1
Week 5/6	Experiment on concurrency	CO3
Week 7/8	Experiment on synchronization or multitasking	CO3
Week 9/10	Project Update	CO1, CO2, and CO3

Week	Lecture Topics	Corresponding CO(s)
Week 11/12	Experiment on scheduling	CO3
Week 13/14	Presentation on Project, Project demonstration; Submission of Final Report on Project	CO1, CO2, and CO3

#### 20.51.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments: There will be Assignments and a Project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.51.12 Distribution of Marks

Attendance:	10 %
Assignments:	26%
Projects:	40%
Quiz:	26%
Total:	100%

#### 20.51.13 Textbook/ Reference

- “Real-Time Embedded Systems: Design Principles and Engineering Practices” 1st Edition, by Xiaocong Fan

### 20.52 Description of Course CSE 417

#### PART A: General Information

20.52.1 Course Title	: CYBER-PHYSICAL SYSTEMS
20.52.2 Type of Course	: THEORY
20.52.3 Offered to	: DEPARTMENT OF CSE
20.53.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

#### 20.52.5 Course Content (As approved by the Academic Council)

Cyber-physical systems: tight integration of computing, control, and communication; Applications of cyber-physical systems: vehicle systems, smart buildings, mobile computing, and medical devices; Hardware platforms: processors, sensors, actuators, and networks; Software and control: RTOS, scheduling, optimization, optimal control, and algorithm development; Modeling: system modeling, model-based design, and timed-automata; Resource-constrained platforms; Security in cyber-physical systems.

#### 20.52.6 Course Objectives

The students are expected to:

- Analyze and design of different system-level components of cyber physical systems.
- Distinguish and select appropriate applications of cyber physical systems.
- Investigate security and model variants of cyber physical systems.

#### 20.52.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Logic design
- Modeling

### 20.52.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze and design</b> of different system-level components of cyber physical systems.	PO1 and PO3	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Distinguish and select</b> appropriate applications of cyber physical systems.	PO2 and PO6	C4, A5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Investigate</b> security and model variants of cyber physical systems.	PO4	C5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.52.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√		√	√	√			√			√				
CO 2		√	√	√	√	√	√		√	√	√			√		√	√		√	√
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

### 20.52.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to cyber-physical systems	CO1 and CO2
Week 2	Control and communication in cyber-physical systems	CO1
Week 3	Applications of cyber-physical systems	CO2
Week 4	Processors and sensors	CO1
Week 5	Actuators and networks	CO1
Week 6	Actuators and networks	CO1
Week 7	RTOS and scheduling	CO1
Week 8	Optimization, optimal control, and algorithm development	CO1

Week	Lecture Topics	Corresponding CO(s)
Week 9	System modeling, model-based design, and timed-automata	CO3
Week 10	System modeling, model-based design, and timed-automata	CO3
Week 11	Resource-constrained platforms	CO3
Week 12	Security in cyber-physical systems	CO3
Week 13	Security in cyber-physical systems	CO3
Week 14	Wrap up	CO1, CO2, and CO3

#### 20.52.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.52.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.52.13 Textbook/ Reference

- “Introduction to Embedded Systems, A Cyber-Physical Systems Approach” by Edward A. Lee and Sanjit A. Seshia, Second Edition, MIT Press, ISBN 978-0-262-53381-2, 2017 [Source: [https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia\\_DigitalV2\\_2.pdf](https://ptolemy.berkeley.edu/books/leeseshia/releases/LeeSeshia_DigitalV2_2.pdf)]
- “Principles of Cyber-Physical Systems” by Rajeev Alur, ISBN: 9780262029117, Published: April 10, 2015
- “Logical Foundations of Cyber-Physical Systems” by André Platzer, Springer, Cham, 2018. 659 pages. ISBN 978-3-319-63587-3

### 20.53 Description of Course CSE 419

#### PART A: General Information

20.53.1 Course Title	: INTERNET OF THINGS (IoT)
20.53.2 Type of Course	: THEORY
20.53.3 Offered to	: DEPARTMENT OF CSE
20.53.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

### 20.53.5 Course Content (As approved by the Academic Council)

Basics of the Internet of Things (IoT): IoT and its importance, elements of an IoT ecosystem, IoT applications; Sensors and sensor nodes: sensing components and devices; Actuators; Connectivity and networks: wireless technologies for the IoT, edge connectivity and protocols, wireless sensor networks; Variants of IoT: low power embedded systems, distributed systems, cloud, and edge IoT systems, and real-time IoT systems; Basics of IoT security; Performance analysis of IoT systems; Analytics and applications: signal processing, real-time and local analytics, databases, and cloud analytics.

### 20.53.6 Course Objectives

The students are expected to:

- Understand and explain the key components that make up an IoT system.
- Differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack.
- Apply the knowledge and skills to build and test complete, working IoT system(s) involving prototyping, programming, and data analysis

### 20.53.7 Knowledge required

#### Technical

- System design and development

#### Analytical

- Logic design

### 20.53.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> architectures and operations of different types of IoT systems	PO1 and PO2	C4, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and develop</b> IoT systems for different real-life scenarios	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Create and evaluate</b> IoT systems	PO6	C6, P7	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.53.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√		√	√	√	√					√		√		
CO 2		√	√	√	√	√		√	√	√	√			√	√	√	√	√		√
CO 3		√	√	√	√	√			√	√	√				√	√				√

### 20.53.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to IoT and its importance	CO1
Week 2	Elements of an IoT ecosystem	CO1
Week 3	Sensors and Sensor nodes	CO1
Week 4	Actuators in an IoT ecosystem	CO1 and CO2
Week 5	Wireless technologies for IoT	CO2
Week 6	Edge connectivity and protocols	CO2
Week 7	Wireless sensor networks	CO2
Week 8	Low-power embedded systems	CO2
Week 9	Distributed, cloud, edge, and real-time IoT systems	CO2
Week 10	Basics of IoT security	CO3
Week 11	Performance analysis of IoT systems	CO3
Week 12	Signal processing, real-time and local analytics	CO3
Week 13	Databases and cloud analytics	CO3
Week 14	Wrap up;	CO1, CO2, and CO3

### 20.53.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.53.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.53.13 Textbook/ Reference

- a. "Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects)" by Cuno Pfister, 1st Edition
- b. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, 1st Edition

### 20.54 Description of Course CSE 421

#### PART A: General Information

20.54.1 Course Title	Basic Graph Theory
20.54.2 Type of Course	Optional
20.54.3 Offered to	Department of Computer Science and Engineering
20.54.4 Pre-requisite Course(s)	

#### PART B: Course Details

##### 20.54.5 Course Content (As approved by the Academic Council)

Graphs: simple graphs, digraphs, subgraphs, vertex-degrees, walks, paths and cycles; Trees, spanning trees in graphs, distance in graphs; Complementary graphs, cut-vertices, bridges and blocks, k-connected graphs; Euler tours, Hamiltonian cycles, Chinese Postman Problem, Traveling Salesman Problem; Chromatic number, chromatic polynomials, chromatic index, Vizing theorem, planar graphs, perfect graphs.

##### 20.54.6 Course Objectives

- To introduce applications and terminologies of graph theory.
- To make the student capable of deriving proofs of graph theoretic propositions.
- To teach the students how to develop efficient algorithms based on graph theoretic proofs.
- To demonstrate the modeling of real-world problems with graph theoretic concept with a view to solve them using graph theoretic algorithms.

##### 20.54.7 Knowledge required

Discrete Mathematics, Data Structures and Algorithms

### 20.54.8 Course Outcomes

CO No.	CO Statement After completing this course students will be able to	Corresponding PO(s)	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Explain</b> the concepts and terminologies of graph theory,		C2, A2	Lectures	Written exams; assignment
CO2	<b>Derive</b> proof of graph theoretic propositions,		C6, A3	Lectures	Written exams; assignment
CO3	<b>Design</b> efficient algorithms based on graph theoretic proofs	PO1	C6, A3	Lectures	Written exams; assignment
CO4	<b>Develop</b> graph theoretic models of real world problems in a view to solve them using graph algorithmic techniques.	PO2	C6, A3	Lectures	Written exams; assignment

### 20.54.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1			√	√	√	√										√				
CO 2			√	√	√	√			√	√	√			√			√			
CO 3			√	√	√	√			√	√	√				√			√		√
CO 4			√	√	√	√			√	√	√					√				

### 20.54.10 Lecture Plan / Activity Plan

Week	Topics	References	Corresponding CO(s)
Week 1	Graphs and their applications; Basic graph terminologies: graphs and multigraphs.	Ch1	CO1
Week 2	Basic graph terminologies: adjacency, incidence and degree, subgraphs; Elementary classes of graphs, Operations on graphs.	Ch2	CO1
Week 3	Graph Isomorphism; Data structures and graph representations; Degree sequence.	Ch2	CO1

Week	Topics	References	Corresponding CO(s)
Week 4	Walks, trails, paths and cycles; Eulerian graphs.	Ch3	CO1, CO2
Week 5	Hamiltonian graphs; Connectivity.	Ch3	CO1-CO4
Week 6	Connected separable graphs and block-cutvertex tree; 2-connected graphs, Ear decomposition.	Ch3	CO1-CO4
Week 7	Properties of trees, rooted trees, spanning trees	Ch4	CO1-CO4
Week 8	Counting of trees, distances in trees and graphs, graceful labeling.	Ch4	CO1-CO4
Week 9	Matching: perfect matching, maximum matching, Hall's matching condition.	Ch5	CO1-CO4
Week 10	Covers, independent sets, dominating sets; Planar graphs: Kuratowski's characterization, Euler's formula.	Ch5, Ch6	CO1-CO4
Week 11	Planar graphs: thickness of graphs, dual graphs, straight-line drawings of planar graphs.	Ch6	CO1-CO4
Week 12	Graph coloring: vertex coloring, edge coloring, map coloring.	Ch7	CO1-CO4
Week 13	Chromatic polynomials ; Digraphs	Ch7, Ch8	CO1-CO4
Week 14	Special classes of graphs. Recent advancement in graph theory.	Ch9, Ch10	CO1-CO4

#### 20.54.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

#### 20.54.12 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

#### 20.54.13 Textbook / References

1. Md. Saidur Rahman, Basic Graph Theory, Springer, 2017.
2. Robin J. Wilson, Introduction to Graph Theory, 4<sup>th</sup> Edition, Pearson Education Asia, 1995.
3. Douglas B. West, Introduction to Graph Theory, 2<sup>nd</sup> Edition, Pearson Education Asia, 2001.
4. Takao Nishizeki and Md. Saidur Rahman, Planar Graph Drawing, World Scientific, 2004.

## 20.55 Description of Course CSE 423

### PART A: General Information

20.55.1 Course Title : FAULT TOLERANT SYSTEMS

20.55.2 Type of Course : THEORY

20.55.3 Offered to : DEPARTMENT OF CSE

20.55.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.55.5 Course Content (As approved by the Academic Council)

Introduction: background and motivation, dependability attributes, probability distributions; Reliability modeling: combinational modeling, state-space modeling; System view of high availability design; Defects: defect avoidance, shielding and hardening, defect circumvention, yield enhancement; Faults: fault testing, design for testability, fault masking, replication with voting; Errors: error detection, self-checking modules, error correction, redundant disk arrays; Hardware redundancy: basic approaches, static and dynamic, voting, fault tolerant interconnection networks; Software redundancy: software reliability models, software aging, N-version programming; Degradation allowance: performability of a fail-soft system, checkpointing and rollback.

#### 20.55.6 Course Objectives

The students are expected to:

- Analyze different notions of fault tolerance.
- Investigate reliability of different types of systems.
- Distinguish and design methodologies to overcome defects and to harden systems.

#### 20.55.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Probability theory

#### 20.55.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> different notions of fault tolerance.	PO1, PO2, and PO7	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Investigate</b> reliability of different types of systems.	PO4 and PO6	A5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Distinguish</b> and <b>design</b> methodologies to overcome defects	PO3 and PO5	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	and to harden systems.				

### 20.55.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√					√					√
CO 2		√	√	√	√	√			√	√				√		√	√			
CO 3		√	√	√	√	√			√		√	√			√			√		√

### 20.55.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction and terminologies	CO1
Week 2	Fault models	CO1
Week 3	Probability theory	CO1
Week 4	Reliability modeling using probability theory	CO1 and CO2
Week 5	Reliability modeling using probability theory	CO2
Week 6	Different modeling approaches	CO2
Week 7	Different modeling approaches	CO2
Week 8	Reliability modeling different types of systems	CO2
Week 9	Defect avoidance	CO3
Week 10	Defect circumvention	CO3
Week 11	Shielding and hardening	CO3
Week 12	Yield enhancement	CO3
Week 13	Degradation allowance	CO3
Week 14	Revision	CO1, CO2, and CO3

### 20.55.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.55.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.55.13 Textbook/ Reference

- a. Dependable Computing: A Multilevel Approach (by Behrooz Parhami)  
[[http://www.ece.ucsb.edu/~parhami/text\\_dep\\_comp.htm#text](http://www.ece.ucsb.edu/~parhami/text_dep_comp.htm#text)]

## 20.56 Description of Course CSE 426

### PART A: General Information

20.56.1 Course Title : HUMAN COMPUTER INTERACTION

20.56.2 Type of Course : THEORY

20.56.3 Offered to : DEPARTMENT OF CSE

20.56.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.56.5 Course Content (As approved by the Academic Council)

User interface development: iterative design, rapid prototyping, low-fidelity interactive prototyping, comparative evaluation of multiple interfaces, evaluation of user interface, heuristic evaluation; UI design models: system model, interface model, user model; Usability: consistency, simplicity, learnability, efficiency, safety, ergonomics, aesthetics; Accessibility: kinds of impairments, assistive technology, universal design, accessibility APIs; Internationalization and Localization: translation, text direction, sort order, formatting, color conventions, icons; User research methods: experiments, experiment design techniques, eld study, survey; Multimodal signal processing: recognize human emotions through a combination of spoken language, gestures, facial expressions; Case studies.

#### 20.56.6 Course Objectives

The students are expected to:

- Analyze and understand different notions of Human-Computer Interaction (HCI).
- Distinguish and select appropriate applications of different aspects of Human-Computer Interaction (HCI).
- Design and create different systems using/ensuring HCI issues.

#### 20.56.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Modelling

**20.56.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Analyze</b> and <b>understand</b> different notions of Human-Computer Interaction (HCI)	PO1 and PO3	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Distinguish</b> and <b>select</b> appropriate applications of different aspects of Human-Computer Interaction (HCI)	PO2 and PO6	A5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Design</b> and <b>create</b> different systems using/ensuring HCI issues	PO4	C5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

**20.56.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√			√	√									√	
CO 2		√	√	√	√	√			√	√					√	√	√			
CO 3		√	√	√	√	√	√		√		√	√						√		√

**20.56.10 Lecture/ Activity Plan**

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	Introduction to Human-Computer Interaction	CO1 and CO2
Week 2	Interaction Design	CO1
Week 3	Understanding Users, Cognitive and Affective Factors	CO2
Week 4	The Computer and Human-Computer Interaction	CO1
Week 5	Web Interfaces	CO1
Week 6	Introduction to Interactive System Design	CO1
Week 7	Discuss Data Gathering and Requirements Analysis with focus on HCI aspects	CO1
Week 8	Data Gathering and Requirements Analysis with a focus in HCI aspects	CO1

Week	Lecture Topics	Corresponding CO(s)
Week 9	Interfaces Design	CO3
Week 10	Prototyping	CO3
Week 11	Usability Testing	CO3
Week 12	Analytic Evaluation	CO3
Week 13	Project Presentation	CO3
Week 14	Evaluation	CO1, CO2, and CO3

### 20.56.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.56.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

## 20.57 Description of Course CSE 427

### PART A: General Information

20.57.1 Course Title	: Network Security
20.57.2 Type of Course	: THEORY
20.57.3 Offered to	: DEPARTMENT OF CSE
20.57.4 Pre-requisite Course(s)	: CSE 321, CSE 405

### PART B: Course Details

#### 20.57.5 Course Content (As approved by the Academic Council)

Network security policies, strategies and guidelines; Network security assessments and matrices; Security at Transport layer: SSL, TLS, SSH; Security on Network layer: IPsec; Security for wireless network protocols: WEP, WPA, WPA2; Security protocols for Ad-hoc network; Security protocols for Sensor network; Security for communication protocols; Security for operating system and mobile agents; Security for LAN and WAN; Switching and routing security; Network security applications: AAA standards, e-mail securities, PGP, S/MIME; PKI smart cards; Sandboxing; Firewalls and Proxy server.

#### 20.57.6 Course Objectives

The students are expected to:

- i. **Explain** security features, policies and strategies adopted on different layers of protocol stack of computer networks.
- ii. **Identify** security flaws and solutions of different network and communication technologies and devices.
- iii. **Apply** network security concepts to mitigate cyber security risks on real life applications.

#### 20.57.7 Knowledge required

##### Technical

- Computer programming

##### Analytical

- None

#### 20.57.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Explain</b> security features, policies and strategies adopted on different layers of protocol stack of computer networks.	PO1, PO4	C2, A3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 2	<b>Identify</b> security flaws and solutions of different network and communication technologies and devices.	PO1, PO2	C3	Lecture, Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO 3	<b>Apply</b> network security concepts to mitigate cyber security risks on real life applications	PO3, PO5	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

#### 20.57.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√						√				√		√		
CO 2		√	√	√	√	√		√	√	√	√					√	√	√		√
CO 3		√	√	√	√	√			√	√	√			√	√	√	√			√

### 20.57.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Network security policies, strategies and guidelines	CO1, CO2
Week 2	Network security assessments and matrices	CO1, CO2
Week 3	Security at Transport layer: SSL, TLS, SSH	CO1
Week 4	Security on Network layer: IPSec	CO1
Week 5	Security for wireless network protocols: WEP, WPA, WPA2	CO1
Week 6	Security protocols for Ad-hoc network	CO2
Week 7	Security protocols for Sensor network	CO2
Week 8	Security for communication protocols	CO2
Week 9	Security for operating system and mobile agents	CO2
Week 10	Security for LAN and WAN; Switching and routing security	CO2
Week 11	Network security applications: AAA standards, e-mail securities	CO3
Week 12	Network security applications: PGP, S/MIME; PKI smart cards	CO3
Week 13	Network security applications: Sandboxing; Firewalls and Proxy server	CO3
Week 14	Wrap up;	CO1, CO2, and CO3

### 20.57.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.57.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.57.13 Textbook/ Reference

- a. "Guide to Computer Network Security", Joseph Migga Kizza, 2<sup>nd</sup> Edition

## 20.58 Description of Course CSE 428

### PART A: General Information

20.58.1 Course Title : Network Security Sessional

20.58.2 Type of Course : SESSIONAL

20.58.3 Offered to : DEPARTMENT OF CSE

20.58.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.58.5 Course Content (As approved by the Academic Council)

Seasonal based on CSE 427

#### 20.58.6 Course Objectives

The students are expected to:

- i. **Explain** security features, policies and strategies adopted on different layers of protocol stack of computer networks.
- ii. **Identify** security flaws and solutions of different network and communication technologies and devices.
- iii. **Apply** network security concepts to mitigate cyber security risks on real life applications.

#### 20.58.7 Knowledge required

##### Technical

- Computer programming

##### Analytical

- None

#### 20.58.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Explain</b> security features, policies and strategies adopted on different layers of protocol stack of computer networks.	-	C2, A3, P4	Demonstration and Lab Work	Assignment
CO 2	<b>Identify</b> security flaws and solutions of different network and communication technologies and devices.	PO1, PO2	C3	Demonstration and Lab Work	Assignment
CO 3	<b>Apply</b> network security concepts to mitigate cyber security risks on real life applications	PO3, PO5	C3	Demonstration and Lab Work	Project

**20.58.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√						√				√		√		
CO 2		√	√	√	√	√		√	√	√	√					√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√			√	√	√	√			

**20.58.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Assignment 1 on TLS	CO1
Week 2		
Week 3	Assignment 2 on IPSec	CO1
Week 4		
Week 5	Assignment 3 on Wireless Network	CO1, CO2
Week 6		
Week 7	Assignment 4 on Operating Systems and Mobile Agents	CO2
Week 8		
Week 9	Project Proposal Presentation	CO3
Week 10		
Week 11	Project Progress Evaluation	CO3
Week 12		
Week 13	Final Project Submission and Quiz	CO1, CO2, CO3
Week 14		

**20.58.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

**20.58.12 Distribution of Marks**

Attendance:	10%
Online Assignment:	20%
Offline Assignment	20%

Final Project:	30%
Final Quiz:	20%
Total:	100%

## 20.59 Description of Course CSE 429

### PART A: General Information

20.59.1 Course Title	: Deep Learning
20.59.2 Type of Course	: THEORY
20.59.3 Offered to	: DEPARTMENT OF CSE
20.59.4 Pre-requisite Course(s)	: CSE 329 Machine Learning

### PART B: Course Details

#### 20.59.5 Course Content (As approved by the Academic Council)

Modern practices in deep neural networks: hidden units, architectural design, back-propagation and automatic differentiation; Regularization: norm penalties, dataset augmentation, noise robustness, early stopping, parameter tying and parameter sharing; Optimization algorithms: adaptive gradient methods, approximate second-order methods; Linear factor models: probabilistic PCA, factor analysis, independent component analysis (ICA), sparse coding, manifold interpretation of PCA; Deep generative models: autoencoders, generative adversarial networks (GAN), variational autoencoder (VAE); Representation learning: transfer learning and domain adaptation, semi-supervised, self-supervised deep learning, contrastive learning; Deep recommender systems: neural collaborative filtering for personalized ranking, deep factorization machines; Deep learning on graphs; Deep reinforcement learning; Bayesian deep learning; Efficient neural networks: sparsity, parameter and compute efficient neural networks; Multi-task and meta learning, multi-modal learning; Energy-based models; Interpretability and analysis of deep neural networks; Causality and explainability in deep learning.

#### 20.59.6 Course Objectives

After undergoing this course, students should be able to:

- Know and comprehend the fundamentals of deep learning.
- Interpret, analyse and evaluate deep learning systems.
- Design and construct suitable deep learning models, within the boundaries of the ethical and societal obligations of engineers, to solve practical problems.

#### 20.59.7 Knowledge required

##### Technical

- Differential calculus, linear algebra, probabilistic reasoning.

##### Analytical

- Problem formulation and solving.

### 20.59.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Know</b> and <b>comprehend</b> the fundamentals of deep learning.	PO6, PO7, PO8	C2	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Interpret, analyse</b> and <b>evaluate</b> deep learning systems.	PO1, PO2, PO4, PO5	C5, A5	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO3	<b>Design</b> and <b>construct</b> suitable deep learning models, within the boundaries of the <b>ethical and societal obligations of engineers</b> , to solve practical problems.	PO3, PO5, PO6, PO8, PO12	C6, A5	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

### 20.59.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√	√	√	√	√														
CO2		√	√	√	√	√			√	√		√			√	√	√	√		
CO3		√	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	√

### 20.59.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Modern practices in deep neural networks	CO1
Week 2	Regularization	CO1
Week 3	Optimization algorithms	CO1
Week 4	Linear factor models	CO1
Week 5	Deep generative models	CO1
Week 6	Representation learning	CO1
Week 7	Deep recommender systems	CO1
Week 8	Deep learning on graphs	CO1
Week 9	Deep reinforcement learning	CO1

Week	Lecture Topics	Corresponding CO(s)
Week 10	Bayesian deep learning	CO1
Week 11	Efficient neural networks	CO1, CO2, CO3
Week 12	Multi-task and meta learning, multi-modal learning, Energy-based models	CO1
Week 13	Interpretability, causality and explainability in deep learning	CO1, CO2, CO3
Week 14	Review	CO1, CO2, CO3

### 20.59.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.59.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.59.13 Textbook/ Reference

- “Deep learning” by Ian Goodfellow, Yoshua Bengio and Aaron Courville.
- “Dive into Deep Learning” (Online Edition) by Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola

## 20.60 Description of Course CSE 431

### PART A: General Information

20.60.1 Course Title : NATURAL LANGUAGE PROCESSING

20.60.2 Type of Course : THEORY

20.60.3 Offered to : DEPARTMENT OF CSE

20.60.4 Pre-requisite Course(s) : CSE 329 (Machine Learning)

### PART B: Course Details

#### 20.60.5 Course Content (As approved by the Academic Council)

Introduction to Natural Language Processing (NLP): NLP tasks and applications; Language Models: The role of language models, Simple N-gram models, Estimating parameters and smoothing, Evaluating language models; Sequence Labeling; Topic modeling: TF-IDF, LSI, LDA; Deep Learning for NLP: word embeddings, RNNs, LSTMs, sequence-to-sequence models; Self-attention and Transformers; Parsing: semantic parsing, dependency parsing, constituency parsing; NLP for information extraction and information retrieval; Transfer learning and

pre-trained language models: ELMo, GPT, BERT, T5; NLP for social media; Interpretability and analysis of language models; Advanced topics in NLP.

### 20.60.6 Course Objectives

The students are expected to:

- i. Understand the basic concepts of natural language processing
- ii. Understand different NLP tasks and applications
- iii. Develop, analyze, and evaluate language models for different NLP tasks
- iv. Understand the working mechanisms of different NLP models and algorithms

### 20.60.7 Knowledge required

#### Technical

- Introductory knowledge of machine learning, probability, statistics, and linear algebra is recommended. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

#### Analytical

- None

### 20.60.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Interpret</b> different NLP tasks and applications	PO1 and PO2	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 2	<b>Design and implement</b> different NLP models for various downstream tasks	PO3 and PO4	C6, A4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO 3	<b>Analyze and evaluate</b> language models used in different NLP tasks	PO5	BC6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.60.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√		√	√	√	√	√			√	√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

### 20.60.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to Natural Language Processing (NLP): NLP tasks and applications	CO1
Week 2	Language Models: The role of language models, Simple N-gram models, Estimating parameters and smoothing	CO2
Week 3	Evaluating language models, Sequence Labeling;	CO2
Week 4	Topic modeling: TF-IDF, LSI, LDA	CO2 and CO3
Week 5	Deep Learning for NLP: word embeddings, RNNs	CO1 and CO2
Week 6	LSTMs, sequence-to-sequence models	CO2
Week 7	Self-attention and Transformers	CO2
Week 8	Parsing: semantic parsing, dependency parsing, constituency parsing	CO2
Week 9	NLP for information extraction and information retrieval	CO1 and CO2
Week 10	Transfer learning and pre-trained language models, ELMo	CO1 and CO2
Week 11	GPT, BERT, T5	CO1 and CO2
Week 12	NLP for social media	CO2 and CO3
Week 13	Interpretability and analysis of language models	CO2 and CO3
Week 14	Advanced topics in NLP; Wrap up	CO1, CO2, and CO3

### 20.60.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.60.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.60.13 Textbook/ Reference

- Foundations of Statistical Natural Language Processing by Christopher D. Manning and Hinrich Schütze
- Speech and Language Processing by Dan Jurafsky and James H. Martin

## 20.61 Description of Course CSE 432

### PART A: General Information

20.61.1 Course Title : NATURAL LANGUAGE PROCESSING SESSIONAL

20.61.2 Type of Course : SESSIONAL

20.62.3 Offered to : DEPARTMENT OF CSE

20.62.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.62.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 431

#### 20.62.6 Course Objectives

The students are expected to:

- Understand the basic concepts of natural language processing.
- Understand different NLP tasks and applications.
- Develop, analyze, and evaluate language models for different NLP tasks.
- Understand the working mechanisms of different NLP models and algorithms.

#### 20.62.7 Knowledge required

##### Technical

- Introductory knowledge of machine learning, probability, statistics, and linear algebra is recommended. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

##### Analytical

- None

#### 20.62.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Interpret</b> different NLP tasks and applications	PO1 and PO2	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and implement</b> different NLP models for various downstream tasks	PO3 and PO4	C6, P4 and A4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Analyze and evaluate</b> language models used in different NLP tasks	PO5	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

#### 20.62.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√		√	√	√	√	√	√		√	√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

#### 20.62.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1/2	Introduction to NLP; Discussion on Projects	CO1
Week 3/4	Team Formation for Projects, Project Ideation	CO1 and CO2
Week 5/6	Assignment on basics of language modelling	CO1 and CO2
Week 7/8	Assignment on deep learning for NLP	CO1 and CO2
Week 9/10	Project Update	CO1 and CO2
Week 11/12	Project Submission; Quiz	CO1 and CO2
Week 13/14	Presentation on Project, Project demonstration; Submission of Final Report on Project	CO1, CO2, and CO3

#### 20.62.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

#### 20.62.12 Distribution of Marks

Attendance:	10 %
Assignments and Projects:	60%
Quiz Exam:	30%
Total:	100%

#### 20.62.13 Textbook/ Reference

- Foundations of Statistical Natural Language Processing by Christopher D. Manning and Hinrich Schütze
- Speech and Language Processing by Dan Jurafsky and James H. Martin

## 20.62 Description of Course CSE 433

### PART A: General Information

20.62.1 Course Title	: IMAGE PROCESSING AND COMPUTER VISION
20.62.2 Type of Course	: THEORY
20.62.3 Offered to	: DEPARTMENT OF CSE
20.62.4 Pre-requisite Course(s)	: CSE 329 (Machine Learning)

### PART B: Course Details

#### 20.62.5 Course Content (As approved by the Academic Council)

Introduction; Digitization of images and its properties; Data structures for image analysis; Image processing; Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region-oriented segmentation, use of motion in segmentation; Image transforms: Z-transform, 2D Fourier transform, discrete cosine transform; Image compression: run-length coding, transform coding, standards. Introduction to computer vision; Image classification using convolutional neural networks; CNN architectures; image augmentation; semantic segmentation, object detection, and instance segmentation with RCNN and YOLO networks, Deep generative models: variational autoencoders (VAE) and generative adversarial networks (GAN) for computer vision; Image style transfer; Computer vision for multi-modal and video data; Advanced topics in computer vision.

#### 20.62.6 Course Objectives

The students are expected to:

- Understand the basic concepts of image processing and computer vision
- Understand different image processing and computer vision tasks and applications
- Develop, analyze, and evaluate image processing and computer vision models for different IP and CV tasks
- Understand the working mechanisms of different IP and CV models and algorithms

#### 20.62.7 Knowledge required

##### Technical

- Introductory knowledge of machine learning, probability, statistics, and linear algebra is recommended. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

##### Analytical

- None

#### 20.62.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Interpret</b> different image processing and computer vision tasks and applications	PO1 and PO2	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and implement</b> different image processing and computer vision	PO3 and PO4	C6, A4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	models for various downstream tasks				
CO3	<b>Analyze and evaluate</b> models used in different image processing and computer vision tasks	PO5	C4, C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.62.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√		√	√	√	√				√	√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

### 20.62.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction; Digitization of images and its properties	CO1
Week 2	Data structures for image analysis	CO1
Week 3	Image processing; Segmentation: detection of discontinuities, edge linking and boundary detection	CO2 and CO3
Week 4	Segmentation: thresholding, region-oriented segmentation, use of motion in segmentation	CO2 and CO3
Week 5	Image transforms: Z-transform, 2D Fourier transform	CO1 and CO2
Week 6	Image transforms: discrete cosine transform; Image compression: run-length coding	CO2
Week 7	Image compression: transform coding, standards; Revision	CO1, CO2, and CO3
Week 8	Introduction to computer vision; Image classification using convolutional neural networks	CO2
Week 9	CNN architectures; image augmentation;	CO1 and CO2
Week 10	Semantic segmentation, object detection, and instance segmentation with RCNN and YOLO networks	CO1 and CO2

Week	Lecture Topics	Corresponding CO(s)
Week 11	Deep generative models: variational autoencoders (VAE) for computer vision	CO1 and CO2
Week 12	Deep generative models: generative adversarial networks (GAN) for computer vision	CO2 and CO3
Week 13	Image style transfer; Computer vision for multi-modal and video data;	CO2 and CO3
Week 14	Advanced topics in computer vision; Revision	CO1, CO2, and CO3

### 20.62.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.62.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.62.13 Textbook/ Reference

- Digital Image Processing, Third Edition, by Rafael C. Gonzalez and Richard E. Woods
- Computer Vision: Algorithms and Applications by Richard Szeliski
- Computer Vision: Models, Learning, and Inference by Simon. J. D. Prince

## 20.63 Description of Course CSE 434

### PART A: General Information

20.63.1 Course Title : IMAGE PROCESSING AND COMPUTER VISION

20.63.2 Type of Course : SESSIONAL

20.63.3 Offered to : DEPARTMENT OF CSE

20.63.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.63.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 433 (IP and CV)

### 20.63.6 Course Objectives

The students are expected to:

- Understand the basic concepts of image processing and computer vision
- Understand different image procession and computer vision tasks and applications
- Develop, analyze, and evaluate image processing and computer vision models for different IP and CV tasks
- Understand the working mechanisms of different IP and CV models and algorithms

### 20.63.7 Knowledge required

#### Technical

- Introductory knowledge of machine learning, probability, statistics, and linear algebra is recommended. Knowledge of any high-level programming language, such as python, may be an added advantage for the learners

#### Analytical

- None

### 20.63.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Interpret</b> different image processing and computer vision tasks and applications	PO1 and PO2	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and implement</b> different image processing and computer vision models for various downstream tasks	PO3 and PO4	C6, A4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Analyze and evaluate</b> models used in different image processing and computer vision tasks	PO5	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.63.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√		√	√	√	√				√	√	√	√		√
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

### 20.63.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1/2	Introduction to IP and CV; Discussion on Projects	CO1
Week 3/4	Team Formation for Projects, Project Ideation	CO1 and CO2
Week 5/6	Assignment on basics of IP and CV	CO1 and CO2
Week 7/8	Assignment on deep learning for IP and CV	CO1 and CO2
Week 9/10	Project Update	CO1 and CO2
Week 11/12	Project Submission; Quiz	CO1 and CO2
Week 13/14	Presentation on Project, Project demonstration; Submission of Final Report on Project	CO1, CO2, and CO3

### 20.63.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

### 20.63.12 Distribution of Marks

Attendance:	10 %
Assignments and Projects:	60%
Quiz Exam:	30%
Total:	100%

### 20.63.13 Textbook/ Reference

- Digital Image Processing, Third Edition, by Rafael C. Gonzalez and Richard E. Woods
- Computer Vision: Algorithms and Applications by Richard Szeliski
- Computer Vision: Models, Learning, and Inference by Simon. J. D. Prince

## 20.64 Description of Course CSE 435

### PART A: General Information

20.64.1 Course Title : Introduction to Quantum Computing

20.64.2 Type of Course : THEORY

20.64.3 Offered to : DEPARTMENT OF CSE

20.64.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.64.5 Course Content (As approved by the Academic Council)

Quantum computation: evolution and applications; Basics of quantum computing: qubit representation, measurement, and superposition; Multi-qubit operations; Quantum circuits: design and architecture; Bell state and Bell-basis; Quantum operations: entanglement and teleportation; Noise and error correction; Quantum hardware; Quantum algorithms; Quantum artificial intelligence; Quantum networking.

### 20.64.6 Course Objectives

The students are expected to:

1. Learn the theory and practice of quantum systems and computing (including differences with conventional computing)
2. Learn to formulate and solve various conventional problems in quantum computing paradigm
3. Learn various frontier technologies in computer science (e.g., artificial intelligence, networking etc.) in quantum computing framework

### 20.64.7 Knowledge required

#### Technical

- Programming
- Engineering Mathematics including Linear Algebra

#### Analytical

- Logic design

### 20.64.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Study and Analyze</b> the theory and practice of quantum systems and computing (including differences with conventional computing)	PO1 and PO2	C4, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Formulate and solve</b> various conventional problems in quantum computing paradigm	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Study and Analyze</b> frontier technologies in computer science in quantum computing framework.	PO6	C4, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.64.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√							√		√	
CO 2		√	√	√	√	√	√		√		√	√		√		√	√		√	√
CO 3		√	√	√	√	√		√	√		√	√		√						

### 20.64.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Quantum computation: evolution and applications	CO1
Week 2	Basics of quantum computing	CO1
Week 3	Multi-qubit operations	CO1
Week 4	Quantum circuits	CO1 and CO2
Week 5	Bell state and Bell-basis	CO1
Week 6	Quantum operations	CO1, CO2
Week 7	Noise and error correction	CO1
Week 8	Quantum hardware	CO1, CO2, CO3
Week 9	Quantum hardware	CO1, CO2, CO3
Week 10	Quantum algorithms	CO2
Week 11	Quantum algorithms	CO2
Week 12	Quantum artificial intelligence	CO3
Week 13	Quantum networking	CO3
Week 14	Wrap up	CO1, CO2, CO3

### 20.64.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.64.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.64.13 Textbook/ Reference

- a. "Quantum Computing: An Applied Approach" by Jack D. Hidary, 2<sup>nd</sup> Edition, 2021, Springer.
- b. "Dancing with Qubits: How quantum computing works and how it can change the world" by Robert S. Sutor, 2<sup>nd</sup> Edition.
- c. "Quantum Computing Explained" by David McMahon 1st Edition.

## 20.65 Description of Course CSE 437

### PART A: General Information

20.65.1 Course Title : Data Science and Big Data Analytics

20.65.2 Type of Course : THEORY

20.65.3 Offered to : DEPARTMENT OF CSE

20.65.4 Pre-requisite Course(s) : CSE 329 Machine Learning

### PART B: Course Details

#### 20.65.5 Course Content (As approved by the Academic Council)

Introduction to data science and big data: business intelligence, application domains; Data analytics life cycle: discovery, data preparation, model planning, model building, communicating results & operationalize; Exploratory data analysis and statistical evaluation using R; Data wrangling and visualization: feature extraction, handling missing values, dimensionality reduction, PCA, t-SNE, UMAP, plotting with ggplot2, visualization with Tableau; Machine learning: libraries and platforms for classification, regression, clustering, association rules, recommendations and ranking; Time series analysis: Box-Jenkins method, ARIMA; Text analysis: TF/IDF, LDA, topic modeling; Streaming, spatial, audio, video and graph data analytics; Advanced data analytics using deep learning; Data engineering: extract, transform, and load (ETL), database, parallel database, data warehouse, data lake, OLAP, JSON, XML, NoSQL; Big data analytics: characteristics of big data, analytics using MapReduce, Hadoop, Spark, managing big data, HDFS, Hive, MongoDB, Cassandra; Data provenance, privacy, security and ethics; Applications in financial technology (Fintech), cybersecurity, governance, social media, smart city, healthcare, bioinformatics, physical sciences, environmental and climates sciences.

#### 20.65.6 Course Objectives

Students are expected to:

- Apply data science and big data analytics methods to various data types
- Analyze data from different domains using data science, data engineering, big data analytics methodologies
- Develop data science, data engineering and big data analytics methods and pipelines.

#### 20.65.7 Knowledge required

##### Technical

- Databases and machine learning.

##### Analytical

- Problem formulation and solving.

#### 20.65.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Apply</b> data science and big data analytics methods to various data types	PO1, PO5	C3	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Analyze</b> data from different domains using data science, data engineering, big data analytics methodologies	PO1, PO4	C4	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO3	<b>Develop</b> data science, data engineering and big data analytics methods and pipelines	PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

### 20.65.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√		√							√		√
CO 2		√	√	√	√	√		√	√		√	√			√			√		√
CO 3		√	√	√	√	√		√	√		√	√	√		√			√		√

### 20.65.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction and application domains, Data analytics life cycle	CO1, CO2, CO3
Week 2	Exploratory data analysis and statistical evaluation	CO1, CO2, CO3
Week 3	Data wrangling and visualization	CO1, CO2
Week 4	Data wrangling and visualization	CO1, CO2
Week 5	Libraries for machine learning Time series analysis	CO1, CO2
Week 6	Text analysis Streaming, spatial, audio, video and graph data analytics	CO1, CO2
Week 7	Streaming, spatial, audio, video and graph data analytics	CO1, CO2
Week 8	Advanced data analytics using deep learning	CO1, CO2
Week 9	Data Engineering	CO2, CO3
Week 10	Data engineering	CO2, CO3
Week 11	Big data analytics	CO1, CO2, CO3
Week 12	Big data analytics	CO1, CO2, CO3
Week 13	Big data storage	CO2, CO3
Week 14	Misc, review, applications	CO1, CO2, CO3

### 20.65.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.65.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.65.13 Textbook/ Reference

- Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services
- R for Data Science by Hadley Wickham and Garrett Golemud

## 20.66 Description of Course CSE 438

### PART A: General Information

20.66.1 Course Title : Data Science and Big Data Analytics Sessional

20.66.2 Type of Course : SESSIONAL

20.66.3 Offered to : DEPARTMENT OF CSE

20.66.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.66.5 Course Content (As approved by the Academic Council)

Sessional based on the theory course.

#### 20.66.6 Course Objectives

Students are expected to:

- Apply data science and big data analytics methods to various data types
- Analyze data from different domains using data science, data engineering, big data analytics methodologies
- Develop data science, data engineering and big data analytics methods and pipelines
- Engage in independent learning and independent & team work

#### 20.66.7 Knowledge required

##### Technical

- Databases and machine learning.

##### Analytical

- Problem formulation and solving.

#### 20.66.8 Course Outcomes (COs)

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Apply</b> data science and big data analytics methods to various data types	PO5	C3	Lecture, Demonstration, Hands on	Assignments, Quiz
CO2	<b>Analyze</b> data from different domains using data science, data engineering, big data analytics methodologies	PO4	C4	Lecture, Demonstration, Hands on	Assignments, Project, Quiz
CO3	<b>Develop</b> data science, data engineering and big data analytics methods and pipelines	PO2, PO3, PO5	C6	Lecture, Demonstration, Hands on	Assignments, Project, Quiz
CO4	<b>Engage</b> in independent learning and independent & team work	PO9, PO12	A5	Independent study, teamwork	Project presentation

#### 20.66.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√		√							√		√
CO 2		√	√	√	√	√		√	√		√	√			√			√		√
CO 3		√	√	√	√	√		√	√		√	√	√		√			√		√
CO 4		√	√	√	√	√		√	√	√	√	√	√							√

#### 20.66.10 Lecture/ Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	Data analytics life cycle demo	CO1, CO2, CO3
Week 2-3	Exploratory data analysis and statistical evaluation	CO1, CO2
Week 4-5	Data wrangling and visualization Project proposal	CO1, CO2
Week 6-7	Data analytics	CO1, CO2
Week 8-9	Data Engineering	CO2, CO3
Week 10-11	Big data analytics	CO1, CO2, CO3

Week	Lecture Topics	Corresponding CO(s)
Week 12-13	Project presentation	CO2, CO3. CO4

#### 20.66.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments: There will be online and offline assignments
- Project: There will be a project involving analytics of data from a domain of choice by the students
- Quiz: A final quiz will be held at the end of the semester..

#### 20.66.12 Distribution of Marks

Attendance:	10 %
Assignments:	40%
Project:	30%
Quiz:	20%
Total:	100%

### 20.67 Description of Course CSE 439

#### PART A: General Information

20.67.1 Course Title : Functional Programming

20.67.2 Type of Course : THEORY

20.67.3 Offered to : DEPARTMENT OF CSE

20.67.4 Pre-requisite Course(s) : NONE

#### PART B: Course Details

#### 20.67.5 Course Content (As approved by the Academic Council)

Fundamental theories of programming languages: lambda-calculus and programming computable functions (PCF); Functional and imperative languages; Functional programming: types, pattern matching, functions, recursion, higher-order functions, modules, custom types and type classes, input and output, applicative functors, monads; Functional data structures; Concurrent programming and parallelism; Program analysis, formal verification and abstraction using functional programming. Reference language: Haskell/Kotlin.

#### 20.67.6 Course Objectives

The students are expected to:

- Write well-typed functional programs
- Develop specifications and prove program correctness using rigorous techniques
- Apply equational, evaluational, and compositional reasoning techniques, and use mathematical and structural induction in proofs
- Analyze sequential and parallel running time of programs using the concepts of work and span
- Develop cost graphs and recurrences from programs, and use them to derive asymptotic bounds on work and span
- Use abstract types and modules to structure code with clear and well-designed interfaces
- Identify opportunities for parallelism in code and exploit parallelism by choosing appropriate data structures and function designs

#### 20.67.7 Knowledge required

**Technical**

- Knowledge of any structured or object-oriented programming language

**Analytical**

- None

**20.67.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the theoretical and mathematical foundation of functional programming	-	C2, A1	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and implement</b> programs, based on given specification(s), to solve a computing problem with proper code organization using functional programming	PO1, PO2, PO3, PO4	C5, A4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Utilize</b> functional programming for concurrent programming, program analysis, formal verification and abstraction	PO1, PO2, PO4	C4	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam

**20.67.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving, and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√														
CO 2		√	√	√	√	√			√	√							√	√		√
CO 3		√	√	√	√	√			√	√						√				

**20.67.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Fundamental theories of programming languages, Lambda calculus: syntax, reduction, normalization, confluency, expressiveness	CO1
Week 2	Typed lambda calculi and PCF	CO1

Week	Lecture Topics	Corresponding CO(s)
Week 3	Functional programming: evaluation, recursion schemes, higher-order functions, modules, data types, pattern matching	CO1 and CO2
Week 4	Type classes, type inference	CO1 and CO2
Week 5	PCF: operational and denotational semantics	CO1
Week 6	Imperative languages and monad	CO1
Week 7	Advanced type systems	CO1 and CO2
Week 8	Concurrent programming and parallelism	CO2 and CO3
Week 9	Advanced functional programming: applicative functors, monad, concurrent programming	CO2 and CO3
Week 10	Functional data structures	CO1 and CO2
Week 11	Advanced topics in type theory	CO1 and CO2
Week 12	Program analysis using functional programming	CO2 and CO3
Week 13	Formal program verification and abstraction using functional programming	CO2 and CO3
Week 14	Advanced use cases of functional programming	CO1, CO2, and CO3

#### 20.67.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.67.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.67.13 Textbook/ Reference

- a. Learn You a Haskell by Miran Lipovaca

## 20.68 Description of Course CSE 440

### PART A: General Information

20.68.1 Course Title : Functional Programming Sessional

20.68.2 Type of Course : SESSIONAL

20.68.3 Offered to : DEPARTMENT OF CSE

20.68.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.68.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 439.

#### 20.68.6 Course Objectives

The students are expected to:

- Write well-typed functional programs
- Develop specifications and prove program correctness using rigorous techniques
- Apply equational, evaluational, and compositional reasoning techniques, and use mathematical and structural induction in proofs
- Analyze sequential and parallel running time of programs using the concepts of work and span
- Develop cost graphs and recurrences from programs, and use them to derive asymptotic bounds on work and span
- Use abstract types and modules to structure code with clear and well-designed interfaces

#### 20.68.7 Knowledge required

##### Technical

Knowledge of any structured or object-oriented programming language

#### 20.68.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the theoretical and mathematical foundation of functional programming	-	C2, A1	Lecture, coding and development	Assignments, Quiz
CO2	<b>Design and implement</b> programs, based on given specification(s), to solve a computing problem with proper code organization using functional programming	PO1, PO2, PO3, PO4, PO5	C5, A4	Lecture, coding and development	Assignments, Quiz
CO3	<b>Utilize</b> functional programming for concurrent programming, program analysis, formal verification and abstraction	PO1, PO2, PO4, PO5	C4	Lecture, exercise, hands-on, coding and development	Assignments, Quiz

**20.68.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√														
CO 2		√	√	√	√	√			√	√							√	√		√
CO 3		√	√	√	√	√			√	√						√				

**20.68.10 Lecture/ Activity Plan**

Week	Topics	Corresponding CO(s)
Week 1, 2	Functional programming demonstration and environment set-up	CO1
Week 3, 4	Functional programming: types, pattern matching, functions	CO1, CO2
Week 5, 6	Functional programming: recursion, higher-order functions, modules, custom types and type classes	CO1, CO2
Week 7, 8	Functional programming: applicative functors, monads; Functional data structures	CO1, CO2
Week 9, 10	Concurrent programming and parallelism	CO1, CO3
Week 11, 12	Program analysis, formal verification and abstraction using functional programming	CO1, CO3
Week 13, 14	Quiz / Final evaluation	CO1, CO2, CO3

**20.68.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Offline/Online Assignments and Viva: Offline/Online assignments will be given regularly. Viva may be taken to assess knowledge and skill of the students.
- Quiz / Final evaluation: A quiz or some other type of final evaluation will be held as per the institutional ordinance.

### 20.68.12 Distribution of Marks (Tentative)

Attendance:	0-10%
Offline and Viva:	40-60%
Online:	15-26%
Quiz:	15-26%
Total:	100%

### 20.68.13 Textbook/ Reference

- Learn You a Haskell by Miran Lipovaca

## 20.69 Description of Course CSE 441

### PART A: General Information

20.69.1 Course Title	: Mobile Computing
20.69.2 Type of Course	: THEORY
20.69.3 Offered to	: DEPARTMENT OF CSE
20.69.4 Pre-requisite Course(s)	:

### PART B: Course Details

#### 20.69.5 Course Content (As approved by the Academic Council)

Mobile technologies: anatomy of a mobile device, survey of mobile devices, usability issues of mobile devices; Mobile application development: mobile operating systems and development environments/frameworks, mobile SDKs, programming for smart-phones; Cellular communications: standards for cellular wireless networks, mobile IPv4 and mobile IPv6; Mobility in cellular networks: types of mobility, mobility management, mobility models, traffic models, channel allocation, interferences, handoffs, and location management; User interaction: user interface issues, the united look and feel paradigm, common human interface guidelines; Context aware mobile computing: types of context, modeling context information, collecting and disseminating context, applications development for changing context; Data and information management: mobile database, transactions, web services; Privacy and security issues.

#### 20.69.6 Course Objectives

The students are expected to:

- Describe mobile technologies in terms of hardware, software and communications.
- Gain in depth knowledge about technologies (languages, frameworks, sdks, databases) used in mobile application development.
- Utilize well designed HCI paradigms and guidelines to design intuitive user interfaces.

#### 20.69.7 Knowledge required

##### Technical

- Computer programming

##### Analytical

- None

### 20.69.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Describe</b> mobile technologies in terms of hardware, software and communications.	-	C1, A1	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Discover</b> knowledge about technologies (languages, frameworks, sdks, databases) used in mobile application development.	PO1, PO3, PO5	C3	Lecture, Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Employ</b> well designed HCI paradigms and guidelines to design intuitive user interfaces.	PO3, PO5	C3	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.69.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√							√				
CO 2		√	√	√	√	√		√	√	√	√	√	√	√		√	√			√
CO 3		√	√	√	√	√			√	√	√	√		√	√	√	√			√

### 20.69.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Mobile technologies: anatomy of a mobile device, survey of mobile devices;	CO1
Week 2	Mobile technologies: usability issues of mobile devices;	CO1
Week 3	Mobile application development: mobile operating systems and development environments/frameworks, mobile SDKs;	CO1, CO2
Week 4	Mobile application development: programming for smart-phones;	CO2
Week 5	Cellular communications: standards for cellular wireless networks;	CO1
Week 6	Cellular communications: mobile IPv4 and mobile IPv6; Mobility in cellular networks: types of mobility, mobility management, mobility models, traffic models;	CO1

Week	Lecture Topics	Corresponding CO(s)
Week 7	Mobility in cellular networks: channel allocation, interferences, handoffs, and location management;	CO1
Week 8	User interaction: user interface issues, the united look and feel paradigm;	CO1, CO3
Week 9	User interaction: common human interface guidelines;	CO1, CO3
Week 10	Context aware mobile computing: types of context, modeling context information;	CO1
Week 11	Context aware mobile computing: collecting and disseminating context, applications development for changing context;	CO1, CO2
Week 12	Data and information management: mobile database, transactions;	CO2
Week 13	Data and information management: web services; Privacy and security issues;	CO1, CO2
Week 14	Wrap up;	CO1, CO2, and CO3

#### 20.69.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.69.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.69.13 Textbook/ Reference

- “Mobile Computing Deployment and Management: Real World Skills for CompTIA Mobility+ Certification and Beyond” by Robert J. Bartz, 1<sup>st</sup> edition, 2015.
- “Fundamentals of Mobile Computing” by Prasant Kumar Pattnaik and Rajib Mall, 2<sup>nd</sup> Edition, 2015.

## 20.70 Description of Course CSE 445

### PART A: General Information

20.70.1 Course Title : Data Mining and Information Retrieval

20.70.2 Type of Course : THEORY

20.70.3 Offered to : DEPARTMENT OF CSE

20.70.4 Pre-requisite Course(s) :

### PART B: Course Details

#### 20.70.5 Course Content (As approved by the Academic Council)

Introduction to Data Mining; Finding Similar Items, Applications of Set Similarity, Shingling of Documents, Locality-Sensitive Hashing, Distance Measures, The Theory of Locality-Sensitive Functions, LSH Families for Other Distance Measures, Applications of Locality-Sensitive Hashing, Methods for High Degrees of Similarity; Mining Data Streams, The Stream Data Model, Sampling, Filtering, Counting Distinct Elements, Estimating Moments, Counting Ones in a Window, Decaying Windows; Link Analysis, PageRank Algorithms, Topic-Sensitive PageRank, Link Spam, Hubs and Authorities; Frequent Itemsets, The Market-Basket Model, the A-Priori Algorithm; Clustering, Hierarchical Clustering, K-means Algorithms, The CURE Algorithm, Clustering in Non-Euclidean Spaces, Clustering for Streams and Parallelism; Advertising on the Web, Issues in On-Line Advertising, On-Line Algorithms, The Matching Problem, Adwards, Search Engine Optimization; Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, UV-Decomposition; Mining Social-Network, Clustering of Social-Network Graphs, Discovery of Communities, Partitioning of Graphs, Finding Overlapping Communities, Simrank, Counting Triangles, Neighbourhood Properties of Graphs; Dimensionality Reduction, Principal Component Analysis (PCA), Singular-Value Decomposition, CUR Decomposition.

#### 20.70.6 Course Objectives

The students are expected to:

- Understand concepts and algorithms related to data mining and information retrieval
- Analyze large scale data and apply relevant concepts and algorithms to fulfill various data mining and information retrieval tasks
- Design and evaluate algorithms/solutions to solve various real-world problems related to data mining and information retrieval

#### 20.70.7 Knowledge required

##### Technical

- Data handling, analysis, and management

##### Analytical

- Algorithm analysis and design

#### 20.70.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> concepts and algorithms related to data mining and information retrieval	-	C2, A1, A2	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO2	<b>Analyze</b> large scale data and <b>apply</b> relevant concepts and algorithms to fulfill various data mining and information retrieval tasks	PO2 and PO4	C4	Lecture, Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Design</b> and <b>evaluate</b> algorithms/solutions to solve various real-world problems related to data mining and information retrieval	PO3	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

#### 20.70.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√				√						√				
CO 2		√	√	√	√	√			√	√	√			√		√	√			
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

#### 20.70.10 Lecture/ Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	Finding Similar Items	CO1
Week 2	Locality-Sensitive Hashing	CO1
Week 3	Mining Data Streams	CO1
Week 4	Link Analysis	CO1 and CO2
Week 5	Frequent Itemsets	CO2
Week 6,7	Clustering	CO2
Week 8,9	Advertising on the Web	CO2
Week 10	Recommendation Systems	CO2
Week 11,12	Mining Social-Network	CO2
Week 13	Dimensionality Reduction	CO3

Week	Lecture Topics	Corresponding CO(s)
Week 14	Review	CO1, CO2, and CO3

#### 20.70.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.70.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.70.13 Textbook/ Reference

- a. Mining of Massive Datasets by Jeffrey D. Ullman et al.

### 20.71 Description of Course CSE 447

#### PART A: General Information

20.71.1 Course Title	: INTRODUCTION TO BLOCKCHAIN
20.71.2 Type of Course	: THEORY
20.71.3 Offered to	: DEPARTMENT OF CSE
20.71.4 Pre-requisite Course(s)	: NONE

#### PART B: Course Details

##### 20.71.5 Course Content (As approved by the Academic Council)

Basics of Blockchain: P2P networks, hashing, cryptography, digital signature, key exchange, checksum, blocks, and bitcoin; Distributed ledger systems; Miners; Block creation; Security on Blockchain; Categories of Blockchain; Consensus in Blockchain; Ethereum and Hyperledger; Applications of Blockchain.

##### 20.71.6 Course Objectives

The students are expected to:

- Analyze system-level components of Blockchain.
- Investigate development of a Blockchain solution.
- Apply Blockchain in different relevant applications.

##### 20.71.7 Knowledge required

###### Technical

- Networking
- Network security

###### Analytical

- Probability theory

### 20.71.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> system-level components of Blockchain.	PO1 and PO2	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Investigate</b> development of a Blockchain solution.	PO3 and PO4	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Apply</b> Blockchain in different relevant applications.	PO6	C3, A5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.71.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√			√		√				√
CO 2		√	√	√	√	√			√	√	√	√		√		√	√			
CO 3		√	√	√	√	√		√	√	√	√				√	√	√	√		√

### 20.71.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Basics of Blockchain: P2P networks and hashing	CO1
Week 2	Basics of Blockchain: cryptography and digital signature	CO1
Week 3	Basics of Blockchain: key exchange, checksum, blocks, and bitcoin	CO1
Week 4	Distributed ledger systems	CO2
Week 5	Miners	CO2
Week 6	Block creation	CO2
Week 7	Security on Blockchain	CO2
Week 8	Security on Blockchain	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 9	Categories of Blockchain	CO3
Week 10	Consensus in Blockchain	CO2
Week 11	Consensus in Blockchain	CO2
Week 12	Ethereum and Hyperledger	CO3
Week 13	Applications of Blockchain	CO3
Week 14	Revision	CO1, CO2, and CO3

### 20.71.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.71.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.71.13 Textbook/ Reference

- a. "Blockchain revolution: How the technology behind Bitcoin is changing money, business, and the world" by Nicole Radziwill, Taylor & Francis Ltd., 2018
- b. "Blockchain" by Melanie Swan, O'Reilly Media, 2015

## 20.72 Description of Course CSE 448

### PART A: General Information

20.72.1 Course Title : INTRODUCTION TO BLOCKCHAIN SESSIONAL

20.72.2 Type of Course : SESSIONAL

20.72.3 Offered to : DEPARTMENT OF CSE

20.72.4 Pre-requisite Course(s) : NONE

### PART B: Course Details

#### 20.72.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 447 – Introduction to Blockchain.

#### 20.72.6 Course Objectives

The students are expected to:

- Execute system-level components of Blockchain.
- Design and develop a Blockchain solution.
- Apply Blockchain for a particular relevant application.

#### 20.72.7 Knowledge required

**Technical**

- Networking
- Network security

**Analytical**

- Probability theory

**20.72.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Execute</b> system-level components of Blockchain.	PO1 and PO2	C4, P4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and develop</b> a Blockchain solution.	PO3 and PO4	C6, P6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Apply</b> Blockchain for a particular relevant application.	PO6	C3, P7	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

**20.72.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√		√			√			√	
CO 2		√	√	√	√	√		√	√	√	√	√				√	√			
CO 3		√	√	√	√	√		√	√	√	√				√	√	√	√		√

**20.72.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Blockchain solutions – steps and measures	CO1
Week 2	Blockchain solutions – steps and measures	CO1
Week 3	Blockchain solutions – steps and measures	CO1
Week 4	Mapping of a Blockchain solution to a use case	CO2
Week 5	Consensus in Blockchain	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 6	Term Project proposal	CO3
Week 7	Ethereum and Hyperledger	CO2
Week 8	Design of the Term Project	CO3
Week 9	Development progress of Term Project	CO3
Week 10	Security enforcement in the Term Project	CO3
Week 11	Consensus in the Term Project	CO3
Week 12	Scalability in the Term Project	CO3
Week 13	Final submission of the Term Project	CO3
Week 14	Wrap up	CO1, CO2, and CO3

#### 20.72.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.72.12 Distribution of Marks

Attendance:	10 %
Online assignment(s):	10%
Offline assignment(s):	20%
Term project:	40%
Quiz:	20%
Total:	100%

#### 20.72.13 Textbook/ Reference

- “Blockchain revolution: How the technology behind Bitcoin is changing money, business, and the world” by Nicole Radziwill, Taylor & Francis Ltd., 2018
- "Blockchain" by Melanie Swan, O'Reilly Media, 2015

#### 20.73 Description of Course CSE 449

##### PART A: General Information

20.73.1 Course Title	: Cloud Computing
20.73.2 Type of Course	: THEORY
20.73.3 Offered to	: DEPARTMENT OF CSE
20.73.4 Pre-requisite Course(s)	: CSE 313 Operating System, CSE 321 Computer Networks

## **PART B: Course Details**

### **20.73.5 Course Content (As approved by the Academic Council)**

Cloud computing paradigms: cluster computing, grid computing, parallel and distributed computing; Cloud computing service models: infrastructure as a service, platform as a service, software as a service; Distributed computation models: MapReduce, Spark, remote procedure call, message passing; Virtualization: consolidation, resource provisioning, cost/profit optimization, customer satisfaction optimization, virtual machine management; Cloud system architecture: high availability, horizontal/vertical scaling, thin client, disaster recovery, performance measurement and monitoring; Cloud computing models: federation/presence/identity/security/privacy in cloud computing, multi-party computation; Mobile cloud computing: architecture, applications, privacy and security; Green cloud computing: dynamic capacity provisioning, power saving policies, geographical load balancing.

### **20.73.6 Course Objectives**

Students are expected to:

- Understand cloud computing service models, cloud computing system architecture, models and applications of Cloud
- Design distributed algorithms and programs for Cloud
- Develop efficient and optimized programs for Cloud

### **20.73.7 Knowledge required**

#### **Technical**

- Networking and operating system.

#### **Analytical**

- Problem formulation and solving.

### **20.73.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	Understand cloud computing service models, cloud computing system architecture, models and applications of Cloud	-	C2	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	Design distributed algorithms and programs for Cloud	PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO3	Develop efficient and optimized programs for Cloud	PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

### **20.73.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√														

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 2		√	√	√	√	√			√	√	√	√	√		√		√			
CO 3		√	√	√	√	√			√	√	√	√	√		√		√			

### 20.73.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Cloud computing overview Cloud computing paradigms: cluster computing, grid computing, parallel and distributed computing	CO1
Week 2	Types of Cloud computing: public, private, hybrid	CO1
Week 3	Cloud computing service models: infrastructure as a service, platform as a service, software as a service	CO1
Week 4	Distributed computation models: MapReduce, Spark	CO1, CO2
Week 5	Programming with MapReduce, Spark	CO1, CO2, CO3
Week 6	Remote procedure call Message passing	CO2, CO3
Week 7	Virtualization: consolidation, resource provisioning	CO1, CO2
Week 8	Cost/profit optimization, Customer satisfaction optimization Virtual machine management and monitoring	CO2, CO3
Week 9	Cloud system architecture: high availability, horizontal/vertical scaling, thin client	CO1, CO2
Week 10	Disaster recovery models Performance measurement and monitoring	CO1, CO2, CO3
Week 11	Cloud computing models: federation, presence, identity, security, privacy in cloud computing Multi-party computation	CO1, CO2, CO3
Week 12	Mobile cloud computing: architecture, applications, privacy and security	CO1, CO2
Week 13	Green cloud computing Dynamic capacity provisioning	CO1, CO2, CO3
Week 14	Power saving policies Geographical load balancing	CO2, CO3

### 20.73.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.73.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.73.13 Textbook/ Reference

- Mastering Cloud Computing, Rajkumar Buyya; Christian Vecchiola; S.Thamarai Selvi. Morgan Kaufmann, ISBN: 978-0-12-409539-7
- Cloud Computing: Concepts, Technology & Architecture, Thomas Erl, Zaigham Mahmood, Ricardo Puttini. Prentice Hall/PearsonPTR, ISBN: 978-0-13-338752-0
- Distributed and Cloud Computing: From Parallel Processing to the Internet of Things Hwang, Kai / Dongarra, Jack / Fox, Geoffrey C. , 2011 ISBN13: 9780123858801
- Dan Marinescu, Cloud Computing: Theory and Practice, Morgan Kaufmann, 2013

## 20.74 Description of Course CSE 453

### PART A: General Information

20.74.1 Course Title	: High Performance Database System
20.74.2 Type of Course	: THEORY
20.74.3 Offered to	: DEPARTMENT OF CSE
20.74.4 Pre-requisite Course(s)	: CSE 215 Database

### PART B: Course Details

#### 20.74.5 Course Content (As approved by the Academic Council)

Distributed DBMS: design issues, architectures; Distributed and parallel database design: data fragmentation, allocation; Data control: view management, access control, integrity control; Query processing: data localization, query optimization, cost model; Transaction processing: concurrency control, reliability; Replication: consistency, update management, replication protocols; Multidatabase systems: integration; Parallel database systems: parallel architectures, load balancing, fault tolerance; Big Data databases: storage systems, processing frameworks; NoSQL systems: data models, system architectures; Hybrid data stores: NewSQL, multimodel NoSQL.

#### 20.74.6 Course Objectives

Students are expected to:

- Understand high performance database system (HPDS), distributed database architecture, issues and strategies in HPDS
- Design parallel algorithms and programs for HPDS
- Develop parallel and optimized programs for HPDS

#### 20.74.7 Knowledge required

##### Technical

- Programming and operating system.

##### Analytical

- Problem formulation and solving.

**20.74.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> high performance database system (HPDS), distributed database architecture, issues and strategies in HPDS	-	C2	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Design</b> parallel algorithms and programs for HPDS	PO1, PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO3	<b>Develop</b> parallel and optimized programs for HPDS	PO1, PO2, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

**20.74.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√		√	√	√														
CO 2		√		√	√	√			√	√	√	√	√		√		√			
CO 3		√		√	√	√			√	√	√	√	√		√		√			

**20.74.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to High Performance Database System	CO1
Week 2	Distributed DBMS design issues, architectures	CO1
Week 3	Distributed and parallel database design: data fragmentation, allocation	CO1
Week 4	Data control: view management, access control, integrity control	CO1, CO2
Week 5	Query processing: data localization	CO1, CO2
Week 6	Query optimization, cost model	CO2, CO3
Week 7	Transaction processing: concurrency control, reliability	CO2, CO3
Week 8	Replication: consistency, update management, replication protocols	CO2, CO3
Week 9	Multidatabase systems integration	CO2, CO3

Week	Lecture Topics	Corresponding CO(s)
Week 10	System Parallel database systems: parallel architectures	CO1, CO2, CO3
Week 11	System Parallel database systems: load balancing, fault tolerance	CO2, CO3
Week 12	Big Data databases: storage systems, processing frameworks	CO2, CO3
Week 13	NoSQL systems: data models, system architectures	CO1, CO2, CO3
Week 14	Hybrid data stores: NewSQL, multimodel NoSQL	CO2, CO3

#### 20.74.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.74.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.74.13 Textbook/ Reference

- Database System Concepts 7th Edition by Abraham Silberschatz, Henry F. Korth and S. Sudarshan
- Fundamentals of Database Systems, 7th edition, by Ramez Elmasri and Shamkant B. Navathe
- Principles of Distributed Database Systems, Fourth Edition, M. Tamer Ozsu, Patrick Valduriez

### 20.75 Description of Course CSE 455

#### PART A: General Information

20.75.1 Course Title	: 5G: TECHNOLOGY, ARCHITECTURE AND PROTOCOLS
20.75.2 Type of Course	: THEORY
20.75.3 Offered to	: DEPARTMENT OF CSE
20.75.4 Pre-requisite Course(s)	: N/A

#### PART B: Course Details

##### 20.75.2 Course Content (As approved by the Academic Council)

5G architecture: interfaces and protocols; New radio (NR) architecture: physical channels and signals, frame structure, resource block, carrier aggregation, use of TDD; 5G core: 5G system architecture, function of each network and function of 5G core, 5G reference point architecture, 5G service based architecture; Network Function Virtualisation (NFV); Network Slicing; Multi Access Edge Computing (MEC); Quality of service in 5G: QoS architecture, QoS Flow, QoS Rule, QoS Profile, 5G numbering, addressing and identities, Dynamic spectrum sharing: coexistence of 5G NR with 4G LTE; Open radio access network (open RAN) and 5G: basic concept of traditional RAN, vRAN and open RAN, Centralised RAN, Cloud RAN; Network function virtualization and 5G: Concept of Softwarisation, Virtualization; Transmission requirement for 5G: backhaul , mid-haul and fronthaul for 5G; 5G Security: security enhancement in 5G, new challenges and its mitigation.

### 20.75.3 Course Objectives

- The objectives of this course are to:
- Plan, design, develop and manage 5G networks by applying and contributing the best practices, standards, algorithms and tools.
- Discover the key differences between 5G and previous generations of mobile technology.
- Analyse issues and challenges for 5G deployment and explore possible solutions.

### 20.75.4 Knowledge required

#### Technical

- System design and development

#### Analytical

- Logic design

### 20.75.5 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Explain</b> the underlying technologies, concepts and use cases scenarios associated with 5G.		C2	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Differentiate</b> between 5G and previous generations and <b>analyze</b> the evolution of cellular network technology	PO1, PO2	C4, A3	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Identify</b> the key challenges of 5G deployment and <b>design</b> solutions for addressing them.	PO3, PO4	C5	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.75.6 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√				√			√				√			
CO 2		√	√	√	√	√			√	√							√			
CO 3		√	√	√	√	√			√	√	√							√		√

### 20.75.7 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to 5G New Radio (NR) architecture	CO1
Week 2	5G system architecture, reference point architecture	CO1
Week 3	5G service-based architecture	CO1, CO2
Week 4	Network Function Virtualisation (NFV)	CO1, CO2
Week 5	Network Slicing; Multi Access Edge Computing (MEC)	CO1, CO2
Week 6	Quality of service in 5G	CO1, CO3
Week 7	Quality of service in 5G	CO2, CO3
Week 8	5G numbering, addressing and identities	CO1, CO3
Week 9	Dynamic spectrum sharing: coexistence of 5G NR with 4G LTE	CO2, CO3
Week 10	Basic concept of traditional RAN, vRAN and open RAN, Centralised RAN, Cloud RAN	CO1
Week 11	Network function virtualization and 5G	CO1, CO3
Week 12	Transmission requirement for 5G	CO1, CO2
Week 13	5G Security: security enhancement in 5G, new challenges and its mitigation	CO3
Week 14	Wrap up;	CO1, CO2, and CO3

### 20.75.8 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.75.9 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.75.10 Textbook/ Reference

- 5G NR: The Next Generation Wireless Access Technology, Erik Dahlman, Stefan Parkvall, Johan Skold, 1st Edition, Academic Press, 2018.
- 5G Mobile Communications - Concepts and Technologies, Saad Z. Asif, 1st Edition, Taylor & Francis Group LLC - CRC Press, 2019.

## 20.76 Description of Course CSE 457

### PART A: General Information

20.76.1 Course Title	: Wireless Networks
20.76.2 Type of Course	: THEORY
20.76.3 Offered to	: DEPARTMENT OF CSE
20.76.4 Pre-requisite Course(s)	: CSE 321 Computer Networks

### PART B: Course Details

#### 20.76.5 Course Content (As approved by the Academic Council)

Cellular concepts: frequency reuse, handoff strategies, interference and system capacity, grade of service, improving capacity and coverage, call blocking probability; Propagation effects: outdoor propagation models, indoor propagation models, power control, Doppler's effect, small and large scale fades; Wireless LAN Technology; IEEE 802.11: standard, protocol architecture, physical layer and media access control; Mobile IP; Wireless Application Protocol; IEEE 802.16 Broadband Wireless Access; Brief review of 2nd and 3rd generation wireless: GSM, GPRS, CDMA; Cordless system; Wireless local loop; Bluetooth: overview and baseband specifications.

#### 20.76.6 Course Objectives

After undergoing this course, students should be able to:

- i. Gain knowledge and experiences in wireless systems and mobile interface;
- ii. Analyse and apply various computational methods and algorithms in software development of wireless systems and real-life problem solving; and
- iii. Design new services and applications like vehicular communications based on various computational methods, algorithms and protocols used in wireless systems.

#### 20.76.7 Knowledge required

##### Technical

- Computer networks and secured data communications.

##### Analytical

- Problem formulation and solving as well as protocols design.

#### 20.76.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Gain</b> knowledge and experiences in wireless systems and mobile interface	-	C1	Lecture and Demonstration	Class Tests or Assignments, and Final Exam
CO2	<b>Analyze and apply</b> various computational methods and algorithms in software development of wireless systems and real-life problem solving	PO2, PO4, PO5	C4	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO3	<b>Design</b> new services and applications like vehicular communications based on various computational methods, algorithms and protocols used in wireless systems	PO1, PO3, PO5	C6	Lecture and Demonstration	Class Tests or Assignments, and Final Exam

### 20.76.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√														
CO 2		√	√	√	√	√			√	√	√	√			√		√			√
CO 3		√	√	√	√	√			√	√	√	√	√		√			√		√

### 20.76.10 Lecture/ Activity Plan

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 1	Cellular concepts: frequency reuse, handoff strategies, interference and system capacity	CO1, CO2, CO3
Week 2	Grade of service, improving capacity and coverage, call blocking probability;	CO1, CO2, CO3
Week 3	Propagation effects: outdoor propagation models, indoor propagation models	CO1, CO2
Week 4	Power control, Doppler's effect, small- and large-scale fades	CO1, CO2
Week 5	Wireless LAN Technology	CO1, CO2
Week 6	IEEE 802.11: standard, protocol architecture, physical layer and media access control	CO1, CO2
Week 7	Mobile IP	CO1, CO2
Week 8	Wireless Application Protocol	CO1, CO2
Week 9	IEEE 802.16 Broadband Wireless Access	CO2, CO3
Week 10	Brief review of 2nd and 3rd generation wireless	CO2, CO3
Week 11	GSM, GPRS, CDMA	CO1, CO2, CO3
Week 12	Cordless system	CO1, CO2, CO3

Week	Lecture Topics	Corresponding CO(s)
Week 13	Wireless local loop	CO2, CO3
Week 14	Bluetooth: overview and baseband specifications	CO1, CO2, CO3

#### 20.76.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.76.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.76.13 Textbook/ Reference

- Andrea Goldsmith, Wireless Communications, Cambridge University Press
- Cory Beard and William Stallings, Wireless Communication Networks and Systems, Pearson
- David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press

### 20.77 Description of Course CSE 459

#### PART A: General Information

20.77.1 Course Title : COMMUNICATION SYSTEMS

20.77.2 Type of Course : THEORY

20.77.3 Offered to : DEPARTMENT OF CSE

20.77.4 Pre-requisite Course(s) : CSE 219

#### PART B: Course Details

#### 20.77.5 Course Content (approved by the Academic Council)

Communication link engineering: Fundamental noise processes, Brightness and antenna noise, Polarization-wave and antenna, Wave propagation, Channel impairment effects, Receiver system noise, Receiver types and sub-assembly survey, Low noise antenna design; Signal power budgets and system design techniques; Interference and frequency reuse; System- and circuit-level design and implementation of communication hardware: mixers, RF amplifiers, filters, oscillators and frequency synthesizers, modulators and detectors, carrier and symbol timing recovery subsystems; Issues in software-defined radio transmitter and receiver implementation.

#### 20.77.6 Course Objectives

The students are expected to:

- Understand the basic components of a communication system.
- Analyze the sources and effects of different types on noise in a communication system.

- Design and implement communication hardware and systems.

### 20.77.7 Knowledge required

- Electrical circuit design
- Advanced calculus

### 20.77.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the basic components of a communication system	PO1, PO2	C4, A3,	Lecture and problem solving	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Analyze</b> the sources and effects of different types on noise in a communication system	PO1, PO2, PO4	C3, A3	Lecture and problem solving	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Design and implement</b> communication hardware and systems	PO3, PO5 PO12	C5, A4	Lecture and problem solving	Class Tests or Assignments or Projects, and Final Exam

### 20.77.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√						√	√			
CO 2		√	√	√	√	√			√	√								√		
CO 3		√	√	√	√	√			√	√										√

### 20.77.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Fundamental noise processes, Brightness and antenna noise	CO1, CO2
Week 2	Polarization-wave and antenna, Wave propagation	CO1
Week 3	Channel impairment effects, Receiver system noise, Receiver types and sub-assembly survey	CO1, CO2
Week 4	Low noise antenna design	CO2, CO3
Week 5	Signal power budgets and system design techniques	CO3

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 6	Interference and frequency reuse	CO1, CO3
Week 7	System- and circuit-level design and implementation of communication hardware: mixers	CO3
Week 8	System- and circuit-level design and implementation of communication hardware: RF amplifiers	CO3
Week 9	System- and circuit-level design and implementation of communication hardware: filters	CO3
Week 10	System- and circuit-level design and implementation of communication hardware: oscillators and frequency synthesizers	CO3
Week 11	System- and circuit-level design and implementation of communication hardware: modulators and detectors	CO3
Week 12	System- and circuit-level design and implementation of communication hardware: Carrier and symbol timing recovery subsystems	CO3
Week 13	Issues in software-defined radio transmitter and receiver implementation.	CO3
Week 14	Recap	CO1, CO2, CO3

#### **20.77.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.77.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.77.13 Textbook/ Reference**

- Communication Systems by Simon Haykin
- Rf Circuit Design: Theory and Applications by Reinhold Ludwig and Pavel Bretchko

### **20.78 Description of Course CSE 461**

#### **PART A: General Information**

**20.78.1 Course Title** : Algorithm Engineering

20.78.2 Type of Course : THEORY

20.78.3 Offered to : DEPARTMENT OF CSE

20.78.4 Pre-requisite Course(s) : CSE 207

**PART B: Course Details**

**20.78.5 Course Content (As approved by the Academic Council)**

Computational complexity; Exact Algorithms; Parameterized complexity; Practical computing and heuristics; Approximation algorithms; LP based approximation algorithms; Randomized algorithms; On-line algorithms; Experimental algorithmics; Contemporary and state-of-the-art.

**20.78.6 Course Objectives**

- i. To introduce complexity classes of computational problems to the students and teach them the methods of comparing and identifying hard problems.
- ii. To make the student capable of designing fast exact algorithms, approximation algorithms, heuristics and metaheuristics to deal with computational hard problems.
- iii. To make the students familiar with design techniques of contemporary algorithms such as randomized algorithms, on-line algorithms and low-memory algorithms.

**20.78.7 Knowledge required**

Discrete Mathematics, Data Structures and Algorithms, Graph Theory

**20.78.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Compare</b> the time and space complexities of computational problems	PO1, PO2	C4, A2	Lectures	Written exams; assignment
CO2	<b>Design</b> feasible and useful algorithms (such as fast exact algorithms, approximation algorithms, randomized algorithms, heuristics and metaheuristics) for computationally hard optimization problems,	PO3	C6, A2	Lectures	Written exams; assignment
CO3	<b>Analyze</b> performance parameters and their trade-off	PO4	C4, A2	Lectures	Written exams; assignment

**20.78.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1			√	√	√	√		√	√	√	√							√		
CO 2			√	√	√	√		√	√	√	√				√			√		
CO 3			√	√	√	√		√	√	√	√							√		

**20.78.10 Lecture/ Activity Plan**

Week	Topics	References	Corresponding CO(s)
Week 1	Computational Complexity: Polynomial-time reductions, Vertex Cover Problem vs Independent Set Problem, Vertex Cover Problem vs Set Cover Problem, Independent Set vs Set Packing.	Ch2	CO1
Week 2	Classes P, NP, NP-hard, NP-complete, Co-NP, PSPACE, Satisfiability Problem and Cook's Theorem. Proving NP-completeness.	Ch2	CO1
Week 3	Proving NP-completeness. Exact Exponential Algorithms: Dynamic Programming for TSP.	Ch2, Ch3	CO1
Week 4	Exact Exponential Algorithms: branching algorithm for Independent Set Problem and Parameterized Algorithms for Vertex Cover Problem.	Ch3	CO2
Week 5	Approximation Algorithms: 2-approximation algorithm for vertex cover, 2-approximation for simple knapsack, APX, APX-hard, PTAS, FPTAS.	Ch4	CO2
Week 6	FPTAS for Knapsack Problem, PTAS for independent set problem in planar graphs.	Ch4	CO2
Week 7	Approximability of TSP, 2-approximation and 3/2 approximation for Metric TSP. Linear programming and rounding for vertex cover problem.	Ch4	CO2
Week 8	Randomized Algorithms: Shuffling Problem, Coupon Collector's Problem, Median-Finding. MAX-SAT Problem	Ch5	CO3
Week 9	Randomized Algorithms: Min-Cut Problem; Online Algorithms: Ski-rental Problem,	Ch6	CO3, CO4
Week 10	Online Algorithms: Linear-list search problem, k-server problem.	Ch6	CO4, CO3
Week 11	Low Memory Algorithms	Ch7	CO1

Week	Topics	References	Corresponding CO(s)
Week 12	Heuristics and Metaheuristics: Simulated Annealing, The Ant Colony Method; Performance and Limitations of Metaheuristics.	Ch8	CO5
Week 13	Heuristics and Metaheuristics: Local Search, Tabu Search.	Ch8	CO5

#### 20.78.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.78.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.78.13 Textbook/ Reference

- Md. Saidur Rahman, Entrance to Advanced Algorithms, manuscript, 2021.
- Jon Kleinberg and Eva Tardos, , Algorithm Design, Pearson, 2011.
- Fedor V. Fomin and Dieter Kratsch, Exact Exponential Algorithms, Springer, 2010.
- David P. Williamson and David B. Shmoys, The design of Approximation Algorithms, Cambridge, 2011.
- Dennis Komm, An Introduction to Online Computation, Springer, 2016.
- Allan Borodin and Ran El-Yaniv, Online Computation and Competitive Analysis, Cambridge, 1998.
- Bastien Chopard and Marco Tomassini, An Introduction to Metaheuristics for Optimization, Springer, 2018.
- M. Mitzenmacher and E. Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge, 2005.

### 20.79 Description of Course CSE 462

#### PART A: General Information

20.79.1 Course Title	: Algorithm Engineering Sessional
20.79.2 Type of Course	: Sessional
20.79.3 Offered to	: DEPARTMENT OF CSE
20.79.4 Pre-requisite Course(s)	:

## **PART B: Course Details**

### **20.79.5 Course Content (As approved by the Academic Council)**

Computational complexity; Exact Algorithms; Parameterized complexity; Practical computing and heuristics; Approximation algorithms; LP based approximation algorithms; Randomized algorithms; On-line algorithms; Experimental algorithms; Contemporary and state-of-the-art.

### **20.79.6 Course Objectives**

- study algorithmic computational problems as a teamwork,
- explain computational problems and their hardness,
- seek feasible algorithmic solutions of hard computational problems by exploring exact algorithms, approximation algorithms, heuristics and metaheuristics,
- prepare presentation materials and give logically attractive presentations,
- face viva voce confidently, and
- implement algorithms efficiently and write technical reports.

### **20.79.7 Knowledge required**

Discrete Mathematics, Data Structures and Algorithms, Graph Theory

### **20.79.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Demonstrate</b> mathematical and algorithmic concepts	PO1, PO2	C4, A4	Lectures	Written exams; assignment
CO2	<b>Derive</b> mathematical and algorithmic relations,	PO3	C6, A4	Lectures	Written exams; assignment
CO3	<b>Solve</b> complex algorithmic problems by teamwork	PO3	C6, A4	Lectures	Written exams; assignment
CO4	<b>Experiment</b> with implementations of algorithms	PO3	C6, A4, P7	Lectures	Written exams; assignment
CO5	<b>Find</b> ways for life-long learning	PO3	C3, A2	Lectures	Written exams; assignment

### **20.79.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1			√	√	√	√		√	√	√						√		√		
CO 2			√	√	√	√		√	√	√						√		√		

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 3			√	√	√	√		√	√	√	√					√		√		
CO 4			√	√	√	√		√	√	√	√					√		√		
CO 5			√	√	√	√		√	√	√	√					√		√		

### 20.79.10 Lecture/ Activity Plan

Week	Topics	Corresponding CO(s)
Week 1	Holiday	CO1
Week 2	Introduction	CO1
Week 3	No class	CO1
Week 4	Student Presentation (1-6)	CO2
Week 5	Student Presentation (7-12)	CO2
Week 6	No Class	CO2
Week 7	Mid-term Project Update	CO2
Week 8	Student Presentation (13-18)	CO3
Week 9	No class	CO3, CO4
Week 10	Student Presentation (19-26)	CO4, CO3
Week 11	Student Presentation (26-30)	CO1
Week 12	No Class	CO5
Week 13	Project Final Update + Quiz	CO5

### 20.79.11 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

### 20.79.12 Distribution of Marks

Class Participation	10%
Book reading presentation	40%
Project	30%
Quiz	20%
Total	100%

### 20.79.13 Textbook/ Reference

1. Cygan, Marek, Fedor V. Fomin, Łukasz Kowalik, Daniel Lokshantov, Dániel Marx, Marcin Pilipczuk, Michał Pilipczuk, and Saket Saurabh. *Parameterized algorithms*. Vol. 5, no. 4. Cham: Springer, 2015.

## **20.80 Description of Course CSE 463**

### **PART A: General Information**

<b>20.80.1 Course Title</b>	: Bioinformatics
<b>20.80.2 Type of Course</b>	: THEORY
<b>20.80.3 Offered to</b>	: DEPARTMENT OF CSE
<b>20.80.4 Pre-requisite Course(s)</b>	: CSE 207

### **PART B: Course Details**

#### **20.80.5 Course Content**

Molecular biology basics: DNA, RNA, genes, and proteins; Genome sequencing: graph-based assembly; Protein sequencing; Sequence alignment: dynamic programming, local and global alignment; Combinatorial pattern matching: rapid string matching, database search, BLAST; Genome rearrangements; Evolutionary trees and phylogenetics; Computational phylogenomics; Statistical and machine learning methods in bioinformatics: clustering and classification, gene expression analysis, protein classification and attribute prediction.

#### **20.80.6 Course Objectives**

The students are expected to:

- understand the intersection between computer science and biology,
- understand the basic concepts of bioinformatics and its significance in biological data analyses and solving different biological questions.
- gain knowledge of the theory and practice of different important branches in bioinformatics and computational biology such as DNA sequencing, sequence alignments, phylogenetic tree constructions, genome assembly, etc.
- solve various biological problems using by formulating them using concepts from computer science (e.g., graph theory, discrete optimization, etc.) and by design efficient algorithms,
- utilize advanced data structures for efficient implementations of the algorithms for solving different biological questions.

#### **20.80.7 Knowledge required**

##### **Technical**

- None

##### **Mathematics**

- Basic Mathematics (HSC level), statistics, and probability theory

### 20.80.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the intersection between computer science and biology	PO12	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Study and analyze</b> the theory and practice of different important branches in bioinformatics and computational biology	PO2, PO3, PO4, PO5	C4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Formulate and solve</b> biological problems using efficient algorithms and data structures	PO1, PO2, PO3, PO12	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.80.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1	√	√	√	√	√	√			√											
CO 2		√	√	√	√	√			√		√				√			√		√
CO 3		√	√	√	√	√		√	√		√				√			√		√

### 20.80.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to algorithms and computational complexity; Basic graph theoretic terminologies	CO1, CO2
Week 2	DNA/RNA sequencing and Sequence analyses	CO1-CO3
Week 3	DNA/RNA sequencing and Sequence analyses	CO1-CO3
Week 4	Advanced data structures and their applications	CO1-CO3
Week 5	Genome rearrangement	CO1-CO3

Week	Lecture Topics	Corresponding CO(s)
Week 6	Protein sequence analyses and protein attribute prediction using machine learning	CO1-CO3
Week 7	Protein sequence analyses and protein attribute prediction using machine learning	CO1-CO3
Week 8	Multiple sequence alignments; local and global alignments	CO1-CO3
Week 9	Phylogenetic tree construction	CO1-CO3
Week 10	Phylogenomic analyses	CO1-CO3
Week 11	Phylogenomic analyses	CO1-CO3
Week 12	Genome assembly	CO1-CO3
Week 13	Genome assembly	CO1-CO3
Week 14	Advanced and recent topics in bioinformatics	CO1-CO3

#### 20.80.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.80.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.80.13 Textbook/ Reference

- An Introduction to Bioinformatics Algorithms by Neil C. Jones and Pavel A. Pevzner
- Bioinformatics Algorithms an Active Learning Approach (2nd Edition) by Phillip Compeau & Pavel Pevzner
- Fundamentals of Molecular Evolution (2nd Edition) by Dan Graur and Wen-Hsiung Li
- Computational Phylogenetics: An introduction to designing methods for phylogeny estimation by Tandy Warnow

#### 20.81 Description of Course CSE 467

##### PART A: General Information

20.81.1 Course Title : SOFTWARE ARCHITECTURE

20.81.2 Type of Course : THEORY

20.81.3 Offered to : DEPARTMENT OF CSE

20.81.4 Pre-requisite Course(s) :

## **PART B: Course Details**

### **20.81.5 Course Content (As approved by the Academic Council)**

Definition and overview; Architecture design: patterns, Attribute-Driven Design (ADD) method; Architecture influence cycle: what influences software architects and software architecture; Understanding and achieving quality attributes: Quality Attribute Workshop (QAW) method for identifying critical quality attributes; Documenting software architecture; Evaluating software architecture: Architecture Tradeoff Analysis Method (ATAM) for evaluating software architecture; Architecture reuse; Architecture review; Improving an existing architecture design; Software Architecture in Agile projects; Software Architecture in service oriented systems; Software Architecture in embedded and mobile systems.

### **20.81.6 Course Objectives**

The students are expected to:

- Identify software architecture design patterns and sources of influence for that.
- Apply software quality assurance techniques to communicate, test and improve existing software architecture.
- Evaluate software architectures and improve in a systematic way.
- Design software architecture for real world software.

### **20.81.7 Knowledge required**

#### **Technical**

- System design and development

#### **Analytical**

- Software Engineering

### **20.81.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> software architecture designs and methods	-	C2, A1	Lecture	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Analyze</b> quality of software systems.	PO1, PO2, PO4	C4, A2	Lecture	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Create and evaluate</b> software systems and make systematic improvements.	PO1, PO2, PO3, PO4	C5, A3	Lecture	Class Tests or Assignments or Projects, and Final Exam

**20.81.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1	√		√							√						√				
CO 2			√			√			√	√					√		√			
CO 3			√		√	√			√	√					√			√		√

**20.81.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Definition and overview	CO1 and CO2
Week 2	Architecture design: patterns	CO1 and CO2
Week 3	Architecture design: Attribute-Driven Design (ADD) method	CO1 and CO2
Week 4	Architecture influence cycle: what influences software architects and software architecture	CO1 and CO2
Week 5	Understanding and achieving quality attributes	CO1 and CO2
Week 6	Quality Attribute Workshop (QAW) method for identifying critical quality attributes	CO1 and CO2
Week 7	Documenting software architecture	CO1 and CO2
Week 8	Evaluating software architecture: Architecture Tradeoff Analysis Method (ATAM) for evaluating software architecture	CO2 and CO3
Week 9	Architecture reuse	CO2 and CO3
Week 10	Architecture review	CO2 and CO3
Week 11	Improving an existing architecture design	CO2 and CO3
Week 12	Software Architecture in Agile projects	CO2 and CO3
Week 13	Software Architecture in service-oriented systems	CO2 and CO3
Week 14	Software Architecture in embedded and mobile systems	CO2 and CO3

### 20.81.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.81.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.81.13 Textbook/ Reference

- Software Architecture in Practice by Leonard J. Bass and Len Bass

## 20.82 Description of Course CSE 469

### PART A: General Information

20.81.1 Course Title	: Software Testing and Quality Assurance
20.81.2 Type of Course	: THEORY
20.82.3 Offered to	: DEPARTMENT OF CSE
20.82.4 Pre-requisite Course(s)	: None

### PART B: Course Details

#### 20.82.5 Course Content (As approved by the Academic Council)

Objectives of software testing, Software Testing Life Cycle (STLC), Test Driven Development, Software Testing Terminology and Methodology; Test Plan, Testcase design and Testdata generation, Equivalence Partitioning, Boundary Value Analysis, Test Coverage; Review of Common testing methods: Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Alpha and Beta Testing, White box and black box testing; GUI Testing, API Testing; Code Review; Performance testing: Load and Stress Testing, Volume Testing, Capacity Testing; Software Security: Concept of software security, Common Vulnerabilities and their mitigation, Buffer Overflow, SQLInjection, Cross-site Scripting, Automated Security Testing, Fuzz Testing; Testing tools and Test Automation : Open source and commercial software testing tools; Automatic Bug Detection, Automated Program Repair Techniques; Software Quality, Quality Control and Quality Assurance, Software Quality Metrics;

#### 20.82.6 Course Objectives

The students are expected to:

- Understand the concepts related to software testing and learn different manual and automated testing techniques.
- Apply testing techniques and relevant tools to automate testing and program repair.
- Learn different software quality assurance methods.

#### 20.82.7 Knowledge required

##### Technical

- Software Engineering.

##### Analytical

- Problem analysis.

### 20.82.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> the concepts related to software testing and <b>learn</b> different manual and automated testing techniques	PO1, PO2	C3	Lecture	Class test, assignment, final exam
CO2	<b>Apply</b> testing techniques and relevant tools to automate testing and program repair	PO4, PO5	C3	Lecture	Class test, assignment, final exam
CO3	<b>Learn</b> different software quality assurance methods	-	C1	Lecture	Class test, assignment, final exam

### 20.82.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√				√	√	√			√
CO 2		√	√	√	√	√			√	√	√	√			√	√	√			√
CO 3		√	√	√	√	√			√		√		√			√	√			

### 20.82.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Objectives of software testing, Software Testing Life Cycle (STLC), Test Driven Development, Software Testing Terminology and Methodology	CO1
2	Test Plan, Testcase design and Testdata generation, Equivalence Partitioning, Boundary Value Analysis.	CO1
3	Test Coverage	CO1
4	Review of Common testing methods: Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Alpha and Beta Testing, White box and black box testing	CO1
5	GUI Testing, API Testing	CO1, CO2
6	Code Review	CO1

Week	Topic	Course Outcomes
7	Performance testing: Load and Stress Testing, Volume Testing, Capacity Testing	CO1, CO2
8	Software Security: Concept of software security, Common Vulnerabilities and their mitigation, Buffer Overflow, SQLInjection,	CO1
9	Cross-site Scripting, Automated Security Testing, Fuzz Testing	CO1
10	Testing tools and Test Automation: Open source and commercial software testing tools	CO2
11	Code Smell, Automatic Bug Detection	CO1, CO2
12	Automated Program Repair Techniques	CO1
13	Software Quality, Quality Control and Quality Assurance	CO3
14	Software Quality Metrics	CO3

#### 20.82.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.82.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.82.13 Textbook/ Reference

- Glenford J. Myers, Corey Sandler, and Tom Badgett. The Art of Software Testing, 3rd Edition, John Wiley & Sons
- Ron Patton. Software Testing, 2nd edition, Sams Publishing.
- Paul C. Jorgensen. Software Testing: A Craftsman's Approach, Fourth Edition, Shroff Publishers and Distributors.

#### 20.83 Description of Course CSE 470

##### PART A: General Information

20.83.1 Course Title : Software Testing and Quality Assurance

20.83.2 Type of Course : SESSIONAL

20.83.3 Offered to : DEPARTMENT OF CSE

20.83.4 Pre-requisite Course(s) : None

## **PART B: Course Details**

### **20.83.5 Course Content (As approved by the Academic Council)**

Sessional based on CSE 469 (Software Testing and Quality Assurance).

### **20.83.6 Course Objectives**

After undergoing this course, students should be able to:

- i. Understand the concepts related to software testing and learn different manual and automated testing techniques
- ii. Apply testing techniques and relevant tools to automate testing and program repair
- iii. Learn different software quality assurance methods

### **20.83.7 Knowledge required**

#### **Technical**

- Databases, Object Oriented Programming, Design Patterns, Software Engineering Fundamentals.

#### **Analytical**

### **20.83.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> the concepts related to software testing and learn different manual and automated testing techniques	-	C2	Lecture and demonstration	Assignment, Quiz
CO2	<b>Apply</b> testing techniques and relevant tools to automate testing and program repair	PO1, PO2, PO3	C3	Lecture and demonstration	Assignment, Quiz
CO3	<b>Assess</b> software using different software quality assurance methods	PO1, PO5	C3	Lecture and demonstration	Assignment, Quiz

### **20.83.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√		√	√															
CO 2					√	√			√			√			√	√				
CO 3		√		√	√				√		√		√		√	√				√

### 20.83.10 Lecture/ Activity Plan

Week	Topic	Course Outcomes
1	Discussion on Software Testing Life Cycle, Test Driven Development, and Software Testing Methodologies	CO1
2-3	Assignment on Test Plan, Test case design, and Test data generation	CO2
4-5	Assignment on Unit Testing, Integration Testing, and Regression Testing on a selected project	CO2
6-7	Assignment on GUI Testing and API Testing on the selected project	CO2
8-9	Assignment on Performance testing (Load and Stress Testing) on the selected project Discussion on Code Review, Code Smell, and Automated Program Repair Techniques	CO2
10-11	Assignment on implementing an automatic program repair technique on the selected project	CO2
12-14	Discussion on different software quality assurance techniques and tools, Quiz Final Code and Report Submission	CO1, CO2, CO3

### 20.83.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Projects: There will be assignments and a project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

### 20.83.12 Distribution of Marks

Attendance:	10 %
Assignments/Projects:	60%
Final Quiz:	30%
Total:	100%

### 20.83.13 Textbook/ Reference

- a. Software Testing by Ron Patton
- b. The Art of Software Testing by Glenford J. Myers, Corey Sandler, and Tom Badgett.
- c. Software Testing: A Craftsman's Approach by Paul C. Jorgensen.
- d. Software Engineering at Google: Lessons Learned from Programming Over Time by Titus Winters, Tom Manshreck, Hyrum Wright

## 20.84 Description of Course CSE 475

### PART A: General Information

20.84.1 Course Title	: Robotics
20.84.2 Type of Course	: THEORY
20.84.3 Offered to	: DEPARTMENT OF CSE
20.84.4 Pre-requisite Course(s)	: CSE 317

## **PART B: Course Details**

### **20.84.5 Course Content (As approved by the Academic Council)**

Introduction: what is a robot, types of robots, robotics and AI; Automation & autonomy architectures; Introduction to Robot Operating System (ROS); Robot hardware: sensors and effectors; Localization: Markov localization, particle filter, Kalman filter, extended Kalman filter, and multi-object localization; Mapping; Simultaneous localization and mapping (SLAM); Navigation and path planning; Locomotion and manipulation; Robot Kinematics: forward and inverse kinematics; Robot dynamics: dynamics of a Rigid Body, Newton-Euler Formula, and Euler-Lagrange Formula; Human-robot interaction; Control system of robots; Image processing and analysis with vision systems; Robotics and multi-agent systems.

### **20.84.6 Course Objectives**

The students are expected to:

- To make students understand the basic principles, techniques, and applications of robotics.
- To familiarize students with the mathematical theories and algorithms involved in robotics such as kinematics, dynamics, control, localization, mapping, navigation, and path planning of robot systems.
- To teach students how the theories and techniques of robotics can be applied in real-world problem solving.

### **20.84.7 Knowledge required**

#### **Technical**

- Calculus, geometry, physics, algebra, and computer programming

#### **Analytical**

- Problem solving and creating thinking.

### **20.84.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Understand</b> basic principles of robotics, its applications and relationships with human and AI systems.	-	C2	Lectures and demonstration	Class Tests, Assignments, and Final Exam
CO2	<b>Understand</b> and <b>analyze</b> the mathematical theories involved in kinematics, dynamics, and control of robot systems.	PO1	C4	Lectures and demonstration	Class Tests, Assignments, and Final Exam
CO3	<b>Apply</b> the techniques used in localization, mapping, navigation, and path planning of robot systems in practical applications.	PO1	C3	Lectures and demonstration	Class Tests, Assignments, and Final Exam

### **20.84.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√							√	√			
CO 2		√	√	√	√	√		√	√	√				√	√	√				√
CO 3		√	√	√	√	√			√	√	√	√			√	√	√			√

#### 20.84.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to robots, types of robots, and applications	CO1
Week 2	Automation & autonomy architectures	CO1
Week 3	Introduction to robot operating system (ROS)	CO1
Week 4	Robot hardware: sensors and effectors	CO1
Week 5	Localization: Markov localization, particle filter, Kalman filter, extended Kalman filter, and multi-object localization	CO3
Week 6	Introduction to mapping techniques; Simultaneous localization and mapping (SLAM)	CO3
Week 7	Introduction to navigation and path planning	CO3
Week 8	Locomotion and manipulation;	CO2
Week 9	Robot Kinematics: forward and inverse kinematics	CO2
Week 10	Robot dynamics: dynamics of a Rigid Body, Newton-Euler Formula, and Euler-Lagrange Formula	CO2
Week 11	Control system of robots	CO2
Week 12	Human-robot interaction	CO1
Week 13	Image processing and analysis with vision systems	CO1
Week 14	Introduction to Robotics and multi-agent systems;	CO1

#### 20.84.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

**20.84.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

**20.84.13 Textbook/ Reference**

- “Elements of Robotics” by Mordechai Ben-Ari and Francesco Mondada
- “Introduction to Autonomous Robots: Kinematics, Perception, Localization and Planning” by Nikolaus Correll
- “Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy” by Lentin Joseph

**20.85 Description of Course CSE 476****PART A: General Information**

<b>20.85.1 Course Title</b>	: Robotics Sessional
<b>20.85.2 Type of Course</b>	: Sessional
<b>20.85.3 Offered to</b>	: DEPARTMENT OF CSE
<b>20.85.4 Pre-requisite Course(s)</b>	: None

**PART B: Course Details****20.85.5 Course Content (As approved by the Academic Council)**

- Sessional based on the theory course CSE 475 titled “Robotics”

**20.85.6 Course Objectives**

The main objectives of this course are as follows:

- To teach students how to write effective programs using robot operating system (ROS).
- To teach students how to design and implement computer programs to solve problems in robotics such as kinematics, dynamics, control, localization, mapping, navigation, and path planning of robot systems.

**20.85.7 Knowledge required****Technical**

- Calculus, geometry, physics, algebra, and computer programming

**Analytical**

- Problem solving and creating thinking

**20.85.8 Course Outcomes (COs)**

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Demonstrate</b> the knowledge to write effective programs using robot operating system (ROS) for robotics applications.	PO5	C3	Program design for real-world problem solving	Lab assignment, viva, final quiz
CO2	<b>Design</b> algorithms for localization/mapping/ path planning/ trajectory planning/ vision systems problems of robotics	PO1 and PO3	C6	Program design for real-world problem solving	Lab assignment, viva, final quiz
CO3	<b>Develop</b> programs for finding solutions to robot kinematics, dynamics, and control systems problems.	PO1 and PO3	C6	Program design for real-world problem solving	Lab assignment, viva, final quiz

**20.85.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√				√	√	√			
CO 3		√	√	√	√	√			√	√	√				√	√				√

**20.85.10 Lecture/ Activity Plan**

Week(s)	Lecture Topics	Corresponding CO(s)
Weeks 1-4	Assignment on robot operating system (ROS) basics: publisher/subscriber, service/client, broadcaster/listeners.	CO1
Week 5-6	Assignments on robot kinematics.	CO3
Week 7-8	Assignments on robot path planning/trajectory generation.	CO2
Weeks 9-11	Assignment on robot dynamics and control algorithm.	CO3
Week 12-13	Assignments on localization/mapping/vision systems techniques.	CO2

Week(s)	Lecture Topics	Corresponding CO(s)
Week 14	Final quiz	CO1 - CO3

#### 20.85.11 Assessment Strategy

- Assignment: There will be four to six assignments. Some assignments may have sub-problems covering multiple topics.
- Viva: There will be a short viva examination on every assignment.
- Final quiz: A final quiz will be held at the end of the semester.

#### 20.85.12 Distribution of Marks

Assignment:	50-60%
Viva:	10-20%
Final quiz:	20-30%
Total:	100%

#### 20.85.13 Textbook/ Reference

- “Elements of Robotics” by Mordechai Ben-Ari and Francesco Mondada
- “Introduction to Autonomous Robots: Kinematics, Perception, Localization and Planning” by Nikolaus Correll
- “Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy” by Lentin Joseph

### 20.86 Description of Course CSE 481

#### **PART A: General Information**

20.86.1 Course Title	: VLSI Design
20.86.2 Type of Course	: THEORY
20.86.3 Offered to	: DEPARTMENT OF CSE
20.86.4 Pre-requisite Course(s)	:

#### **PART B: Course Details**

##### **20.86.5 Course Content (As approved by the Academic Council)**

Methodology: PLA, FPGA, cell-based and full custom design methods, System-on-chip design, Design Partitioning: structural and behavioral design with HDL, Physical design, Introduction to CMOS technology: characteristics and performance, CMOS processing technology, CMOS building blocks: inverters and basic gates, adder, multiplier, data path and memory structures, CMOS layout design rules, Design robustness: Variability, Reliability and Scaling, Testing, Debugging and Verification. VLSI Design Automation and Optimization: partitioning, floor-planning, channel routing, data-path synthesis.

### 20.86.6 Course Objectives

After undergoing this course, students should be able to:

- Understand concepts of VLSI technology
- Understand CMOS logics and fabrication technology
- Implement and analyze different algorithms for VLSI physical design
- Understand Fabrication process of chips
- Implement system specification using software

### 20.86.7 Knowledge required

#### Technical

- System design and development

#### Analytical

- Logic design

### 20.86.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> CMOS logics and fabrication technology	-	C1	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and develop</b> different algorithms for VLSI physical design.	PO3 and PO4	C4, C6, A2	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Create</b> system specification using software, <b>and evaluate</b> fabrication process of chips.	PO5	A3, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.86.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1		√	√	√	√	√										√				
CO2		√	√	√	√	√			√	√	√			√			√			
CO3		√	√	√	√	√			√	√	√				√			√		√

### 20.86.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to VLSI, VLSI design cycle	CO1
Week 2	MOS Structure, MOS Characteristics	CO1
Week 3	VLSI design methodology: PLA, FPGA	CO1
Week 4	System-on-chip design, Design Partitioning: structural and behavioral design with HDL,	CO1 and CO2
Week 5	Physical design	CO2
Week 6	Introduction to CMOS technology: characteristics and performance, CMOS processing technology,	CO2
Week 7	CMOS building blocks: inverters and basic gates, adder	CO2
Week 8	CMOS building blocks: multiplier, data path and memory structures	CO2
Week 9	CMOS layout design rules	CO2
Week 10	Design robustness: Variability, Reliability	CO3
Week 11	Design robustness: Scaling, Testing, Debugging and Verification.	CO3
Week 12	VLSI Design Automation and Optimization: partitioning,	CO3
Week 13	Floor-planning, Channel routing	CO3
Week 14	Data-path synthesis, Wrap Up	CO1, CO2, and CO3

#### 20.86.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.86.12 Distribution of Marks

Attendance:	10%
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.86.13 Textbook/ Reference

- CMOS VLSI Design: A Circuits and Systems Perspective [Fourth Edition] by Neil H. E. Weste & David Money Harris
- Algorithms for VLSI Physical Design Automation [Third Edition] by Naveed A. Sherwani
- Design of VLSI systems: a practical introduction by Linda E. M. Brackenbury
- Modern VLSI design by Wayne Wolf

#### 20.87 Description of Course CSE 482

**PART A: General Information**

- 20.87.1 Course Title** : VLSI Design Sessional
- 20.87.2 Type of Course** : Sessional
- 20.87.3 Offered to** : DEPARTMENT OF CSE
- 20.87.4 Pre-requisite Course(s)** :

**PART B: Course Details**

- 20.87.5 Course Content (As approved by the Academic Council)**  
Sessional based on the theory course.

**20.87.6 Course Objectives**

The students are expected to:

- Simulate and analyze circuits using PSPICE
- Understand and implement different VLSI algorithms
- Describe digital hardware using Verilog HDL

**20.87.7 Knowledge required****Technical**

- System design and development

**Analytical**

- Logic design

**20.87.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	Simulate and analyze circuits using PSPICE	PO1 and PO2	A4	Lecture, Demonstration, Hands-on.	Assessment evaluation, Projects, and Final Quiz
CO2	Design and develop different VLSI algorithms	PO3 and PO4	C5	Lecture, Demonstration, Hands-on.	Assessment evaluation, Projects, and Final Quiz
CO3	Describe digital hardware using Verilog HDL	PO6	P7	Lecture, Demonstration, Hands-on.	Assessment evaluation, Projects, and Final Quiz

**20.87.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√	√			
CO 2		√	√	√	√	√			√	√				√			√			
CO 3		√	√	√	√	√			√	√	√				√		√	√		√

**20.87.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to course	CO1
Week 2	Class on PSPICE Simulation and practice, Section A	CO1
Week 3	Class on PSPICE Simulation and practice, Section B	CO1
Week 4	Offline and Online Evaluation on PSPICE, Section A	CO1 and CO2
Week 5	Offline and Online Evaluation on PSPICE, Section B	CO2
Week 6	VLSI algorithm – I (Offline/Online Evaluation), Section A	CO2
Week 7	VLSI algorithm – I (Offline/Online Evaluation), Section B	CO2
Week 8	VLSI algorithm – II (Offline/Online Evaluation), Section A	CO2
Week 9	VLSI algorithm – II (Offline/Online Evaluation), Section B	CO2
Week 10	VLSI algorithm – III (Offline/Online Evaluation), Section A	CO3
Week 11	VLSI algorithm – III (Offline/Online Evaluation), Section B	CO3
Week 12		CO3
Week 13	Quiz	CO1, CO2, and CO3
Week 14		

**20.87.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.87.12 Distribution of Marks

Attendance:	5%
Lab. and Home Assignments:	65-70 %
Quiz:	26-30%

### 20.87.13 Textbook/ Reference

- CMOS VLSI Design: A Circuits and Systems Perspective [Fourth Edition] by Neil H. E. Weste & David Money Harris
- Algorithms for VLSI Physical Design Automation [Third Edition] by Naveed A. Sherwani
- Design of VLSI systems: a practical introduction by Linda E. M. Brackenbury
- Modern VLSI design by Wayne Wolf

### 20.88 Description of Course CSE 483

#### PART A: General Information

20.88.1 Course Title	: INTERFACING
20.88.2 Type of Course	: THEORY
20.88.3 Offered to	: DEPARTMENT OF CSE
20.88.4 Pre-requisite Course(s)	: CSE 205 Digital Logic Design

#### PART B: Course Details

#### 20.88.5 Course Content (As approved by the Academic Council)

Interfacing with floppy and hard-disk controller; serial communication interface; Barcode reader; Sound card; MIDI interface; Printer interface; ISA, PCI, AGP, PS/2 and USB interfaces; Interfacing with stepper motors, controlling semiconductor power switches “ BJT, MOSFET, SCR and Triac, Application of Opto-coupler and relays, Embedded Processors, Embedded Computing Platform, Real Time Embedded Systems, Real Time Operating Systems, Embedded Systems Programming, Mapping between languages and hardware, Embedded Communication Systems, Embedded Computer Security.

#### 20.88.6 Course Objectives

The students are expected to:

- Identify and adapt different types of communication protocols.
- Distinguish and combine different types of memories and peripheral interfacing for microprocessors, microcontrollers, and embedded systems.
- Design and create different embedded systems having sensors and actuators.

#### 20.88.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Logic design

### 20.88.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> different types of communication protocols.	PO1 and PO2	A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and develop</b> memory and peripheral interfacing for microprocessors, microcontrollers, and embedded systems.	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Create and evaluate</b> embedded systems encompassing sensors and actuators.	PO6	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

### 20.88.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√						√				
CO 2		√	√	√	√	√			√	√				√			√			
CO 3		√	√	√	√	√			√	√					√			√		√

### 20.88.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to embedded systems	CO1
Week 2	Introduction to communication protocols	CO1
Week 3	Interfacing with floppy and hard-disk controller serial communication interface; Barcode reader; Sound card; MIDI interface; Printer interface	CO1
Week 4	ISA, PCI, AGP, PS/2 and USB interfaces	CO1 and CO2
Week 5	Interfacing with stepper motors, controlling semiconductor power switches, e.g., BJT, MOSFET, SCR and Triac	CO2
Week 6	Embedded system based on Arduino	CO2
Week 7	Introduction to embedded processors	CO2

Week	Lecture Topics	Corresponding CO(s)
Week 8	Embedded Computing Platform	CO2
Week 9	Embedded Systems Programming	CO2
Week 10	Real-time operating system	CO3
Week 11	Embedded Communication Systems	CO3
Week 12	Embedded Computer Security	CO3
Week 13	Printed circuit board for efficient interfacing	CO3
Week 14	Wrap up;	CO1, CO2, and CO3

### 20.88.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.88.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.88.13 Textbook/ Reference

- “The Intel microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit extensions: architecture, programming, and interfacing” by Barry B. Brey, 8<sup>th</sup> Edition, 2009 [Source: [https://userpages.umbc.edu/~squire/intel\\_book.pdf](https://userpages.umbc.edu/~squire/intel_book.pdf)]
- “Microprocessors and Interfacing Programming and hardware” by Douglas V Hall, 2<sup>nd</sup> Edition.

## 20.89 Description of Course CSE 484

### PART A: General Information

20.89.1 Course Title	: INTERFACING SESSIONAL
20.89.2 Type of Course	: SESSIONAL
20.89.3 Offered to	: DEPARTMENT OF CSE
20.89.4 Pre-requisite Course(s)	:

## **PART B: Course Details**

### **20.89.5 Course Content (As approved by the Academic Council)**

Sessional based on CSE 483.

### **20.89.6 Course Objectives**

The students are expected to:

- Identify and adapt different types of communication protocols.
- Distinguish and combine different types of memories and peripheral interfacing for microprocessors, microcontrollers, and embedded systems.
- Design and create different embedded systems having sensors and actuators.

### **20.89.7 Knowledge required**

#### **Technical**

- System design and development

#### **Analytical**

- Logic design

### **20.89.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Analyze</b> different types of communication protocols.	PO1 and PO2	A4	Lecture, Demonstration and hands-on	Assignments and Quiz
CO2	<b>Design and develop</b> memory and peripheral interfacing for microprocessors, microcontrollers, and embedded systems.	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO3	<b>Create and evaluate</b> embedded systems encompassing sensors and actuators.	PO6	P7	Lecture, Demonstration and hands-on	Assignments and Quiz

### **20.89.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

<b>COs</b>	<b>K 1</b>	<b>K 2</b>	<b>K 3</b>	<b>K 4</b>	<b>K 5</b>	<b>K 6</b>	<b>K 7</b>	<b>K 8</b>	<b>P 1</b>	<b>P 2</b>	<b>P 3</b>	<b>P 4</b>	<b>P 5</b>	<b>P 6</b>	<b>P 7</b>	<b>A 1</b>	<b>A 2</b>	<b>A 3</b>	<b>A 4</b>	<b>A 5</b>
CO 1		√	√	√	√	√			√	√						√				
CO 2		√	√	√	√	√			√	√				√			√			
CO 3		√	√	√	√	√			√	√					√			√		√

**20.89.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1/2	Introduction to embedded systems; Discussion on Projects	CO1
Week 3/4	Team Formation for Projects, Project Ideation	CO1 and CO2
Week 5/6	Interfacing with floppy and hard-disk controller; serial communication interface;	CO1 and CO2
Week 7/8	Interfacing with Barcode reader; Sound card; Printer interface;	CO1 and CO2
Week 9/10	Interfacing with stepper motors	CO1 and CO2
Week 11/12	Controlling semiconductor power switches, e.g., BJT, MOSFET, SCR and Triac	CO1 and CO2
Week 13/14	Quiz, Presentation on Project, Project demonstration; Submission of Final Report on Project	CO1, CO2, and CO3

**20.89.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Assignments: There will be Assignments and a Project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

**20.89.12 Distribution of Marks**

Attendance:	10 %
Assignments:	26%
Projects:	40%
Quiz:	26%
Total:	100%

**20.89.13 Textbook/ Reference**

- “The Intel microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit extensions: architecture, programming, and interfacing” by Barry B. Brey, 8<sup>th</sup> Edition, 2009 [Source: [https://userpages.umbc.edu/~squire/intel\\_book.pdf](https://userpages.umbc.edu/~squire/intel_book.pdf)]
- “Microprocessors and Interfacing Programming and hardware” by Douglas V Hall, 2<sup>nd</sup> Edition.
- Microprocessor Data Handbook.
- Digital Logic and Computer Design by M. Morris Mano

**20.90 Description of Course CSE 485****PART A: General Information**

<b>20.90.1 Course Title</b>	: DIGITAL SIGNAL PROCESSING
<b>20.90.2 Type of Course</b>	: THEORY
<b>20.90.3 Offered to</b>	: DEPARTMENT OF CSE
<b>20.90.4 Pre-requisite Course(s)</b>	:

**PART B: Course Details**

**20.90.5 Course Content (As approved by the Academic Council)**

Discrete time signals and systems: Fourier and Z transforms, DFT, 2-dimensional versions; Linear time invariant discrete time systems; Digital signal processing topics: flow graphs, realizations, FFT, quantization effects, linear prediction; Digital filter design methods: windowing, frequency sampling, S-to-Z methods, frequency-transformation methods, optimization methods, 2-dimensional filter design; Quantization of signals and filter coefficients; Oversampling techniques for ADC and DAC.

**20.90.6 Course Objectives**

The students are expected to:

- Identify discrete-time signals and systems.
- Apply the principles of Fourier and Z transform, and DFT for analyzing signals.
- Use different methods for processing digital signals.
- Design and create filters for digital signals using various methods.
- Develop different types of ADC and DAC.

**20.90.7 Knowledge required**

**Technical**

- System design and development

**Analytical**

- Data Communication

**20.90.8 Course Outcomes (COs)**

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Analyze</b> different methods to process digital signals.	PO1 and PO2	C4, A4	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO2	<b>Design and develop</b> filters for discrete time signals and systems using various methods.	PO3 and PO4	C5	Lecture, Demonstration, and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO3	<b>Create and evaluate</b> different types of ADC and DAC.	PO6	C6	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam

**20.90.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√						√				

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 2		√	√	√	√	√			√	√				√			√			
CO 3		√	√	√	√	√			√	√					√			√		√

#### 20.90.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to discrete time signals and systems	CO1 and CO2
Week 2	Fourier and Z transforms	CO1 and CO2
Week 3	DFT, 2-dimensional versions	CO1 and CO2
Week 4	Linear time invariant discrete time systems	CO1 and CO2
Week 5	Digital signal processing topics: flow graphs, realizations	CO1 and CO2
Week 6	Digital signal processing topics: FFT	CO1 and CO2
Week 7	Digital signal processing topics: quantization effects, linear prediction	CO1 and CO2
Week 8	Digital filter design methods: windowing, frequency sampling	CO2 and CO3
Week 9	Digital filter design methods: S-to-Z methods	CO2 and CO3
Week 10	Digital filter design methods: frequency-transformation methods	CO2 and CO3
Week 11	Digital filter design methods: optimization methods	CO2 and CO3
Week 12	Digital filter design methods: 2-dimensional filter design	CO2 and CO3
Week 13	Quantization of signals and filter coefficients	CO2 and CO3
Week 14	Oversampling techniques for ADC and DAC	CO2 and CO3

#### 20.90.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.90.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

### 20.90.13 Textbook/ Reference

- Digital Signal Processing: Principles, Algorithms, and Applications by Dimitris Manolakis and John G Proakis.
- Essentials of Digital Signal Processing by B. P Lathi and Roger A. Green.
- Digital Signal Processing: A Computer-Based Approach by S. K. Mitra, McGraw-Hill, Third edition, 2006.

### 20.91 Description of Course CSE 486

#### PART A: General Information

20.91.1 Course Title : DIGITAL SIGNAL PROCESSING SESSIONAL

20.91.2 Type of Course : SESSIONAL

20.91.3 Offered to : DEPARTMENT OF CSE

20.91.4 Pre-requisite Course(s) : None

#### PART B: Course Details

#### 20.91.5 Course Content (As approved by the Academic Council)

Sessional based on CSE 485.

#### 20.91.6 Course Objectives

The students are expected to:

- Identify and adapt programs for digital signals and systems.
- Distinguish and combine hardware and software systems for processing digital signals.
- Design and create digital systems with ADC and DAC.

#### 20.91.7 Knowledge required

##### Technical

- System design and development

##### Analytical

- Programming
- Data Communication

#### 20.91.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand</b> and <b>apply</b> programs for digital signals and systems.	PO1 and PO2	C3	Lecture, Demonstration, and hands-on	Assignments and Quiz
CO2	<b>Implement</b> software systems for	PO3 and PO4	C4, A5	Lecture, Demonstration, and hands-on	Assignments and Quiz

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	processing digital signals.				
CO3	<b>Design and develop</b> digital systems with ADC and DAC.	PO6	C6, P7	Lecture, Demonstration, and hands-on	Project and Quiz

### 20.91.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√	√				√			√	
CO 2		√	√	√	√	√			√	√	√	√				√	√			
CO 3		√	√	√	√	√		√	√	√	√				√	√		√		√

### 20.91.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1-2	Course Overview + Continuous-time and Discrete-time representation of basic signals	CO1
Week 3-4	Analog to Digital Conversion + Manipulation of Discrete Time Signals	CO1 and CO2
Week 5-6	Convolution and correlation of Discrete-Time sequences + Project Proposal	CO1, CO2 and CO3
Week 7-8	Z-Transform in Python	CO1 and CO2
Week 9-10	Frequency domain analysis of DT signals by FFT	CO1 and CO2
Week 11-12	Implementation of Digital Filter in Python	CO1 and CO2
Week 13-14	Quiz + Project Submission	CO1, CO2 and CO3

### 20.91.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Assignments and Project: There will be six Assignments and one Term Project.
- Quiz Exam: A comprehensive Quiz exam will be held at the end of the semester.

**20.91.12 Distribution of Marks**

Attendance:	10 %
Assignments and Project:	70%
Quiz Exam:	20%
Total:	100%

**20.91.13 Textbook/ Reference**

1. Digital Signal Processing (DSP) with Python Programming by Maurice Charbit.
2. Think DSP: Digital Signal Processing in Python by Allen B. Downey (<https://greenteapress.com/thinkdsp/thinkdsp.pdf>).

**20.92 Description of Course CSE 487****PART A: General Information**

<b>20.92.1 Course Title</b>	: Mobile Applications Development
<b>20.92.2 Type of Course</b>	: THEORY
<b>20.92.3 Offered to</b>	: DEPARTMENT OF CSE
<b>20.92.4 Pre-requisite Course(s)</b>	:

**PART B: Course Details****20.92.5 Course Content (As approved by the Academic Council)**

Mobile platforms: anatomy of mobile devices, mobile OS (e.g., Android, iOS), mobile programming (e.g., Java, Objective C); Android programming basics: SDKs, activities, life cycles, views, intent, resource, storage, UIs; Android advanced programming: SQLite, networking, maps, multimedia; iOS programming basics: objective C, SDKs, views, view controllers, gestures, storage; iOS advanced programming: memory management, data management, networking, graphics, location technologies; Web-based mobile applications (e.g., HTML5).

**20.92.6 Course Objectives**

The students are expected to:

- Describe Mobile Application Development fundamentals and gain in depth knowledge about technologies (languages, frameworks, SDKs, databases) used in mobile application development.
- Design mobile applications with multiple user interface with multiple system components using provided assets with basic and advanced functionality on a popular mobile development platform.
- Develop a mobile application that uses hardware and software resources (e.g., sensors and configuration etc.) and evaluate functionality performance of mobile applications based on pre-set criteria.

**20.92.7 Knowledge required****Technical**

- Computer programming

**Analytical**

- None

### 20.92.8 Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Describe</b> mobile application development terminologies and technologies in terms of hardware, software and communications.	PO1, PO12	C5, A1	Lecture and Demonstration	Class Tests or Assignments or Projects, and Final Exam
CO 2	<b>Design</b> multi-functional mobile application with multiple user interface and multiple system component.	PO2, PO3, PO4, PO6	C6	Lecture, Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam
CO 3	<b>Develop</b> a fully functional mobile application with real-world application using hardware and software resources.	PO3, PO5, PO9, PO11	C6, A4	Lecture and Demonstration and hands-on	Class Tests or Assignments or Projects, and Final Exam

### 20.92.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√			√		√	√			√
CO 3		√	√	√	√	√			√	√	√				√	√				√

### 20.92.10 Lecture/ Activity Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Mobile platforms: anatomy of mobile devices, mobile OS (e.g., Android, iOS)	CO1
Week 2	Mobile programming (e.g., Java, Objective C, Swift)	CO1
Week 3	Android programming basics: SDKs, Activities, Life cycles	CO1, CO2
Week 4	Android programming basics: Views, Intent, Resource	CO1
Week 5	Android programming basics: Storage, UIs, Design	CO1, CO2
Week 6	Android advanced programming: SQLite, Networking	CO1
Week 7	Android advanced programming: Maps, Multimedia	CO1, CO3
Week 8	iOS programming basics: Objective C, Swift, SDKs, Views	CO1,

<b>Week</b>	<b>Lecture Topics</b>	<b>Corresponding CO(s)</b>
Week 9	iOS programming basics: View controllers, Gestures, Storage	CO1, CO2
Week 10	iOS advanced programming: Memory management, Data management	CO1
Week 11	iOS advanced programming: Networking, Graphics, Location Technologies	CO1, CO3
Week 12	Web-based mobile applications (e.g., HTML5).	CO1, CO3
Week 13	Requirement analysis, interface design and system design	CO2, CO3
Week 14	Wrap up	CO1, CO2, and CO3

#### **20.92.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### **20.92.12 Distribution of Marks**

Attendance:	10%
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### **20.92.13 Textbook/ Reference**

- “Mobile Applications Development (Oracle Press)” by Jim J. Marion and Sarah K. Marion, 1<sup>st</sup> edition, 2015.
- “Programming Android with Kotlin” by Pierre-Olivier Laurence, Amanda Hinchman-Dominguez, Mike Dunn, G. Blake Meike, 1<sup>st</sup> edition, 2021.
- “The Joy of Kotlin” by Pierre-Yves Saumont, 1<sup>st</sup> edition, 2019.
- “iOS 15 Programming Fundamentals with Swift” by Matt Neuburg, 1<sup>st</sup> edition, 2021

### **20.93 Description of Course CSE 488**

#### **PART A: General Information**

**20.93.1 Course Title** : Mobile Applications Development Sessional

**20.93.2 Type of Course** : SESSIONAL

**20.93.3 Offered to** : DEPARTMENT OF CSE

**20.93.4 Pre-requisite Course(s)** :

## **PART B: Course Details**

### **20.93.5 Course Content (As approved by the Academic Council)**

Mobile platforms: anatomy of mobile devices, mobile OS (e.g., Android, iOS), mobile programming (e.g., Java, Objective C); Android programming basics: SDKs, activities, life cycles, views, intent, resource, storage, UIs; Android advanced programming: SQLite, networking, maps, multimedia; iOS programming basics: objective C, SDKs, views, view controllers, gestures, storage; iOS advanced programming: memory management, data management, networking, graphics, location technologies; Web-based mobile applications (e.g., HTML5).

### **20.93.6 Course Objectives**

The students are expected to:

- Describe Mobile Application Development fundamentals and gain in depth knowledge about technologies (languages, frameworks, SDKs, databases) used in mobile application development.
- Design mobile applications with multiple user interface with multiple system components using provided assets with basic and advanced functionality on a popular mobile development platform.
- Develop a mobile application that uses hardware and software resources (e.g., sensors and configuration etc.) and evaluate functionality performance of mobile applications based on pre-set criteria.
- 

### **20.93.7 Knowledge required**

#### **Technical**

- Computer programming

#### **Analytical**

- None

### **20.93.8 Course Outcomes (COs)**

<b>CO No.</b>	<b>CO Statement</b> After undergoing this course, students should be able to:	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Method(s) and Activity(-ies)</b>	<b>Assessment Tool(s)</b>
CO1	<b>Describe</b> mobile application development terminologies and technologies in terms of hardware, software and communications.	PO1, PO12	C5, A1	Demonstration and Lab Work	Lab Assignment
CO2	<b>Design</b> multi-functional mobile application with multiple user interface and multiple system component.	PO2, PO3, PO4, PO6	C6	Demonstration and Lab Work	Lab Assignment
CO3	<b>Develop</b> a fully functional mobile application with real-world application using hardware and software resources.	PO3, PO5, PO9, PO11	C6, A4	Demonstration and Lab Work	Final Project

**20.93.9 Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√	√	√	√			√	√	√					√				
CO 2		√	√	√	√	√			√	√	√	√		√		√	√			√
CO 3		√	√	√	√	√			√	√	√				√	√				√

**20.93.10 Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Android and iOS Basics and App Development Demonstration	CO1
Week 2		
Week 3	Offline 1 evaluation	CO1, CO2
Week 4		
Week 5	Online 1 evaluation	CO1, CO2
Week 6		
Week 7	Project Proposal Presentation	CO2
Week 8		
Week 9	Project design review	CO2, CO3
Week 10		
Week 11	Project Progress Evaluation	CO3
Week 12		
Week 13	Final Project Submission and Quiz	CO1, CO2, CO3
Week 14		

**20.93.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

### 20.93.12 Distribution of Marks

Attendance:	10%
Online Assignment:	15%
Offline Assignment	15%
Final Project:	40%
Final Quiz:	20%
Total:	100%

### 20.93.13 Textbook/ Reference

- “Mobile Applications Development (Oracle Press)” by Jim J. Marion and Sarah K. Marion, 1<sup>st</sup> edition, 2015.
- “Programming Android with Kotlin” by Pierre-Olivier Laurence, Amanda Hinchman-Dominguez, Mike Dunn, G. Blake Meike, 1<sup>st</sup> edition, 2021.
- “The Joy of Kotlin” by Pierre-Yves Saumont, 1<sup>st</sup> edition, 2019.
- “iOS 15 Programming Fundamentals with Swift” by Matt Neuburg, 1<sup>st</sup> edition, 2021

### 20.94 Description of Course EEE 163

#### PART A: General Information

<b>20.94.1</b>	Course Number	EEE 163
	Course Title	Introduction to Electrical Engineering
	Credit (Contact) Hours	3.0 (3.0)
<b>20.94.2</b>	Level and Term (Section)	Level-1, Term-I (All Sections)
	Academic Term	July 2022
<b>20.94.3</b>	Type of Course	Core Course
	Offered to	CSE
<b>20.94.4</b>	Pre-requisite Course(s)	None

#### PART B: Course Details

##### **20.94.5** Course Content (As approved by the Academic Council):

Direct current: Basic Concepts, Charge, Current and Voltage, Power and Energy, Circuit Elements, Applications; Basic Laws, Ohm’s Law, Nodes, Branches, and Loops, Kirchhoff’s Laws, Series Resistors and Voltage Division, Parallel Resistors and Current Division, Solution of simple circuits with both dependent and independent sources, Wye-Delta Transformations, Applications; Nodal and Mesh Analysis, Applications; Linearity Property, Superposition, Source Transformation, Thevenin’s and Norton’s Theorem, Maximum Power Transfer Theorem.

Alternating current: Sinusoids and Phasors, Phasor Relationships for Circuit Elements, Impedance and Admittance, Impedance and Admittance, Kirchhoff’s Laws in the Frequency Domain, Impedance Combinations, Applications; Sinusoidal Steady-State Analysis, Nodal and Mesh Analysis, Superposition Theorem, Source Transformation, Thevenin and Norton Equivalent Circuits; AC Power Analysis, Instantaneous and Average Power, Maximum Average Power Transfer, Effective or RMS Value, Apparent Power and Power Factor, Complex Power, Conservation of AC Power, Power Factor Correction, Applications.

Three-Phase Circuits: Balanced Three-Phase Voltages, Balanced Wye-Wye Connection, Balanced Wye-Delta, Delta-Delta and Delta-Wye Connection, Power in a Balanced System.

Ideal operational amplifier circuits: Ideal operational amplifier and op-amp circuits; Op-amp applications: inverting amplifier, non-inverting amplifier, summing amplifier, differential amplifier, logarithmic amplifier, operational transconductance amplifiers exponential amplifier, differentiator, integrator, voltage to current converter, voltage follower, and other applications.

Active & Passive filters: High pass, Low pass, Band pass & Band stop filters using R, L & C. Construction of active filters using Op-Amp.

### 20.94.6 Course Objectives

- To learn about the different circuit components and electrical quantities of interest of an electrical circuit.
- To learn about the fundamental circuit laws (e.g. Ohm/Kirchoff) and different methods of analysis for solving an electrical circuit.
- To gain fundamental engineering knowledge about linear and non-linear systems for application in linear circuit analysis.
- To identify the most suitable analysis method for circuit solving.
- To gain knowledge about sinusoids and phasors (complex numbers) and their applications in study of alternating current.
- To design A.C. circuits to achieve certain power factor improvements.
- To understand the basic concepts of three phase systems in the context of power systems.
- To solve balanced three phase systems with balanced loads.
- To explain the model of operational amplifier and analyse Op-Amp circuits to perform different operations such as integration, differentiation and filtering on electronic signals.
- To understand the construction and applications of different types of filters.

### 20.94.7 Background Knowledge required

Intermediate level (H.S.C.) math and physics concepts.

### 20.94.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	<b>Apply the concepts of</b> circuit elements, circuit, circuit variables, direct current, voltage, dependent and independent sources, circuit laws, analysis methods, theorems to solve various circuits.	PO1	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	<b>Derive</b> the expressions of voltage, current and power/energy of RL, RC and RLC circuits based on the concepts of phasors	PO1	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
3	<b>Employ</b> circuit laws, analysis methods, theorems to solve various AC circuits.	PO2	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
4	<b>Analyse</b> the 3-phase circuits with different combination of sources and loads that are used in power systems.	PO2	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
5	<b>Explain</b> the operation of Op-Amp and its applications in mathematical and filtering circuits	PO1	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

### 20.94.9 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of class tests, assignments, in-class evaluations.
- A final exam will be taken which will cover the entire syllabus of the course.

#### 20.94.10 Distribution of Marks

Class Participation	10%
Class Test and Assignments	20%
Final Exam	70%
Total	100%

#### 20.94.11 Main Textbook

**20.94.12** Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku; McGraw-Hill, 2013

**20.94.13** Operational Amplifiers and Linear Integrated Circuits by R. F. Coughlin and F. F. Driscoll

#### 20.94.14 Reference Textbooks and relevant resources

- Introductory Circuit Analysis by Rober L. Boylestad; Pearson, 2007
- Alternating-Current Circuits by Russell M. Kerchner and George F. Corcoran

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

#### 20.94.15 Lecture Plan

Week	Lectures	Topic
1	1-3	Introduction to the course; Familiarization with electrical circuit components and electrical quantities, Overview of Ohm's Law; Kirchoff's Laws; Solving basic circuits; Wye-Delta transformation
2	4-6	Introduction to methods of analysis for solving electrical circuits; Nodal analysis; Mesh analysis; supernodes and supermeshes
3	7-9	Introduction to circuit theorems; source transformation; principle of superposition; Thevenin's theorem
4	10-12	<b>Class Test #1</b> Norton's theorem and maximum power transfer theorem; Study of worked out DC circuit problems
5	13-15	Introduction to AC circuits; Familiarization with sinusoids and phasors; Representation of circuit elements by means of complex numbers; phasor algebra
6	16-18	Analysis of sinusoidal waveforms; rms value calculation; Impedance and admittance in AC circuits; RLC circuit analysis in AC
7	19-21	<b>Class Test #2</b> AC circuit solving using principles and concepts learned in DC circuit analysis; AC power analysis; Complex power; Apparent power; Real power and Reactive power
8	22-24	Phasor diagram construction and analyses for RLC circuits; Power Factor Correction; Study of worked out problems

Week	Lectures	Topic
9	25-27	Introduction to three phase AC circuits ; Advantages of three phase over single phase; Balanced and unbalanced three phase circuit analysis <b>Class Test #3</b>
10	28-30	Y-Y, $\Delta$ - $\Delta$ , Y- $\Delta$ , $\Delta$ -Y systems and their analyses; Study of worked out problems; Interactive discussions
11	31-33	Introduction to Op-Amp, its ideal characteristics inverting & non-inverting amplifier, summing & differential amplifier, inverting integrator & differentiator using Op-Amp; Applications of Op-Amp.
12	34-36	Active and passive filters, different types of passive filters & their application <b>Class Test #4</b>

## 20.95 Description of Course EEE 164

### PART A: General Information

<b>20.95.1</b>	Course Number	EEE 106
	Course Title	Introduction to Electrical Engineering Sessional
	Credit (Contact) Hours	1.5 (3.0)
<b>20.95.2</b>	Level and Term (Section)	Level-1, Term-I
	Academic Term	July 2022
<b>20.95.3</b>	Type of Course	Core Course (All Sections)
	Offered to	CSE
<b>20.95.4</b>	Pre-requisite Course(s)	None

### PART B: Course Details

#### 20.95.5 Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 163: Introduction to Electrical Engineering

#### 20.95.6 Course Objectives

- To provide hands-on training on experiments to validate practically the concepts of electrical circuits and to solve basic electrical systems by applying various analysis techniques, likewise KVL, KCL, nodal and mesh analysis, Thevenin and Norton Theorem.
- To give students a practical experience of AC power consumed by inductive and capacitive loads.

#### 20.95.7 Background Knowledge required:

Fundamental of physics, equation solver, calculus, and differential equation solver

#### 20.95.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	<b>Construct</b> electrical circuits at hardware level to measure and analyse DC and AC circuit networks and circuit elements.	PO5	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Assignment, Reports, Lab-tests, Lab-quiz
2	<b>Compare</b> theoretical and experimental results derived from different circuit theorems and method of analysis.	PO4	C5	Lectures, Lab demonstrations	Lab-tasks, Reports, Assignment, Lab-tests

#### 20.95.9 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing, viva, and lab quiz.

#### 20.95.10 Distribution of Marks

To be decided by course instructor(s)

#### 20.95.11 Reference Textbooks and relevant resources

- Fundamentals of Electric Circuits (5<sup>th</sup> Edition)- Charles K. Alexander, Matthew N. O. Sadiku
- Electric Circuits- James William Nilsson
- Basic Engineering Circuit Analysis” - J. David Irwin, R. Mark Nelms
- Introductory Circuit Analysis-(8th Edition)- Robert L Boylestad
- Lab sheets of the simulation study (Software) and experiments (hardware) will be shared with the class

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

#### 20.95.12 Lecture Plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Construction & operation of simple electrical circuits
3	2	Verification of KVL & Voltage Divider Rule
4	3	Verification of KCL & Current Divider Rule
5	4	Verification of Superposition Principle

Week	Experiment no.	Topic
6	-	Lab-test (on Experiment 1-4)
7	5	Verification of Thevenin's Theorem
8	6	Transmission and distribution of electric power
9	7	Familiarization with alternating current (AC) waves
10	8	Verification of KVL and KCL for AC circuits
11	-	Lab-test (on Experiment 5-8)
12	-	Lab Viva
13	-	Lab-Quiz

## 20.96. Description of Course EEE 263

### PART A: General Information

<b>20.96.1</b>	Course Number:	EEE 263
	Course Title:	Electronic Circuits
	Credit (Contact) Hours:	4.0
<b>20.96.2</b>	Level and Term:	Level-2, Term-1 (Jan 2021 academic term)
<b>20.96.3</b>	Course Type:	Non-departmental course
<b>20.96.4</b>	Pre-requisite Courses:	EEE 163
<b>20.96.5</b>	Course Website:	Designated Microsoft Teams for each section

### PART B: Course Details

**20.96.6** Course content:

Ideal device characteristics of diode, bipolar junction transistor (BJT), metal oxide semiconductor field effect transistor (MOSFET). Wave shaping circuits, diode wave shaping techniques, clipping and clamping circuits, comparator circuits, switching circuits. Amplifiers: BJT and MOSFET amplifiers. Linear Integrated Circuits: Op-Amps, Oscillators, Timers (555), Function generators, Phase Locked Loop (PLL), analogue switches. Digital Circuits: Logic gates, Logic families; TTL and CMOS Logics; Flip Flops, counters and registers, memory systems; A/D and D/A converters, S/H circuits.

**20.96.7** Course Objectives:

- The main objective of this course is to learn about characteristics and operation of basic electronic circuit elements like diode, BJT, MOSFET and understand the application of these elements in various electronic circuits like rectifier and amplifier.
- The course talks about the characteristics, operation, and application of Op-amps in linear Circuits.
- The course also aims to teach the students the design principles and/or applications of Oscillators, Timers (555), Function generators, Phase Locked Loop (PLL), D/A and A/D converters.

- The students will also get familiar with Integrated Circuit Technologies like TTL and CMOS and their performance criteria for digital logic gate operations. The student will also learn how to use pull-up and pull-down CMOS circuits in implement any logical expression.
- Thus, the course teaches students how to design amplifiers, oscillators, switches and other electronic circuits using electronic circuit elements like diode, BJT, MOSFET, Op-amps and other linear ICs.
- The course also generates ability in the student so that he can understand any electronic circuit and discuss electronic circuits with specialists as necessary in his academic and professional life.

**20.96.8** Background Knowledge required:  
Basics of electrical circuits, electronics, equation solver, calculus and differential equation solver.

**20.96.9** Course Outcomes (COs):

Upon completion of this course, the successful student will be able to-

COs	CO Statements	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Explain</b> the operation, characteristics, and application of diode, BJT, MOSFET, Op-amps. Learn about various wave shaping circuits using diodes	PO1	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO2	<b>Analyse</b> electronic circuits using DC and AC equivalent circuit models of BJTs and MOSFETs	PO2	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO3	<b>Explain</b> operation and application of Oscillators, Timers (555), Function generators, Phase Locked Loop (PLL), D/A and A/D converters	PO1	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO4	<b>implement analyze</b> logic operations using digital logic gates, pull-up and pull-down networks, CMOS circuits, Flip Flops, counters, registers, memory systems etc.,	PO3	C3, C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
CO5	<b>Design</b> amplifiers, oscillators, switches and other electronic circuits using electronic circuit elements like diode, BJT, MOSFET, Op-amps and other linear ICs	PO3	C5	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

**20.96.10** Assessment Strategy:

a. Class Attendance and Participation

Class participation and attendance will be recorded in every class. Participation and attendance for the students may be considered in case the student could not attend the class due to a valid reason (power failure, internet problem, device problem, health problem, etc.). The student has to inform the teacher over email in case of such occurrences. A maximum of three (03) such missed classes can be considered for this course.

b. Quiz, Assignment, Viva and Presentation

Six nos. of tests (Quiz, Assignment, Viva and Presentation) will be taken and best 4 nos. will be counted.

c. Final Examination

A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**20.96.11** Distribution of Marks:

Individual student will be evaluated based on the following criteria as approved by the University:

Class Participation	10%
Homework Assignment and Quizzes	20%
Final Examination (3 hours)	70%
<b>Total</b>	<b>100%</b>

**20.96.12** Learning Resources

a) Text Books

- Microelectronic circuits ~ Adel Sedra, Kenneth C. Smith

b) Reference Books:

- Electronic Devices and Circuits ~ Louis Nashelsky, Robert Boylestad
- Operational Amplifiers and Linear Integrated Circuits ~ Frederick F. Driscoll and Robert F. Coughlin
- Digital Fundamentals ~ Thomas L. Floyd

c) Other Resources: Online resources or supplementary materials will be shared with the class on a need basis

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**20.96.13** Course Contents and Lecture Plan:

Topic	Lectures (Week)
<b>Diode:</b> Ideal and non-ideal device characteristics and operation. Rectifier circuits, ripple factor, RC time constants. Wave shaping circuits, diode wave shaping techniques, clipping and clamping circuits.	12(1-3)
<b>Bipolar junction transistor (BJT):</b> Operation and characteristics. Transistor Configuration: CB, CE and CC-operation and characteristics. Early effect. Transistor biasing. Amplifiers: BJT amplifiers. DC and AC equivalent circuits. Amplifier and other circuit analysis using equivalent circuits,	8 (4-5)
<b>Metal oxide semiconductor field effect transistor (MOSFET):</b> Operation and characteristics. Current saturation in MOSFET. Depletion and Enhancement type MOSFET. DC and AC equivalent circuits. Amplifier and other circuit analysis using equivalent circuits	8 (6-7)
<b>Operational Amplifiers (Op-amps):</b> Operation and characteristics, inverting and non-inverting amplifiers, summer, integrator, differentiator, Electronic Analog Computation.	3(8)
<b>Linear Integrated Circuits:</b> <ul style="list-style-type: none"> <li>● Oscillators: Barkhausen criteria, Wein bridge oscillator, Crystal oscillator, LC tuned oscillator</li> <li>● Timers (555)</li> <li>● Monostable, astable, bistable multivibrator</li> <li>● Function generators</li> <li>● Phase Locked Loop (PLL)</li> <li>● A/D and D/A converters, S/H circuits</li> </ul>	13(8-10)
<b>Digital Circuits:</b> Logic gates, Logic families; TTL and CMOS Logics; Performance criteria of logic families. Flip Flops, counters and registers, memory systems;	12(11-13)
<b>Review</b>	4(14)

**20.97 Description of Course EEE 263**

**PART A: General Information**

<b>20.97.1</b>	Course Number	EEE 264
	Course Title	Electronic Circuits Laboratory
	Credit (Contact) Hours	1.5 (3)
<b>20.97.2</b>	Level and Term (Section)	Level-2, Term-I
	Academic Term	Jan 2021
<b>20.97.3</b>	Type of Course	Non departmental
	Offered to	CSE
<b>20.97.4</b>	Pre-requisite Course(s)	None

## **PART B: Course Details**

### **20.97.5** Course Content (As approved by the Academic Council)

The students will perform experiments to verify practically the theories and concepts learned in EEE 263.

### **20.97.6** Course Objectives

- To provide hands-on training on electronic circuits using diode, BJT, MOSFET and Op-Amps

### **20.97.7** Background Knowledge required

Understanding of concepts of electronic circuits using diode, BJT, MOSFET and Op-Amps.

### **20.97.8** Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	<b>construct</b> electronic circuits <b>to explain</b> the operation of diode, BJT, MOSFET and Op-amps	PO5	C2, P4	Lectures, Lab demonstrations	Lab-tasks, Lab reports, Lab-tests, viva, quiz
2	Using diode, BJT, MOSFET <b>to implement</b> rectifier, clipping and clamping and amplifier circuits	PO3	C3, P4	Lectures, Lab demonstrations	Lab-tasks, Lab reports, Lab-tests, viva, quiz
4	<b>implement and analyse</b> Mathematical operations using OP-AMP	PO3	C4, P4	Lectures, Lab demonstrations	Lab-tasks, Lab reports, Lab-tests, viva, quiz

### **20.97.9** Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing
- There will be a final Laboratory test, viva, and quiz.

### **20.97.10** Distribution of Marks

To be decided by course instructor(s)

### **20.97.11** Reference Textbooks and relevant resources

Reference Books:

- Microelectronic circuits ~ Adel Sedra, Kenneth C. Smith
- Electronic Devices and Circuits ~ Louis Nashelsky, Robert Boylestad
- Operational Amplifiers and Linear Integrated Circuits ~ Frederick F. Driscoll and Robert F. Coughlin

### **20.97.12** Lecture Plan

Week	Experiment no.	Topic
1	-	Introduction to the scope and objectives of the course Preparing groups for experiments, discuss about assessment policy for the course
2	1	Study of diode characteristics
3	2	Study of diode rectifier circuits
4	3	Study of diode clipping and clamping Circuits
5	4	Study of N-P-N CE and CB transistor characteristics
6	5	Study of BJT biasing circuits
7	6	Study of common emitter (CE) amplifier
8	7	DC characteristics of an enhancement MOSFET
9	8	Mathematical operations using OP-AMP
10	Lab test	Lab test
11	Viva	Viva
12	Quiz	Final Combined Quiz
13	Spare	spare

## 20.98 Description of Course EEE 469

### PART A: General Information

<b>20.98.1</b>	Course Number	EEE 469
	Course Title	Electrical Machines and Instrumentation
	Credit (Contact) Hours	3.0
<b>20.98.2</b>	Level and Term (Section)	Level-4, Term-II
	Academic Term	July 2022
<b>20.98.3</b>	Type of Course	Core Course
	Offered to	CSE
<b>20.98.4</b>	Pre-requisite Course(s)	EEE 163 Introduction to Electrical Engineering

## **PART B: Course Details**

### **20.98.5** Course Content (As approved by the Academic Council)

- **Introduction to single phase and three transformers:** principle of operation, construction, no load and excitation current, behaviour during loading, effect of leakage flux, ideal transformer, leakage reactance and equivalent circuit of a transformer, equivalent impedance, voltage regulation, per unit quantities, regulation, losses and efficiency, determination of parameters by tests.
- **Synchronous generator (Alternator):** Introduction and applications, Basic construction and working principle, Speed of rotation and internal generated voltage of synchronous generators, Equivalent circuit model, Armature reaction, Power flow diagram, Generators while operating alone (frequency-power and voltage-reactive power characteristics),
- **Synchronous Motor:** Introduction and applications, Basic construction and working principle, Equivalent circuit model, Effect of load changes, Effect of field current changes (V-curves)
- **Induction Motor:** Introduction to motors and applications, working principle of induction motor, Basic constructions, Concept of rotor slip and speed, Equivalent circuit mode, Power and torque calculation, Torque speed characteristics of induction motor
- **DC motor:** Principles of construction, operation and applications of DC motor. Shunt, series, and separately excited connections. Equivalent Circuit, torque-Speed Characteristics
- **Introduction to measurement system:** Some important terminologies of measurement systems; Applications of measurement systems. Functional elements of a generalized measurement system; Measurement of Resistance, Inductance and capacitance
- **Analog Instruments and Measurement of electrical quantities:** Galvanometer: D'Arsonval type, Its construction, Torque equation, Dynamic behaviour and Equation of motion Under-damped, undamped, critically-damped and over-damped motion of galvanometer, Sensitivities. Problem PMMC meter, Temperature compensation DC ammeter and voltmeter, Rectifier-based AC meters ; Electrodynamicometer type meter, Electronic analogue meters: (DC , AC) ; Power measurement: Electrodynamicometer type; Energy measurement: Induction type, Instrument transformers (CT,PT), Instrumentation amplifier
- **Transducers:** Introduction, Electric transducers and their advantages and types ; Strain gauges; Variable inductance type transducers: variation of self-inductance, Transducers working on variation of mutual inductance and production of eddy current, Capacitive transducers; Variation of dielectric constant for measurement of distance and liquid level, advantages, disadvantages and application, Optical transducers: photo multiplier tubes, photodiodes and photovoltaic cell
- **Noise:** Sources of noise, noise elimination and compensation
- **Display Devices:** introduction, digital display methods, LED display basics
- **Data Acquisition Systems:** A/D converters: basics, techniques parallel/flash, single slope (ramp), successive approximation, sample and hold circuits; D/A converters: basics, weighted-resistor and ladder type D/A converters; Performance Characteristics analog and pulse (including digital) transmission; Details of PCM; multiplexing (TDM and FDM)

### **20.98.6** Course Objectives

- To understand of the operation and application of some of the most commonly used electrical machines, such as transformer, alternator, induction motors, synchronous motors and DC motors.
- To study analogue DC and AC measuring instruments, the use and application of different measuring instruments
- To design electronic circuits for specific applications such as rectification, amplification, switching, mathematical operations, etc.

- To get familiarized with commonly used Transducers and their application for measurement of non-electrical quantities
- To learn basics causes of signal impairment such as noise in a measurement device and their mitigation
- To get familiarized with recording and display devices and data acquisition systems

### 20.98.7 Background Knowledge required

Fundamental understanding of EEE 163 Introduction to Electrical Engineering course.

### 20.98.8 Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	<b>explain</b> the operation and working principles of electrical machineries, and measurement systems, standards, elements of a generalized instrumentation system, different types of transducers, source of noise, data acquisition system	PO1	C2	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
2	<b>apply</b> knowledge to solve problems relevant to the operation of electrical machineries, different analogue types of instruments and techniques for measurement of electrical quantities, noise elimination	PO2	C3	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
3	<b>analyse</b> the operation of electrical machineries, different analogue types of instruments and techniques for measurement of electrical quantities, noise elimination	PO2	C4	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam
4	<b>design</b> control circuits for electrical machines such that specified performance characteristics are attained, <b>select</b> the appropriate transducer/sensor for measurement the non - electrical quantities.	PO3	C5	Lectures, Tutorials, Homeworks	Assignment, Class test, Final exam

### 20.98.9 Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

**20.98.10 Distribution of Marks**

Class Participation	10%
Homework, Assignment and Quizzes	20%
Final Examination	70%
Total	100%

**20.98.11 Main Textbook**

- Electric Machines- Charles I Hubert (2<sup>nd</sup> edition)
- Electric Machinery Fundamentals- Stephen J Chapman (5<sup>th</sup> edition)
- A Course in Electrical and Electronic Measurements and Instrumentation- A. K. Sawhney, 19th Revised Edition, Publisher: Dhanpat Rai and Sons, Delhi
- Electronic Instruments and Instrumentation Technology- M. M. S. Anand, @2004 by Prentice-Hall of India

**20.98.12 Reference Textbooks and relevant resources**

- Online resources or supplementary materials will be shared with the class on a need basis.

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**20.98.13 Lecture Plan**

Week	Lectures	Topic	COs
1	1-3	Single phase and three phase transformers: principle of operation, construction, no load and excitation current, behaviour during loading, effect of leakage flux, ideal transformer, leakage reactance and equivalent circuit of a transformer	CO1 CO2 CO3
2	4-6	Single phase and three phase transformers: equivalent impedance, voltage regulation, per unit quantities, regulation, losses and efficiency, determination of parameters by tests.	CO1 CO2 CO3 CO4
3	7-9	Synchronous generator (Alternator): Introduction and applications, Basic construction and working principle, Speed of rotation and internal generated voltage of synchronous generators, Equivalent circuit model	CO1 CO2 CO3
4	10-12	Synchronous generator (Alternator): Armature reaction, Power flow diagram, Generators while operating alone (frequency-power and voltage-reactive power characteristics)	CO1 CO2 CO4
5	13-15	Synchronous Motor: Introduction and applications, Basic construction and working principle, Equivalent circuit model, Effect of load changes, Effect of field current changes (V-curves)	CO1 CO2
6	16-18	Induction Motor: Introduction to motors and applications, working principle of induction motor, Basic constructions, Concept of rotor slip and speed, Equivalent circuit mode, Power and torque calculation, Torque speed characteristics of induction motor	CO1 CO2
7	19-21	DC motor: Principles of construction, operation and applications of DC motor. Shunt, series, and separately excited connections. Equivalent Circuit, torque-Speed Characteristics	CO1 CO2

Week	Lectures	Topic	COs
8	20-24	Introduction to measurement system: Some important terminologies of measurement systems; Applications of measurement systems. Functional elements of a generalized measurement system; Measurement of Resistance, Inductance and capacitance	CO1 CO2 CO3
9	25-27	Analog Instruments and Measurement of electrical quantities: Galvanometer: D'Arsonval type, Its construction, Torque equation, Dynamic behaviour and Equation of motion Under-damped, undamped, critically-damped and over-damped motion of galvanometer, Sensitivities. Problem PMMC meter, Temperature compensation DC ammeter and voltmeter	CO1 CO2 CO3
10	28-30	Analog Instruments and Measurement of electrical quantities: Rectifier-based AC meters ; Electrodynamometer type meter, Electronic analog meters: (DC , AC) ; Power measurement: Electrodynamometer type; Energy measurement: Induction type, Instrument transformers (CT,PT), Instrumentation amplifier	CO1 CO2 CO3 CO4
11	31-33	Transducers: Introduction, Electric transducers and their advantages and types; Strain gauges; Variable inductance type transducers: variation of self-inductance, Transducers working on variation of mutual inductance and production of eddy current, Capacitive transducers; Variation of dielectric constant for measurement of distance and liquid level, advantages, disadvantages and application, Optical transducers: photo multiplier tubes, photodiodes and photovoltaic cell	CO1 CO2 CO4
12	34-36	Noise: Sources of noise, noise elimination and compensation Display Devices: introduction, digital display methods, LED display basics	CO1 CO2 CO3
13	37-39	Data Acquisition Systems: A/D converters: basics, techniques parallel/flash, single slope (ramp), successive approximation, sample and hold circuits; D/A converters: basics, weighted-resistor and ladder type D/A converters; Performance Characteristics analog and pulse (including digital) transmission; Details of PCM; multiplexing (TDM and FDM)	CO1 CO2 CO3

## 20.99 Description of Course EEE 470

### PART A: General Information

<b>20.99.1</b>	Course Number	EEE 470
	Course Title	Electrical Drives and Instrumentation Sessional
	Credit (Contact) Hours	1.5 (3)
<b>20.99.2</b>	Level and Term (Section)	Level-2, Term-II
	Academic Term	April 2022
<b>20.99.3</b>	Type of Course	Compulsory Course
	Offered to	CSE
<b>20.99.4</b>	Pre-requisite Course(s)	None

## **PART B: Course Details**

### **20.99.5** Course Content (As approved by the Academic Council)

This is a Laboratory course based on the content of the Theory course EEE 269: Electrical Drives and Instrumentation

### **20.99.6** Course Objectives

- To provide hands-on training on different electrical drives and instrumentation components such as three phase circuits, transformers, motors, and generators
- To provide hands-on training on experimental techniques used for characterization of electrical components such as transformers and motors.

### **20.99.7** Background Knowledge required

Fundamental understanding of concepts of the AC circuits, transformers, induction motors, synchronous motors, generators and instrumentation.

### **20.99.8** Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	<b>compare</b> theoretical and experimental results of three phase voltage current relations for different loads.	PO4	C5	Lectures, Lab demonstrations	Lab-tasks, Assignment, Lab-tests
2	<b>use</b> two-watt meter method to measure the power consumed by a balanced three phase load	PO5	C4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
3	<b>characterize</b> different electrical components by evaluating their equivalent circuits based on experiments.	PO2	C4	Lectures, Lab demonstrations	Lab-tasks, Report, Assignment, Lab-tests
4	demonstrate effective <b>individual and team-working skills</b>	PO9	A3		Peer and instructor assessment

### **20.99.9** Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of laboratory tasks, assignments, laboratory-tests, report writing and viva.
- A group project on the design of an electrical drive must be completed by the end of this course. A project report must be submitted, and the project must be demonstrated and presented in the class.

### **20.99.10** Distribution of Marks

To be decided by course instructor(s)

### **20.99.11** Reference Textbooks and relevant resources

- Electric Machinery Fundamentals 5th Edition by Stephen Chapman
- Electric Machines: Theory, Operating Applications, and Controls (2nd Edition) by Charles I. Hubert

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**20.99.12** Lecture plan

Week	Experiment no.	Topic
1	-	Introductory class and overview of the course
2	1	Verification of three phase voltage and current relations by balanced resistive load.
3	2	Two wattmeter method of measuring power in a balanced three phase wye connected R-L load.
4	3	Study of a single-phase transformer and determination of turns ratio.
5	4	Determination of the equivalent circuit parameters of a transformer and calculation of efficiency and regulation.
6	5	Characteristic of a D.C. shunt generator.
7	6	Speed control of a dc shunt motor and observation of the existence of back emf.
8	7	Study of the characteristics of instrumentation amplifier.
9	8	Study of a computer-based data acquisition system.
10	-	Labtest
11	-	Viva
12	-	Final project demonstration and presentation
13	-	Final sessional quiz

**20.99.13** Mapping of Knowledge Profile (K), Complex Engineering Problem Solving (CP) and Complex Engineering Activities (CA)

K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	C P1	C P2	C P3	C P4	C P5	C P6	C P7	C A1	C A2	C A3	C A4	C A5
				√	√		√	√	√	√					√	√	√		

**20.100.13** Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizzes	20%
Final Examination	70%
Total	100%

**20.100.14** Main Textbook

- Fiber-Optic Communication Systems- Govind P. Agrawal, 4th Edition, John Wiley & Sons, Inc.
- **20.100.15** Reference Textbooks and relevant resources
- Optical Fiber Communications- John M. Senior, 3rd Edition, PHI
- Nonlinear Optics – Robert W. Boyd, 4th Edition, AP
- Nonlinear Fiber Optics - Govind P. Agrawal, 5th Edition, AP

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**20.100.16** Lecture Plan

<b>Week</b>	<b>Lectures</b>	<b>Topic</b>
1	1-3	Introduction to Optical Fiber Communication
2	4-6	Guided and unguided light propagation, Light Propagation theory – Ray optics theory and Mode theory.
3-4	7-12	Optical Fibers- SI Fibers, GI Fibers, Wave Propagation, Fiber Modes, Single mode Fiber, Multimode fiber, Fiber Birefringence, PMD
5	13-15	Transmission impairments – Dispersion in Single Mode Fiber (SMF), Dispersion-induced limitation, Different types of fibers: DSF, NZDSF, DCF, Fiber Loss
6	16-18	Nonlinear Effects- SRS, SBS, SPM, XPM, and FWM
7	19-21	Optical Transmitters – Light Emitting Diodes (LED), LASER Diodes (LD); their basic mechanisms, structures, characteristics, applications
8-10	19-27	Optical Receivers – Photo-Detectors (PD): Detector responsivity, PN photodiode, PIN photo-detector, Avalanche photo-detector, Direct detection (IM/DD system) and coherent detection, Phase modulated system, Noise at the receiver, BER and Eye pattern
11	31-33	Optical Amplifiers – Optoelectronic amplifier, Fiber amplifier: Erbium doped fiber amplifier (EDFA) and Raman amplifier, SOA
12	34-36	Optical Modulators: MZI, MZM, EAM, EOM
13	37-39	Multichannel Optical Systems – Optical FDM, TDM and WDM
14	40-42	Power Budget/link design and Free space optical communication

## 20.100 Description of Course EEE 465

### PART A: General Information

20.100.1	Course Number	EEE 465
	Course Title	Telecommunication Engineering
	Credit and Contact Hours	3.0 Credit Hours and 3 Contact Hours per Week
20.100.2.	Level and Term (Section)	Level-4, Term-I
	Academic Term	July 2021
20.100.3.	Type of Course	Elective Course
	Offered to	CSE
20.100.4	Pre-requisite Course(s)	None

### PART B: Course Details

#### 20.100.5 Course Content (As approved by the Academic Council)

Introduction: Principle, evolution and telecommunication networks; National and International regulatory bodies, Basic elements of Telecommunication, Message source and bandwidth; Transmission media: twisted pair cable, coaxial cable, wireless channel and electromagnetic spectrum, satellite channel and fiber-optic cable, Transmission impairments, Noise and signal-to-noise ratio, Transmission capacity, Analog and digital transmission; Telephone apparatus, telephone exchanges, subscriber loop, supervisory tones, PSTN; Switching systems: Introduction to analogy system: Strowger and Crossbar switching systems, Stored program control (SPC) systems; Digital switching systems: space division switching, time division switching; Traffic analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing; Integrated services digital network (ISDN): N-ISDN and B-ISDN, architecture of ISDN, B-ISDN implementation; Digital subscriber loop (DSL), Wireless local loop (WLL), FTTx, PDH and SONET/SDH, WDM Network, IP telephony and VoIP, ATM network and Next Generation Network (NGN).

#### 20.100.6. Course Objectives

- This course is intended to introduce to students an overview of telecommunication systems – guided and unguided
- To provide students with the design and operation of different telecommunication switching systems and communication networks
- The students should be familiar with different types of transmission media, switching technology, teletraffic analysis and network architecture

#### 20.100.7. Background Knowledge required

Fundamental understanding of concepts of Communication System and Electromagnetic courses

#### 20.100.8. Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	<b>Understanding</b> different telecommunication switching technologies, telephone transmitters, receivers, and other apparatus, signalling, transmission media, teletraffic, circuit-switched and packet-switched networks etc.	PO1	C2	Lectures, Discussions	Assignment, Class test, Final exam

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
2	<b>apply</b> the above technological knowledge to solve the problems of telecommunication depending on the situations and requirements	PO2	C3	Lectures, Discussions	Assignment, Class test, Final exam
3	<b>analyse</b> transmission media, teletraffic, switching systems and network architecture so that desired telecommunication network can be implemented with required grade-of-service and quality-of-service	PO3	C4	Lectures, Discussions	Assignment, Final exam

#### 20.100.12. Assessment Strategy

- Class participation will be judged by in-class evaluation; attendance will be recorded in every class.
- Continuous assessment will be done in the form of quizzes, assignments, in-class evaluations.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

#### 20.100.13. Distribution of Marks

Class Participation	10%
Homework, Assignment and Quizzes	20%
Final Examination	70%
Total	100%

#### 20.100.14. Main Textbook

- Digital Telephony – by John Bellamy, 4th Ed., John Wiley & Sons.

#### 20.100.15. Reference Textbooks and relevant resources

- Telecommunication System Engineering - by Roger L. Freeman, 4th Ed., John Wiley & Sons
- Telecommunication Switching Systems and Networks – by Thiagarajan Viswanathan, PHI
- Connection-Oriented Networks, by Harry G. Perros, John Wiley & Sons

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

#### 20.100.16. Lecture Plan

Week	Lectures	Topic
1	1-3	Introduction: Principle, evolution, Telecommunication networks, Telephone Exchange, National and International regulatory bodies.
2	4-6	Telephone apparatus: Microphone, speakers, ringer, ASTIC, pulse dialing and tone dialing mechanisms.
3-4	7-12	Side-tone mechanism in Telephone, Local and Central batteries and advanced features.

Week	Lectures	Topic
5-6	13-18	Switching system: Introduction to analog system: Strowger and Crossbar switching system, digital switching systems, space division switching, SPC.
7	19-21	Blocking probability and multistage switching, time division switching and two-dimensional switching.
8	22-24	Traffic analysis: Traffic characterization, grades of service (GOS), network blocking probabilities, delay system and queuing.
9-11	25-33	Modern telephone services and networks: Internet telephony (VoIP), facsimile (Fax), Integrated services digital network (ISDN): N-ISDN and B-ISDN, DSL
12-13	34-39	Asynchronous transfer mode (ATM), FTTx, SONET/SDH
14	40-42	WDM Network and Next Generation Network (NGN).

## 20.102 Description of Course HUM 347

### Section A: General Information

- 20.102.1 Course Title: Ethics in Society and E-Governance  
 20.102.2 Type of Course: Theory  
 20.102.3 Offered to: Department of Computer Science and Engineering  
 20.102.4 Pre-requisite Course(s): None

### Section B: Course Details

- 20.102.5 Course Content (As approved by the Academic Council)

**Ethics in Society (Credit-2.00):** Approaches, ethical dimensions of technology, historical perspectives; Categorical imperative: motivation of action; Deviance, delinquency, moral, law, ethics; Ethics in social survey; Online communication: manifest and latent functions; Social group dynamics; Technology and inequality: class and gender issues; Social media: effect on individual autonomy, socialization, privacy, cyber bullying; Dramaturgy: presentation of self; Social interaction: distant learning, work from home; Value system, cultural ethics; Other social issue: individualism, community, minority; Digital Bangladesh and SDGs; Professional ethics: ACM code of ethics and professional conduct, responsibility, liability, loyalty, whistle blowing, trust and reliability in research and testing, conflict of interest; Intellectual property: licensing, copyrights, patents, trade secrets, plagiarism; Environmental impact: energy consumption by computing systems, electronic waste, repairing and recycling.

**E-Governance (Credit-1.00):** Defining government, institutional framework, democracy, leadership, bureaucracy, accountability and transparency in decision-making, concept of governance and e-governance, good governance and citizen engagement, e-governance for good governance, e-governance and public service delivery, public-private partnership for e-government system, legal and ethical issues in e-government, e-government development index (EGDI), ICT policy and smart government.

### 20.102.6 Course Objectives

- To analyze ethical, societal, environmental and sustainability aspects of computer technologies
- To learn the principles of social ethics to practice them in professional and personal lives
- To become equipped with imperative ethical skills which will help them in their future careers
- To introduce the basic knowledge of governance and to develop understanding on e-governance for quality public service delivery

20.102.7 Knowledge required  
None

20.102.8 Course Outcomes

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Justify</b> the extent of ethics in interactions among people, groups, and the community	PO8, PO9, PO12	C3, C5, A5, P6	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Examination
CO2	<b>Distinguish</b> social ethics regarding culture, privacy, inequality, and social media	PO8, PO12	C2, C3, A3, P1, P2	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Examination
CO3	<b>Practice</b> ethical decision making in professional and personal lives	PO8	C3, A5	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Examination
CO4	<b>Assess</b> ethical, societal, environmental and sustainability aspects of computer technologies	PO6, PO7, PO8	C5	Lectures, Group Discussion, Homework	Assignment, Quiz, Presentation, Class Test, Term Final Examination
CO5	<b>achieve knowledge</b> on the emergence of institutional and legal frameworks, citizen participation, regulatory authorities, public-private partnerships and ethical issues related to e-governance.	PO6, PO7, PO8	C1, C4, C6; A3, A5; P1, P5, P6	Lectures; power point presentations; Group discussion; Home work	Class test; extempore test; assignment; final exam
CO6	<b>engage</b> in critical thinking by solving contextual puzzles relating to the improvement of the quality of public service delivery through e-governance.	PO6, PO7, PO8	C1, C2, C3 A1, A2, A3 P2, P3, P4, P5	Lectures; power point presentations; Group discussion	Class test; Quiz, assignment; final exam

**20.102.9** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO -1							√													
CO -2							√													
CO -3							√													
CO -4							√													
CO -5							√													
CO -6							√									√				

**20.102.10** Lecture Plan

**A. Ethics in society: 2 (two) classes/week**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Ethics: approaches, ethical dimensions of technology, historical perspectives	CO1, CO3
Week 2	Deviance, delinquency, moral, law, and ethics	CO1
Week 3	Motivation of action (categorical imperative)	CO1, CO2
Week 4	Ethics in social survey	CO1, CO3, CO4
Week 5	Online communication, and group behaviour	CO1, CO2
Week 6	Community, minority, class, gender, technological inequality	CO1, CO2
Week 7	Social media, individual autonomy,	CO1, CO2
Week 8	Socialization, privacy, cyberbullying	CO2, CO3
Week 9	Presentation of self, social interaction, distant learning	CO3,
Week 10	Intellectual property, SDG	CO3, CO3
Week 11	ACM code, cultural ethics	CO2, CO3
Week 12	Environmental impact of computer technologies	CO3, CO4
Week 13	Digital Bangladesh	CO3, CO4
Week 14	<i>Review of previous classes</i>	

**B. E-Governance: 1 (one) class/week**

Week	Lecture Topics	Corresponding CO(s)
Week 1	Meaning and scope of government	CO5
Week 2	Legal and institutional framework of government	CO5
Week 3	Democracy	CO5
Week 4	Leadership	CO5
Week 5	Bureaucracy	CO5
Week 6	Accountability transparency and responsibility of government	CO5
Week 7	Concept of governance	CO5
Week 8	Good governance and citizen participation	CO5
Week 9	Concept of e-governance	CO5
Week 10	E-governance and public service delivery	CO5, CO6
Week 11	Public-private partnership for e-governance system	CO5, CO6
Week 12	Legal and ethical issues in e-government	CO5, CO6
Week 13	E-government development index (EGDI)	CO5, CO6
Week 14	ICT policy and smart government	CO5, CO6

**20.102.11 Assessment Strategy**

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

**20.102.12 Distribution of Marks**

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

**20.102.13 Textbook/References**

1. Immanuel Kant, Groundwork of the Metaphysics of Morals (Revised Edition), Cambridge University Press 2012.
2. Erving Goffman, The presentation of self in everyday life, Anchor, 1959
3. Richard T. Shaefer, Sociology, McGraw-Hill, 10<sup>th</sup> Edition, 2013
4. George Reynolds, Ethics in Information Technology, Cengage Learning; 6th edition, 2018

5. Jr. Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Ray James, Elaine Englehardt, Engineering Ethics: Concepts and Cases, Cengage Learning; 6th edition, 2018
6. Anabel Quan-Haase, Technology and Society: Social Networks, Power, and Inequality, Oxford University Press; 3rd edition, 2020
7. Ronald M. Baecker, Computers and Society: Modern Perspectives, by Oxford University Press; Illustrated edition, 2019
8. Department of Economic and Social Affairs, United Nations E-Government Survey 2022: The Future of Digital Government, New York: United Nations, 2022.
9. Levi-Faur, D. The Oxford Handbook of Governance, Oxford University Press, 2012.
10. Terry L. Cooper, Handbook of administrative ethics, New York: Marcel Dekker, Inc., 2001
11. Islam, M. Muinul and Ehsan, M. [From Government to E-Governance: Public Administration in the Digital Age](#), IGI Global Publisher, 2012.
12. Heeks, Richard, Implementing and managing E-Government: an international text, London: SAGE, 2006.
13. OECD, E-government for better government, Paris: Organisation for Economic Cooperation and Development, 2005
14. OECD, Rethinking e-Government Services: User-centred Approaches, Paris: Organisation for Economic Co-operation and Development, 2009

## **20.103 Description of Course HUM 402**

### **Section A: General Information**

- 20.103.1** Course Title: Professional Communication in English (Sessional)  
**20.103.2** Type of Course: Non-Departmental, Sessional  
**20.103.3** Offered to: Department of Computer Science and Engineering  
**20.103.4** Pre-requisite Course(s): None

### **Section B: Course Details**

- 20.103.5** Course Contents (As approved by the Academic Council)

Communication basics: level of appropriateness, colloquial and standard, informal and formal, correct pronunciation and grammar in professional communication; Vocabulary building: correct and precise diction, affixes; Communication today: communication over digital media, communication at meetings, internal and client meetings; Improving reading skills: analyzing, interpreting and understanding text varieties, practicing comprehension, study of literary and non-literary texts; Improving listening skills: overcoming barriers to effective listening, building powerful listening skills; Written communication: sentence variety, generating sentences, clarity and correctness of sentences, linking sentences to form paragraphs, writing paragraph and composition; Writing reports and proposals; Business presentations: organizing content, connecting to audience, preparing engaging multimedia presentations; Employment communication: interviewing and following up.

- 20.103.6** Course Objectives

- To enable learners to communicate effectively in academic and professional settings by developing their four core communication skills in English e.g., reading, writing, listening, and speaking
- To develop the ability of learners to appreciate English texts with a view to improving their English communication skills
- To equip students with the skills of writing academic and professional reports as expected in the settings concerned

- 20.103.7** Knowledge required

None

**20.103.8** Course Outcomes

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>express</b> ideas and opinions fluently in English in academic and professional settings	PO(i); PO(j)	C2	Lectures; Extempore speech; Q & A Forums	Viva voce; Presentation; Debate
CO2	<b>follow</b> speech, lectures, and arguments in English accents	PO(j)	A1, A3, P3	Lectures; Listening practice; Q & A Forums	Viva voce; Presentation; Debate
CO3	<b>understand</b> and <b>analyse</b> English texts with ease	PO(j)	C4, C2	Lectures; Group discussion on fictional and non-fictional prose pieces; Q & A Forums	Written exams; Viva voce; Debate
CO4	<b>organize</b> and <b>synthesize</b> ideas in a clear, detailed, and well-structured text	PO(j)	C5, A4	Lectures; Writing practice in peer groups; Corrective feedback on writing; Q & A Forums	Written exams; Assignment on Report writing
CO5	<b>compose</b> paragraphs, essays and reports on relevant topics	PO(j)	C6, P7	Lectures; Writing paragraphs, reports and proposals in peer groups; Q & A Forums	Written exams; Report

**20.103.9** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO-1							✓													
CO-2							✓													
CO-3							✓													
CO-4							✓													

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO-5							✓													

### 20.103.10 Lecture Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Introduction to communication in English Extempore speech	CO1
Week 2	Introduction to paragraph Writing paragraphs in peer groups	CO4, CO5
Week 3	Talk in workplace: Elements of professional talk and courtesy in talk  Conducting and participating in meetings: Techniques of conducting meeting, techniques of participating in a meeting  Listening practice	CO1, CO2
Week 4	Fundamentals of business writing	CO4, CO5
Week 5	Report: Types & layout Assignment on report Selection of the report topic	CO4, CO5
Week 6	Proposal writing	CO4, CO5
Week 7	Discussion on fictional and non-fictional prose pieces Introduction to oral presentation Topic selection for presentation	CO1, CO3
Week 8	Listening practice Submission of topic for mock & final presentation Discussion on fictional and non-fictional prose pieces	CO2, CO3
Week 9	Debate based on fictional and non-fictional prose pieces	CO1, CO2
Week 10	Mock presentation	CO1, CO2
Week 11 & 12	Final presentation	CO1, CO2
Week 13	Final test on reading & writing skills	CO3, CO4, CO5
Week 14	Final test on speaking skills	CO1, CO2

### 20.103.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: The continuous assessment is comprised of class tests, assignments, presentation and viva-voce. The scheme of the continuous assessment for the course will be declared on the day of the first class.
- Final exam: A comprehensive reading and writing skills test will be held at the end of the semester as per the institutional ordinance.

### 20.103.12 Distribution of Marks

Attendance:	10 %
Continuous Assessment: (Report, Final presentation, Speaking skills test etc.)	56.67%
Final Exam: (Reading and writing skills test)	33.33%
Total:	100%

### 20.103.13 Textbook/References

- Guffey, Mary Ellen, & Loewy, Dana. *Essentials of Business Communication*. United States: Cengage Learning, 2018.
- Rentz, Kathryn, & Lentz, Paula. *Lesikar's Business Communication: Connecting in a Digital World*. Irwin: McGraw Hill, 2013.
- Sharma, R C., & Mohan, Krishna. *Commercial Correspondence and Report Writing*. New Delhi: Tata McGraw-Hill, 2017.
- Baker, Ann. *Ship or Sheep?* New Delhi: Cambridge University Press, 2008.
- G, Simon., & Swan, M. *Effective Reading*. Cambridge: CUP, 2001.
- Mosback, G., & Mosback, V. *Practicing Faster Reading*. Cambridge: CUP, 1999.
- Imhoof, M., & Herman, H. *From Paragraph to Essay*. Harlow: Longman, 2000.
- Thomson, A. J., & Martinet, A.V. *A Practical English Grammar*. New Delhi: OUP, 2001.
- Hefferman, AW James. *Writing: A College Handbook*. London: Norton, 2001.
- Fitikides, T.J. *Common Mistakes in English*. London: Longman, 2002.

## 20.104 Description of Course HUM 403

### Section A: General Information

20.104.1	Course Title:	Communication in English
20.104.2	Type of Course:	Theory
20.104.3	Offered to:	Department of Computer Science and Engineering
20.104.4	Pre-requisite Course(s):	None

### Section B: Course Details

20.104.5 Course Content (As approved by the Academic Council)

Communication in society: forms of communication, communication for specific purposes, communication in the digital age, communicating across cultures, linguistic barriers; Grammar: construction of correct sentences; Paragraph; Composition; Vocabulary enrichment: techniques of enriching stock of words for global communication; Phonetics: places and manners of articulation of sounds; Summarizing and expansion of ideas; Reading: analysing literary and non-literary texts; Business communication: anticipating the audience, organizing messages, communicating in internal and client meetings, digital media, positive, neutral, negative and persuasive messages; Report writing: types and layouts of reports, information collection through research, usage of graphics and charts; Business presentations: creating effective business presentations; Employment communication: job search, resumes, cover letters, interviewing and following up.

**20.104.6** Course Objectives

- To address the specific needs of the students in strengthening their English language skills in reading, writing, speaking and listening
- To enhance their ability to understand various modes of professional communication and apply the principles of effective communication
- To prepare students to analyse literary and non-literary texts critically

Knowledge required

None

**20.104.7** Course Outcomes

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Identify</b> the required communication skills in English for smooth navigation in the academic and professional world	PO10	C1, C3	Lectures, PPT Presentation	Assignment, Class Test, Term Final Exam
CO2	<b>acquire</b> necessary skills for successful communication in English	PO10	C2; A1,A4	Lectures, PPT Presentation	Assignment, Class Test, Term Final Exam
CO3	<b>understand</b> various modes of professional communication, and how to utilize them effectively	P10	C5; A4; P7	Lectures, PPT Presentation	Assignment, Class Test, Term Final Exam
CO4	<b>analyse and evaluate</b> literary texts using appropriate critical methods, aiming at improvement of communication	PO8, PO10, PO12	C3, C4; A4, A5; P6, P7	Lectures, PPT Presentation	Assignment, Class Test, Term Final Exam

CO5	<b>demonstrate</b> competence in effective communication in English	PO12	C3; A4, A5; P6, P7	Lectures, PPT Presentation	Assignment, Class Test, Term Final Exam
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**20.104.8** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO1							√													
CO2							√													
CO3							√													
CO4							√													
CO5							√													

**20.104.9** Lecture Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Communication in society: forms of communication, communication for specific purposes, communication in the digital age, communicating across cultures, linguistic barriers	CO1, CO2, CO3
Week 2	Phonetics: places and manners of articulation of sounds	CO1
Week 3	Grammar: construction of correct sentences	CO1,CO2
Week 4	Paragraph writing, composition	CO1,CO2, C3, C5
Week 5	Report writing	CO1, O2, C3, C5
Week 6	Vocabulary enrichment: techniques of enriching stock of words for global communication	CO1, O2, C3, C5
Week 7	Summarizing and expansion of ideas	CO1, O2, C3, C5
Week 8	Reading: analysing literary and non-literary texts	CO1, O2, C3, C5

Week	Lecture Topics	Corresponding CO(s)
Week 9	Reading: analysing literary and non-literary texts	CO1, O2, C3, C5
Week 10	Business communication	CO1, O2, C3, C5
Week 11	Business communication	CO1, O2, C3, C5
Week 12	Business presentations: creating effective business presentations	CO2, CO4
Week 13	Employment communication: job search, resumes, cover letters, interviewing and following up	CO2, CO4
Week 14	Review	CO1, CO2, CO3, CO4

#### 20.104.10 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.104.11 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.104.12 Textbook/References

1. Guffey, Mary., & Loewy, Dana, Essentials of Business Communication. United States: Cengage, 2018
2. Rentz, Kathryn., Flatley, Marie & Lentz, Paula., Lesikar's Business Communication: Connecting in a Digital World. New York: McGraw-Hill Irwin, 2014
3. Sharma, R C., & Mohan, Krishna. Commercial Correspondence and Report Writing. New Delhi: Tata McGraw-Hill, 2017
4. Imhoof, M., & Herman, H. From Paragraph to Essay. Harlow: Longman, 2000
5. G, Simon., & Swan, M. Effective Reading. Cambridge: CUP, 2001
6. Mosback, G., & Mosback, V. Practicing Faster Reading. Cambridge: CUP, 1999
7. Raymond, Murphy. Intermediate English Grammar. Cambridge: CUP
8. ---. Essential Grammar in Use. Cambridge: CUP, 2001
9. Thomson, A. J., & Martinet, A.V. A Practical English Grammar. New Delhi: OUP, 2001
10. McCarthy, Michael & O'Dell, Felicity. English Vocabulary in Use. Cambridge: CUP, 2002

## 20.105 Description of Course HUM 429

### Section A: General Information

20.105.1	Course Title:	Accounting and Entrepreneurship for IT Business
20.105.2	Type of Course:	Theory
20.105.3	Offered to:	Department of Computer Science and Engineering
20.105.4	Pre-requisite Course(s):	None

### Section B: Course Details

#### 20.105.5 Course Content (As approved by the Academic Council)

**Accounting (2 Credit Hours):** Basic accounting concepts; Accounting as information systems; Conceptual framework of accounting; Double entry mechanism; Accounting equation; The recording process: journal, ledger and trial balance; Adjusting entries, preparing an adjusted trial balance; Financial statements preparation: statement of financial position, statement of comprehensive income, statement of owners' equity and statement of cash flows; Financial statements analysis and interpretation; Some applications of accounting in excel; Cost concepts: cost classifications and cost functions; Cost Behavior: analysis and use; Job order costing and preparing job cost sheet; Cost allocation; Standard costing; Working capital management.

**Entrepreneurship (1 Credit Hour):** The foundations of entrepreneurship; Inside the entrepreneurial mind, from ideas to reality: creativity and innovation; Rewards and challenges of entrepreneurship: ethics and social responsibility; Entrepreneurial process: conducting a feasibility analysis, designing a competitive business model, crafting a business plan and building a strategic plan; Forms of business ownership: buying an existing business; Building a marketing plan: bootstrap marketing plan, market research, advertising and promotion, pricing and credit strategies, e-commerce; Building a financial plan: ratio analysis, managing cash-flow, sources of financing-equity and debt; Building an operational plan: location, layout, and physical facilities; Global aspects of entrepreneurship; Planning for the future: exit strategies.

#### 20.105.6 Course Objectives

- To make students conversant about the basic concepts of financial, cost and managerial accounting and demonstrate different accounting methodologies, procedures, tools, and techniques
- To enable students preparing, analysing, and interpreting financial, cost and managerial information and taking appropriate decisions
- To impart the entrepreneurship process and social and ethical responsibilities of an entrepreneur
- To qualify students preparing marketing, financial and operational plans for an IT entrepreneurship venture

#### 20.105.7 Knowledge required None

#### 20.105.8 Course Outcomes

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>Understand and illustrate</b> the basic concepts of financial, cost, and managerial accounting	PO(11)	C2, C3, C4	Lectures, PowerPoint presentation	Class Tests/ Assignments, and Final Exam

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO2	<b>Prepare and analyze</b> financial information to facilitate and justify different financial and investment decisions	PO(7), PO(8), PO(9), PO(11) PO(12)	C3,C5,C6	Lectures, PowerPoint presentation	Class Tests/ Assignments, and Final Exam
CO3	<b>Demonstrate</b> different costing and managerial tools and techniques	PO(9)	C3	Lectures, PowerPoint presentation	Class tests; Assignments; Quiz; Final Exam
CO4	<b>Plan</b> effective costing tools and techniques for cost benefit analysis	PO(11), PO(12)	C5, C6	Lectures, PowerPoint presentation	Class Tests/ Assignments, and Final Exam
CO5	<b>Understand</b> the entrepreneurship process and social and ethical responsibilities of an entrepreneur	PO(6,) PO(7), PO(8)	C2	Lectures, PowerPoint presentation	Class Tests/ Assignments, and Final Exam
CO6	<b>Formulate</b> marketing, financial and operational plans for an IT entrepreneurship venture	PO(10), PO(11)	C6, A4	Lectures, PowerPoint presentation	Class Tests/ Assignments, and Final Exam

**20.105.9** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO -1							√													
CO -2							√													
CO -3							√													
CO -4							√													
CO -5							√													
CO -6							√													

**20.105.10** Lecture Plan

Week		Topics	Corresponding CO(s)
Week 1	(2 Classes)	Introduction to Financial Accounting; Introduction to Cost Accounting	CO1
	(1 Class)	The foundations of entrepreneurship	CO5
Week 2	(2 Classes)	Assumptions and Principles; Cost Concepts and Classification	CO1
	(1 Class)	Inside the entrepreneurial mind, from ideas to reality: creativity and innovation;	CO5
Week 3	(2 Classes)	Accounting as an information system, accounting cycle, Accounting equation; Cost Concepts and Classification (2 Classes)	CO1
	(1 Class)	Rewards and challenges of entrepreneurship: ethics and social responsibility;	CO5
Week 4	(2 Classes)	Transaction Analysis; Cost Sheet: Cost of Goods Manufactured, Cost of Goods Sold and Income Statement (2 Classes)	CO1, CO2
	(1 Class)	Rewards and challenges of entrepreneurship: ethics and social responsibility;	CO5
Week 5	(2 Classes)	Recording Process; Cost Allocation	CO1, CO2
	(1 Class)	Entrepreneurial process	CO5
Week 6	(2 Classes)	Recording Process; Cost Allocation	CO1, CO2
	(1 Class)	Entrepreneurial process	CO5
Week 7	(2 Classes)	Adjusting the Accounts; Standard costing	CO2, CO3, CO4
	(1 Class)	Forms of business ownership: buying an existing business;	CO6
Week 8	(2 Classes)	Adjusting the Accounts; Standard costing	CO2, CO3, CO4
	(1 Class)	Forms of business ownership: buying an existing business;	CO6
Week 9	(2 Classes)	Preparation of Financial Statements or Reports; Standard costing	CO2, CO3, CO4
	(1 Class)	Building a marketing plan	CO6

Week		Topics	Corresponding CO(s)
Week 10	(2 Classes)	Preparation of Financial Statements or Reports; Job order costing	CO2, CO3, CO4
	(1 Class)	Building a marketing plan	CO6
Week 11	(2 Classes)	Preparation of Financial Statements or Reports; Job order costing	CO2, CO3, CO4
	(1 Class)	Building a financial plan	CO6
Week 12	(2 Classes)	Financial Statements/ Report analysis and Interpretation; Job order costing	CO2, CO3, CO4
	(1 Class)	Building an operational plan	CO6
Week 13	(2 Classes)	Financial Statements/ Report analysis and Interpretation; Working capital management	CO2, CO3, CO4
	(1 Class)	Global aspects of entrepreneurship	CO6
Week 14	(2 Classes)	Working capital management	CO3, CO4
	(1 Class)	Planning for the future: exit strategies	CO6

#### 20.105.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance

#### 20.105.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.105.13 Textbook/References

##### (Accounting):

- Weygandt J. J., Kimmel D. P. & Kieso E.D. (2015), Accounting Principles, New Jersey, John Wiley & Sons.
- Garrison R., Moreen E., & Brewer P. (2011), Managerial Accounting, New York, McGraw-Hill/Irwin.
- Horngren C. T., Foster G., & Datar S. M. (2017), Cost Accounting: A Managerial Emphasis , New York, Pearson.

##### (Entrepreneurship for IT Business):

- Hisrich, R. D., & Ramadani, V. (2017), Effective Entrepreneurial Management Strategy, Planning, Risk Management, and Organization, Springer International Publishing AG.
- Hisrich, R. D. (2013), International Entrepreneurship Starting, Developing, and Managing a Global Venture, SAGE Publications, Inc.

#### 20.106 Description of Course HUM 475

### Section A: General Information

- 20.106.1** Course Title: Engineering Economics
- 20.106.2** Type of Course: Theory
- 20.106.3** Offered to: Department of Computer Science and Engineering
- 20.106.4** Pre-requisite Course(s): None

### Section B: Course Details

**20.106.5** Course Content (As approved by the Academic Council)

Economics and engineering; microeconomics and macroeconomics; theory of demand and supply and their elasticities; demand estimation; price determination; indifference curve technique; theory of production; theory of cost and cost estimation; market structure; national income accounting; depreciation; circular flow of income and expenditure; cost-benefit analysis; payback period, net present value (NPV), internal rate of return (IRR), inflation; economic feasibility of engineering undertakings; development economics.

**20.106.6** Course Objectives

This course has been designed for undergraduate students

- To give a clear idea about the fundamental economic problems and provide adequate knowledge for understanding basic economic theories and practices, and their implications in an economy.
- To provide students an understanding of how the modern economy functions in the real world and thereby prepare them to evaluate the state-of-affairs of an economy using an economist's lenses.
- To make students enable to apply their acquired knowledge in different stages of their professional career.

**20.106.7** Knowledge required  
None

**20.106.8** Course Outcomes

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	<b>understand</b> the nature of the discipline, economics science, how it deals with the issues related to scarcity of resources, concepts of microeconomics and macroeconomics	-	C2	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO2	<b>analyze</b> behavior of consumers and, behavior and performance of firms under different market mechanisms and structures	PO9	C4	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment
CO3	<b>evaluate</b> important economic events and	PO9	C4	Lectures, Homework, Q & A Forums	Written exams; viva voce;

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	statistics, and their determining factors				presentation; assignment
CO4	assess implications of different economic policies, and different planning issues for growth and development in the context of Bangladesh	PO7, PO11, PO12	C5	Lectures, Homework, Q & A Forums	Written exams; viva voce; presentation; assignment

**20.106.9** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1							√													
CO2							√												√	√
CO3							√												√	
CO4							√												√	√

**20.106.10** Lecture Plan

Week	Lecture Topics	Corresponding CO(s)
Week 1	Economics and engineering; Microeconomics and macroeconomics	CO1
Week 2	microeconomics: consumer behavior, theory of demand and supply and their elasticity	CO1, CO2
Week 3	price determination; indifference curve technique	CO1, CO2
Week 4	factors of production; marginal analysis and optimization	CO1, CO2
Week 5	theory of production; theory of costs	CO1, CO2
Week 6	market structure.	CO1, CO2
Week 7	internal and external economies and diseconomies	CO1, CO2
Week 8	Macroeconomics: national income analysis	CO1, CO3
Week 9	aggregate demand and aggregate supply	CO1, CO4

Week 10	savings and investment; circular flow of income and expenditure; inflation; money	CO1, CO4
Week 11	monetary policy, fiscal policy, and trade policy with reference to Bangladesh	CO1, CO4
Week 12	economic growth and balance of payments account; Cost-benefit analysis; payback period; Net present value (NPV)	CO1, CO4
Week 13	Internal rate of return (IRR); Economic feasibility of engineering undertakings; development economics	CO1, CO4
Week 14	development economics and reviews	CO1, CO4

#### 20.106.11 Assessment Strategy

- Class Attendance: Class attendance will be recorded in every class.
- Class Tests/Assignments/Projects: There will be a minimum of 4 (four) Class Tests/Assignments/Projects, out of which the best 3 (three) will be considered in the final evaluation.
- Final exam: A comprehensive Final exam will be held at the end of the semester as per the institutional ordinance.

#### 20.106.12 Distribution of Marks

Attendance:	10 %
Class Tests/Assignments/Projects:	20%
Final Exam:	70%
Total:	100%

#### 20.106.13 Textbook/References

- Hubbard, G. & O'Brien, A. P. (2021a). *Microeconomics*. Pearson. 8<sup>th</sup> Edition, <https://www.pearson.com/en-us/subject-catalog/p/microeconomics/P200000005936?view=educator>
- Hubbard, G. & O'Brien, A. P. (2021b). *Macroeconomics*. Pearson. 8<sup>th</sup> Edition, <https://www.pearson.com/en-us/subject-catalog/p/macroeconomics/P200000005935/9780136713791>.
- Todaro, M. P. (2020). *Economic Development*, 13<sup>th</sup> Edition, <https://www.pearson.com/us/higher-education/program/Todaro-Economic-Development-13th-Edition/PGM100003100761.html>.
- Hubbard, G. & O'Brien, A. P. (2021c). *Economics*. Pearson. 8<sup>th</sup> Edition, <https://www.pearson.com/en-us/subject-catalog/p/economics/P200000005930/9780136713951>.
- Sloman, J., Garratt, D. and Guest, J. (2018). *Economics*. Pearson.
- Salvatore, D. (2008). *Microeconomics: theory and applications*. McGraw-Hill.
- Koutsoyiannis, A. (1975). *Modern Microeconomics*. Springer.
- Mankiw, N. G. (2007). *Principles of Microeconomics*.
- Mankiw, N.G. (2020). *Principles of Macroeconomics*. Cengage Learning.
- Dornbusch, R., Fischer, S. and Startz, R. (2011). *Macroeconomics*. McGraw-Hill.
- Diulio, E. (1997). *Macroeconomics: theory and problems*. McGraw-Hill.
- Sloman, J., Garratt, D. and Guest, J. (2018). *Economics*. Pearson.

## 20.107 Description of Course CHEM 113

### PART A: General Information

20.107.1	Course Title	: Chemistry
20.107.2	Type of Course	: Theory
20.107.3	Offered to	: DEPARTMENT OF CSE
20.107.4	Pre-requisite Course(s)	: N/A

### PART B: Course Details

#### 20.107.5. Course Content (As approved by the Academic Council)

Laboratory works based on the following topics.

Quantum concept in atomic structure, VSEPR; molecular geometry, Quantum concept in bonding; VBT and MOT, Frontier MOT and electronic transition, Silicon chemistry, Properties of solutions, Colloid and Nanochemistry, Phase rule and phase diagram; Energy and chemistry, Electrochemistry; electrolytic conduction, corrosion, devices for energy storage, Chemistry of biodegradable and conductive polymer; LED, LCD/touch screen, Chemistry of proteins, nucleic acids (DNA, RNA), carbohydrates and lipids; Introduction to computational chemistry; Design of new molecules, materials and drug.

#### 20.107.6. Course Objectives

The students are expected to:

- To provide an in-depth understanding of the fundamentals of building components in chemical bonding in general as well as bio-organic molecules, solution process and dimension of particles, conditions for equilibrium of different phases, and energetics of physico-chemical systems
- To enable students building a foundation on underlying state-of-the-art scientific knowledge, and to develop critical thinking abilities for identifying and resolving the issues they will encounter in their advanced courses and professional career.

#### 20.107.7. Knowledge required

N/A

#### 20.107.8. Course Outcomes (COs)

Course Outcomes (CO) and their mapping with Program outcomes (PO) and Teaching-Learning Assessment methods:

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Identify fundamental concepts of chemical bonding, properties and structure of molecules in general as well as bio-organic molecules according to quantum theory.	1	C1	Lectures, Homework	Written exams, class test
CO2	Illustrate the basic principles associated with properties of atom/molecule, solution, colloid and nanochemistry, conducting polymers, LED, LCD, thermochemistry, phase diagram, electrolytic conduction and	1	C2	Lectures, Homework, presentation	Written exams, class test

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	electrochemical changes occurs during cell reactions				
CO3	Solve problems associated with physical and chemical changes based on the structure of bio-organic molecules, chemical and electrochemical reactions, electrolytic conduction and electrochemical changes occurs during cell reactions	-	C3	Homework, lecture	Written exams, class test
CO4	Analyze the behavior of materials and chemical systems utilizing the principles of theoretical chemistry & basic computational chemistry tools	-	C4	Lecture, presentation	Written exams, class test

#### 20.107.9. Lecture Plan: Teacher-1

	Lecture Topics	Corresponding CO(s)
L1	General introduction and need of chemistry of engineering students	-
L2	Definition of solution, types, molecular view of solution process	CO2, CO4
L3	Effect of temperature and pressure	CO2, CO4
L4	Distribution law, Raoult's law, Deviations from the ideal behavior	CO2, CO4
L5	Class Test-1	CO2, CO4
L6	Colloid vs solution, Dispersed phase and the dispersion medium	CO2, CO4
L7	Preparation techniques: Condensation method, Dispersion method	CO2, CO4
L8	Electrical Properties	CO2, CO4
L9	Optical and mechanical properties	CO2, CO4
L10	Concept of nanochemistry	CO2
L11	Preparation and properties of nanomaterials	CO2, CO4
L12	Class test -2	CO2, CO4
L13	Basic understanding of Energy and chemistry	CO2, CO4
L14	Laws of thermochemistry, Calorimetric determination of calorific value	CO2, CO4
L15	Phase, component and degrees of freedom	CO2, CO4
L16	Phase rule and condensed system	CO2, CO4
L17	Phase diagram of monocomponent system (water and sulfur) Phase diagram of the condensed system	CO2, CO4
L18	Electrochemistry	CO2, CO4
L19	Electrolytic conduction	CO2, CO4
L20	Corrosion	CO2, CO4
L21	Devices for energy storage	CO2, CO4

#### 20.107.10. Lecture Plan: Teacher-2

	Lecture Topics	Corresponding CO(s)
L1	Quantization of energy and concept of atomic orbitals	CO1, CO4
L2	Wave-particle duality of matter and energy: blackbody radiation and plank's quantum theory, photoelectric effect, dual nature of light	CO1, CO4
L3	Schrodinger wave equation, quantum numbers, Electron configuration of multielectron systems, effect of electronic configuration on atom's size, effective nuclear charge,	CO1, CO4
L4	VSEPR and Molecular geometry	CO1, CO4
L5	Prediction of molecular geometry	CO1, CO2

	Lecture Topics	Corresponding CO(s)
L6	Quantum concept of bonding	CO1, CO2
L7	VBT	CO1, CO4
L8	MOT	CO1, CO3
L9	Frontier MOT and electronic transition	CO1
L10	Class test-1	CO1, CO2
L11	Primary structure of bio-organic macromolecules (proteins, DNA, RNA)	CO1, CO2
L12	Intermolecular forces, Secondary & tertiary structure of bio-organic macromolecules (proteins, DNA, RNA)	CO1, CO3
L13	Structure & function of Carbohydrates and lipids	CO1, CO3
L14	Biodegradable and conductive polymer	CO1, CO3
L15	LED, LCD, touchscreen	CO1, CO2
L16	Si chemistry, band theory	CO1, CO3
L17	Doping and semiconductor	CO1, CO3
L18	Class test -2	CO1, CO3
L19	Introduction to computational chemistry	CO1, CO3
L20	Types & tools of computational chemistry	CO1, CO3
L21	Application of computational chemistry	CO1, CO2, CO4

#### 20.107.11. Assessment Strategy

- i Class Participation: Class participation and attendance will be recorded in every class.
- ii Continuous Assessment: Continuous assessment of any of the activities such as quizzes, assignments, presentations, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes
- iii Final Examination: A comprehensive term final examination will be held at the end of the Term following the guidelines of academic Council.

#### 20.107.12. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

#### 20.107.13. Textbooks

Textbook-1	Chemistry by Raymond Chang, Kenneth A. Goldsby
Textbook-2	General Chemistry by Ebbing, Darrell, Gammon, Steven D.
Textbook-3	Principles of Physical Chemistry by Kindle edition by Maron, S. H., Prutton, C.F.

#### References

Reference-1	Concise Inorganic Chemistry: Fifth Edition by J. D. Lee
Reference-2	Organic Chemistry: Ninth Edition by McMurry

#### 20.107.14. Weighting COs with Assessment methods

Assessment Method	% Weight	Mark distributions on COs and POs			
		CO1	CO2	CO3	CO4
		PO1	PO1	PO2	PO3
Attendance	10	2.5	2.5	2.5	2.5
Continuous Assessment	20		10	10	
Final	70	10	30	20	10

## 20.108 Description of Course CHEM 118

### PART A: General Information

- 20.108.1. Course Title : Chemistry sessional (subject to the approval of academic council)
- 20.108.2. Type of Course : sessional
- 20.108.3. Offered to : DEPARTMENT OF CSE
- 20.108.4. Pre-requisite Course(s) : N/A

### PART B: Course Details

#### 20.108.5. Course Content (Subject to the approval of Academic Council)

Determination of the concentration of battery acid, study of redox system (iodometric study of copper determination), calorimetric determination of heat of reaction, Molecular geometry model based on VSEPR, phase diagram.

#### 20.108.6. Course Objectives

The students are expected to:

- To develop the basic understanding of a student dealing with chemical reagents, equipment necessary to perform chemical analysis along with associated theoretical knowledge on physical chemistry, electrochemistry, phase rule and molecular geometry
- To provide hands-on experience on the techniques of volumetric methods, construct calorimeter for heat of reaction, construct molecules based on VSEPR and to prepare students to present their experimental findings as scientific reports.

#### 20.108.7. Knowledge required

N/A

#### 20.108.8. Course Outcomes (COs)

Course Outcomes (CO) and their mapping with Program outcomes (PO) and Teaching-Learning Assessment methods:

CO No.	CO Statement Upon successful completion of the course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Describe different parameters and techniques related to chemical analysis and determination of physical/chemical parameters	1	C1	Lectures	Quiz, Class performance, viva, Report writing
CO2	Follow the instructions to perform guided enquiry in determining conducting experiments	-	P3	Lectures and Demonstration	Quiz, Class performance, viva, Report writing, final Exam
CO3	Analyze the experimental data individually or in a group	-	C4	Lectures, Demonstration	Quiz, Class performance, viva, Report writing Final Exam
CO4	Prepare scientific reports on experiments by	-	C6	Homework	Quiz, Class performance,

CO No.	CO Statement Upon successful completion of the course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	organizing experimental findings				viva, Report writing, Final Exam

#### 20.108.9. Lecture Plan:

	Lecture Topics	Corresponding CO(s)
L1	Briefing on lab safety protocol and quiz on it	CO1
L2	Course outline and introductory discussions on chemical analysis, determination of physical parameters and construction of molecular geometry	CO1
L3	Determination of the concentration of battery acid and dilution	CO1-CO4
L4	Study of redox system in the determination of copper in the solution by iodometry	CO1-CO4
L5	Preparation of molecular model based on VSEPR	CO1-CO4
L6	Construction of phase diagram	CO1-CO4
L7	Viva, quiz	CO1, CO3

#### 20.108.10. Assessment Strategy

- i Class Participation: Class participation and attendance will be recorded in every class.
- ii Continuous Assessment: Continuous assessment will be accomplished following any of the activities such as quizzes, report writing and viva. The scheme of the continuous assessment for the course will be declared on the first day of classes
- iii Final Examination: Practical examination will be held individually at the end of the sessional classes.

#### 20.108.11. Distribution of Marks

Distribution of Marks	
Attendance and Class Performance	10
Report	20
Quiz	25
Viva	20
Total	75

#### 20.108.12. Textbooks

- Textbook-1 Quantitative Inorganic Analysis, By: A. I. Vogel  
Physical Chemistry, Marron and Prutton

#### 20.108.13. Weighting COs with Assessment methods

Assessment Method	Marks	Mark distributions on COs and POs			
		CO1	CO2	CO3	CO4
		PO1	PO4,PO9	PO2, PO9	PO12
Attendance and class performance	10	5		5	
Report	20				20
Quiz	25	20		5	
Viva	20	20			

#### 20.109 Description of Course PHY 114

#### PART A: General Information

- 20.109.1. Course Title** : Physics Sessional
- 20.109.2. Type of Course** : Non-departmental course
- 20.109.3. Offered to** : Department of Computer Science and Engineering
- 20.109.4. Pre-requisite Course(s)** : N/A

**PART B: Course Details**

**20.109.5. Course Content** (~~As approved by the Academic Council~~)  
Experiments based on Structure of Matter, Electricity & Magnetism, Wave Mechanics

**20.109.6. Course Objectives**

Objective 1: To gain practical knowledge about theories of Physics by performing different experiments.

Objective 2: To develop analytical and scientific report writing skills.

**20.109.7** Knowledge required Insert previous knowledge requirements: N/A

**20.109.8 Course Outcomes**

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	At the end of the course, a student should be able to -				
CO1	Describe various experimental techniques, and use different instruments to collect, tabulate the data.	PO1	C1, C3	Classwork, Q & A Forums	Classwork
CO2	Analyse data, plot graphs, and connect the results for qualitative understanding.	PO1	C3, C4	Classwork, Q & A Forums	Classwork
CO3	Interpret the result, draw conclusions and prepare laboratory report.	PO1	C3	Classwork, Q & A Forums	Classwork

**20.109.9. Lecture Plan**

wk	Lecture Topics	Corresponding CO(s)
1	Introductory class	
2	E2: Determination of the resistance of a galvanometer by half deflection method	CO1, CO2, CO3
3	E3: Verification of Biot-Savart law and Tangent law	
4		

wk	Lecture Topics	Corresponding CO(s)
5	M1: Determination of the threshold frequency for the material of a photo-cathode and hence find the value of the Planck's constant	
6	VL-M3: Determination of lattice constant of NaCl crystal using an X-ray diffraction simulator	
7	E5: Determination of the temperature coefficient of the resistance of the material of a wire	
8		
9	E6: Determination of dielectric constant of materials using a parallel plate capacitor	
10	M4: Verification of Heisenberg's uncertainty principle using single slit diffraction pattern	
11	VL-E1: Verification of the Coulomb's law of electrostatics	
12	VL-E3: To plot the I-V characteristic curves for an Ohmic conductor, a thermistor and a diode	
13	H5: Calibration of a given thermocouple	
	H6: Determination of the melting point of a solid using the calibration curve obtained in experiment H <sub>5</sub>	
	E7: To determine a high resistance by the method of deflection	
	E8: To determine the value of low resistance by the method of fall of potential	
One experiment will be performed by each student per week		
14	Sessional Quiz	

#### 20.109.9 Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment will be evaluated based on viva and laboratory report, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Quiz: A comprehensive quiz will be held at the end of the term following the guideline of the Department.

#### 20.109.10 Distribution of Marks

Class Participation	10%
Continuous Assessment	70%
Quiz	20%
Total	100%

#### 20.109.11 Textbook/ Reference

1. Practical Physics for Degree Students; Giasuddin Ahmad and Md. Sahabuddin.
2. Advanced Practical Physics for students; B. L. Worsnop and H. T. Flint

## 20.110 Description of Course PHY 129

### PART A: General Information

20.110.1 Course Title : Structure of Matter, Electricity & Magnetism, Wave Mechanics

20.110.2 Type of Course : Non-departmental course

20.110.3 Offered to : Department of Computer Science and Engineering

20.109.4 Pre-requisite Course(s) : N/A

### PART B: Course Details

#### 20.110.5. Course Content (~~As approved by the Academic Council~~)

**Structure of Matter:** Crystalline and amorphous solids, crystal systems, crystal directions, Miller indices, co-ordinations number, packing factor, Bragg's law of X-ray diffraction, crystal structure analysis, defects in crystal, bonds in solids, cohesive energy and bonding energy, free electron theory of metals, band theory of solids, solid state devices.

**Electricity & Magnetism:** Electrostatics: electric field, Gauss's law and its applications for various charge distributions, electric potential and equipotential surface, dielectrics and electrostatic energy in capacitors; Magnetostatics: magnetic field and forces, Hall effect, application of Biot-Savart and Ampere's laws, electromagnetic induction and inductance, energy in a magnetic field, Electromagnetic oscillations: RC, LR, LC and LRC circuits, working principle of transformers, motors and generators, magnetic materials and its applications in a computing device.

**Wave Mechanics:** Failure of classical mechanics and historical origins of the quantum mechanics, wave particle duality, uncertainty principle, postulates of quantum mechanics, wave function, operators, Schrödinger equation, expectation value, Ehrenfest theorem, eigen function and eigen values, particle in a box, square well potential, linear harmonic oscillator.

#### 20.110.6. Course Objectives

Objective 1: To develop logical and critical thinking with scientific knowledge of structure of matter, electricity & magnetism, and wave mechanics required for the students of computer science and engineering.

Objective 2: To understand the different laws of Physics associated with structure of matter, electricity & magnetism, and wave mechanics, and apply them to solve the real life problems.

#### 20.110.7. Knowledge required

Insert previous knowledge requirements: N/A

#### 20.110.8. Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	At the end of the course, a student should be able to				
CO1	Describe the basic laws of Physics related to structure of matter, electricity & magnetism, and wave Mechanics to express	PO1	C1	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	At the end of the course, a student should be able to				
	different phenomena in the physical world.				
CO2	Explain the fundamental concepts and theories of structure of matter, electricity & magnetism, and wave Mechanics applicable for different physical conditions.	PO1	C2	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO3	Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences.	PO1	C3, C4	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

#### 20.110.9. Lecture Plan

wk	Lecture Topics	Corresponding CO(s)
1	<ul style="list-style-type: none"> <li>Crystalline and amorphous solids, crystal systems</li> <li>Coulombs law, Electric field</li> <li>Failure of Newtonian mechanics, Galilean transformation, concept of ether</li> </ul>	CO1, CO2, CO3
2	<ul style="list-style-type: none"> <li>Different types of crystals</li> <li>Electric flux, Gauss's law and its applications for various charge distributions</li> <li>Michelson-Morley experiment, consequence of Michelson-Morley experiment</li> </ul>	CO1, CO2, CO3
3	<ul style="list-style-type: none"> <li>Crystal directions, Miller indices, co-ordinations number, packing factor</li> <li>Electric potential and equipotential surface,</li> <li>Postulates of quantum mechanics, wave function</li> </ul>	CO1, CO2, CO3
4	<ul style="list-style-type: none"> <li>Solving mathematical problems related to the crystal system</li> <li>Dielectrics and electrostatic energy in capacitors</li> <li>Schrodinger equation</li> </ul>	CO1, CO2, CO3
5	<ul style="list-style-type: none"> <li>Bragg's law of X-ray diffraction</li> <li>Solving mathematical problems related to electric field, potential and capacitance</li> <li>Mathematical problems related to expectation value</li> </ul>	CO1, CO2, CO3
6	<ul style="list-style-type: none"> <li>Class Test (Structure of Matter)</li> <li>Magnetic field and forces, Hall effect</li> <li>Quantum mechanical operators and expectation value</li> </ul>	CO1, CO2, CO3
7	<ul style="list-style-type: none"> <li>Crystal structure analysis</li> <li>Application of Biot-Savart and Ampere's laws</li> <li>Ehrenfast theorem and its consequences</li> </ul>	CO1, CO2, CO3

wk	Lecture Topics	Corresponding CO(s)
8	<ul style="list-style-type: none"> <li>Defects in crystal</li> <li>Solving mathematical problems related to magnetic force and magnetic field</li> <li>Class Test (Wave mechanics)</li> </ul>	CO1, CO2, CO3
9	<ul style="list-style-type: none"> <li>Solving mathematical problems related to X-ray diffraction and Crystal defects.</li> <li>Class Test (Electricity &amp; Magnetism)</li> <li>Eigen value, Eigen function and time-independent Schrodinger equation</li> </ul>	CO1, CO2, CO3
10	<ul style="list-style-type: none"> <li>Bonds in solids, cohesive energy and bonding energy</li> <li>electromagnetic induction and inductance, energy in a magnetic field,</li> <li>Stationary states and their properties</li> </ul>	CO1, CO2, CO3
11	<ul style="list-style-type: none"> <li>Free electron theory of metals</li> <li>Electromagnetic oscillations: RC, LR, LC and LRC circuits</li> <li>Infinite square well potential</li> </ul>	CO1, CO2, CO3
12	<ul style="list-style-type: none"> <li>Band theory of solids,</li> <li>Working principle of transformers, motors, and generators</li> <li>Free particle</li> <li>Class Test-4</li> </ul>	CO1, CO2, CO3
13	<ul style="list-style-type: none"> <li>Solid state devices.</li> <li>Solving mathematical problems related to the magnetic induction.</li> <li>Particle in a box</li> </ul>	CO1, CO2, CO3
14	<ul style="list-style-type: none"> <li>Solving mathematical problems related to different theories of solid</li> <li>Magnetic materials and its applications in a computing device.</li> <li>Linear harmonic oscillator</li> </ul>	CO1, CO2, CO3

#### 20.110.10. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

#### 20.110.11. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

#### 20.110.12. Textbook/ Reference

- Introduction to Solid State Physics; C. Kittel
- Solid State Physics; M. A. Wahab
- Fundamentals of Physics; D. Halliday, R. Resnick, and J. Walker
- Quantum Physics; R. Eisberg, R. Resnick
- Introduction to Quantum Mechanics, 2<sup>nd</sup> Ed., David. J. Griffiths
- Physics for Engineers - Part-2; Giasuddin Ahmad

#### 20.111 Description of Course PHY 405

**PART A: General Information**

- 20.111.1 **Course Title** : Quantum Mechanics
- 20.111.2 **Type of Course** : Non-departmental course
- 20.111.3 **Offered to** : Department of Computer Science and Engineering
- 20.111.4 **Pre-requisite Course(s)** : PHY 129

**PART B: Course Details****20.111.5. Course Content (As approved by the Academic Council)**

Introduction to quantum mechanics, Born's interpretation of wavefunction, Hilbert space, Schrödinger equation in one dimension.: potential step, potential barrier, tunneling and its applications in metal-oxide-semiconductor, field-effect transistor and other electronic devices, rectangular potential well, linear harmonic oscillator, Schrödinger equation in three-dimension: analytical solution of hydrogen atom, orbital angular momentum and spin angular momentum, addition of angular momenta, Time independent and time dependent perturbation theory, quantum confinement in semiconductors and its energy considerations, applications of quantum mechanics in quantum computation.

**20.111.6. Course Objectives**

Objective 1: To develop logical and critical thinking with scientific knowledge of quantum mechanics required for the students of computer science and engineering.

Objective 2: To understand the different laws of Physics associated with quantum mechanics and apply them to solve the real life problems.

**20.111.7. Knowledge required**

Insert previous knowledge requirements: N/A

**20.111.8. Course Outcomes**

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
	At the end of the course, a student should be able to				
CO1	Describe the basic laws of Physics related to quantum mechanics to express different phenomena in the physical world.	PO1	C1	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO2	Explain the fundamental concepts and theories of quantum mechanics applicable for different physical conditions.	PO1	C2	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment
CO3	Apply the relevant laws of physics to solve various mathematical problems and interpret the result and its consequences.	PO1	C3, C4	e.g., Lectures, Homework	e.g., Written exams; viva voce; presentation; assignment

**20.111.9. Lecture Plan**

wk	Lecture Topics	Corresponding CO(s)
1	<ul style="list-style-type: none"> <li>● Failure of Classical Mechanics</li> <li>● Introduction to quantum mechanics,</li> <li>● Born's interpretation of wavefunction, Hilbert space</li> </ul>	CO1, CO2, CO3
2	<ul style="list-style-type: none"> <li>● Time independent Schrodinger equation and stationary states</li> <li>● Wave function for potential step</li> <li>● Mathematical Problems on time independent Schrodinger equation</li> </ul>	CO1, CO2, CO3
3	<ul style="list-style-type: none"> <li>● Wave function for potential step</li> <li>● Tunnelling and connection formula</li> <li>● Mathematical Problems on potential step</li> </ul>	CO1, CO2, CO3
4	<ul style="list-style-type: none"> <li>● Tunnelling in metal-oxide-semiconductor</li> <li>● Effect of tunnelling in field-effect transistor and other electronic devices</li> <li>● Mathematical Problems</li> </ul>	CO1, CO2, CO3
5	<ul style="list-style-type: none"> <li>● Wave function for rectangular potential well</li> <li>● Dirac delta potential</li> <li>● Class Test-1</li> </ul>	CO1, CO2, CO3
6	<ul style="list-style-type: none"> <li>● Linear harmonic oscillator</li> <li>● Ladder operators and their uses</li> <li>● Mathematical Problems on linear harmonic oscillator</li> </ul>	CO1, CO2, CO3
7	<ul style="list-style-type: none"> <li>● Schrödinger equation in three-dimension: spherical coordinates</li> <li>● Analytical solution of hydrogen atom</li> <li>● Energy levels of hydrogen atom</li> </ul>	CO1, CO2, CO3
8	<ul style="list-style-type: none"> <li>● Angular momentum and their commutation relations</li> <li>● Orbital angular momentum and spin angular momentum, Pauli spin matrices, spin <math>\frac{1}{2}</math> particles</li> <li>● Solving mathematical problems related to angular momentum</li> </ul>	CO1, CO2, CO3
9	<ul style="list-style-type: none"> <li>● Addition of angular momentum</li> <li>● Solving mathematical problems related to the Addition of angular momentum</li> <li>● Class Test-2</li> </ul>	CO1, CO2, CO3
10	<ul style="list-style-type: none"> <li>● Time independent perturbation theory, first and second order correction to wave function and energy</li> <li>● Degenerate perturbation theory</li> <li>● Solving mathematical problems related to time independent perturbation</li> </ul>	CO1, CO2, CO3
11	<ul style="list-style-type: none"> <li>● The fine structure of hydrogen</li> <li>● The Zeeman effect</li> <li>● Class Test-3</li> </ul>	CO1, CO2, CO3
12	<ul style="list-style-type: none"> <li>● Spin-orbit coupling</li> <li>● Time independent perturbation theory for two level system</li> <li>● Emission and absorption of radiation</li> </ul>	CO1, CO2, CO3
13	<ul style="list-style-type: none"> <li>● Quantum confinement</li> <li>● Quantum dots</li> <li>● Class Test-4</li> </ul>	CO1, CO2, CO3
14	<ul style="list-style-type: none"> <li>● Quantum confinement in semiconductors and its energy considerations</li> <li>● Applications of quantum mechanics in quantum computation</li> </ul>	CO1, CO2, CO3

wk	Lecture Topics	Corresponding CO(s)
	<ul style="list-style-type: none"> <li>Review class</li> </ul>	

### 20.111.10. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

### 20.111.11. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

### 20.111.12. Textbook/ Reference

- Quantum Mechanics - John L. Powell, Bernd Crasemann
- Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles- Robert Eisberg and Robert Resnick
- Applied Quantum Mechanics – A. F. J. Levi
- Introduction to Quantum Mechanics, David. J. Griffiths

## 20.112 Description of Course MATH 141

### PART A: General Information

20.112.1 Course Number	MATH 141
Course Title	Calculus I
Credit (Contact) Hours	3.0 (3.0)
20.112.2. Level and Term (Section)	Level-1, Term-1
Academic Session	July 2022
20.112.3. Type of Course	Core Course
Offered to	Department of Computer Science and Engineering
20.112.4. Pre-requisite Course(s)	None

### PART B: Course Details

#### 20.112.5. Course Content (As approved by the Academic Council)

Differential Calculus: Continuity and differentiability; Successive differentiation: Leibnitz's forms; Maxima and minima of functions of single variable: Rolle's theorem, mean value theorem; Evaluation of indeterminate forms by L'Hospital's rule; Expansion of functions: Taylor's and Maclaurin's theorems, Lagrange's and Cauchy's forms of remainders; Partial differentiation, Euler's Theorem; Tangent, normal.

Integral Calculus: Definite integrals and its properties; Wallis' formula; Improper integrals; Beta function and Gamma function; Parametric equations and polar coordinates; Applications of integration: area under a plane curve, area of a region enclosed by two curves and arc lengths in Cartesian and polar coordinates, volume and surface area of solids of revolution; Multiple integrals.

Ordinary Differential Equations (ODE): Definition. Formation of differential equations. Solution of first order differential equations by various methods with applications. Solution of general linear equations of second and higher orders with constant coefficient. Solution of Euler's homogeneous linear equations.

**20.112.6. Course Objectives**

- To provide the appropriate tools of calculus to solve applied problems.
- To understand the standard methods of indefinite and definite integrals with their applications.
- To explain the basic concept of differential equations, their solution techniques.

**20.112.7. Knowledge required**

Familiarity with basic properties of set theory and function; fundamental concepts of pre-calculus and preliminary knowledge to solve algebraic and transcendental equations.

**20.112.8. Course Outcomes**

CO No.	CO Statement After undergoing this course, students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	Explain the fundamental concepts of limits, derivatives, and expansion of functions.	-	C2	Lectures, Homework	Written exams, Assignment
CO 2	Apply the idea of accumulation to calculate area, volume and surface area.	-	C3	Lectures, Homework	Written exams, Assignment
CO 3	Demonstrate the idea of indefinite and definite integrals to evaluate integrals	-	C3	Lectures, Homework	Written exams, Assignment
CO 4	Discuss ordinary differential equations and valued functions.	-	C2	Lectures, Homework	Written exams; assignment

**20.112.9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√						√	√						√				
CO 2		√	√		√				√	√									√	√
CO 3		√	√						√	√									√	√

CO s	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5	
CO 4		√	√						√	√										√	√

#### 20.112.10. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

#### 20.112.11. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

#### 20.112.12. Textbooks

- Calculus by James Stewart
- Calculus: Early Transcendentals by Howard Anton, Irl Bivens and Stephen Davis.
- Differential and Integral Calculus by B. C. Das and B. N. Mukherjee.
- Integral Calculus with applications by A. K. Hazra.
- Elementary Differential Equations by Earl D. Rainville and Phillip E. Bedient.

#### 20.112.13. Reference Books

- Differential Calculus by P. N. Chatterjee.
- Advanced Engineering Mathematics by Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.

#### 20.112.18. Lecture plan

Weekly schedule: For Differential Calculus

Weekly plan for course content and mapping with Cos		
Weeks	Topics	COs
Week-1 to 2	Limits, Continuity, and differentiability.	CO1
Week-3 to 4	Successive differentiation of various types of functions.	CO4
Week-5 to 8	Leibnitz's theorem. Rolle's theorem. Mean value theorem. Taylor's and Maclaurin's theorems in finite and infinite forms. Lagrange's form of remainders. Cauchy's form of remainders.	CO3
Week -9 to 10	Expansion of functions. Evaluation of indeterminate forms by L'Hospitals rule. Partial differentiation. Euler's theorem.	CO2
Week-11 to 12	Tangent and Normal. Subtangent and subnormal in Cartesian and polar co-ordinates.	CO2
Week-13 to 14	Determination of Maximum and minimum values of functions with applications.	CO4

Weekly schedule: For Integral Calculus

Week	Topics	COs
Week-1	Definite integrals, its properties.	CO3
Week-2	Use of definite integral in summing series. Walli's formulae.	CO3
Week-3	Parametric equations and polar coordinates.	CO4
Week-4	Wallis' formula.	CO1
Week-5	Applications of integration.	CO3
Week-6	Class test	
Week-7	Improper integrals.	CO3
Week-8	Beta function and Gamma function.	CO1
Week-9	Area under plane curves in Cartesian and polar coordinates.	CO2
Week-10	Area of a region enclosed by two curves in Cartesian and polar coordinates.	CO2
Week-11	Volume of solids of revolution.	CO2
Week-12	Area of surface of revolution.	CO3
Week-13	Class Test, Multiple integrals.	CO4
Week-14	Review class	

Weekly Schedule for Differential Equations

Week	Topics	COs
Week-1	Degree and order of ordinary differential equations, Formation of differential equations.	CO4
Week-2	Formation of differential equations, Solution of first order differential equations by various methods (separable form and reducible to separable form).	CO4
Week-3	Solution of first order differential equations by various methods (homogeneous form and reducible to homogeneous form).	CO2
Week-4	Solution of first order differential equations by various methods (linear differential equation and Bernoulli's differential equation).	CO4
Week-5	Solution of first order differential equations by various methods (exact differential equation, non-exact differential equation and integrating factor by inspection).	CO4
Week-6	Class Test	
Week-7	Classification of solutions of differential equations, Application of first order differential equations.	CO4
Week-8	Solution of general linear equations of second and higher order with constant coefficients (homogeneous and non-homogeneous).	CO4
Week-9	Solution of general linear equations of second and higher order with constant coefficients (non-homogeneous).	CO4

Week	Topics	COs
Week-10	Solution of homogeneous linear equations (Cauchy-Euler equations).	CO4
Week-11	Solution of homogeneous linear equations (Cauchy-Euler equations).	CO4
Week-12	Various methods with applications.	CO1
Week-13	Euler's homogeneous linear equations.	CO4
Week-14	Class Test	

### 20.113 Description of Course MATH 143

#### **PART A: General Information**

<b>20.113.1.</b> Course Number	MATH 143
Course Title	Linear Algebra
Credit (Contact) Hours	3.0 (3.0)
<b>20.113.2.</b> Level and Term (Section)	Level-1, Term-2
Academic Session	July 2022
<b>20.113.3.</b> Type of Course	Core Course
Offered to	Department of Computer Science and Engineering
<b>20.113.4.</b> Pre-requisite Course(s)	None

#### **PART B: Course Details**

#### **20.113.5. Course Content (As approved by the Academic Council)**

Introduction to vectors, their products, matrices and systems of linear equations; Solving linear equations: Gaussian elimination, inverse and transpose of a matrix, factorization into  $A = LU$ ; Vector spaces and subspaces: four fundamental subspaces, solving  $Ax = 0$  and  $Ax = b$ , independence, basis and dimension, dimensions of the four subspaces; Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt; Determinants: properties, formulas, Cramer's rule, inverses and volumes; Eigenvalues and eigenvectors: eigendecomposition, systems of differential equations, symmetric and positive definite matrices; Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations; Complex vectors and matrices: complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.

#### **20.113.6. Course Objectives**

- To solve systems of linear equations by different methods and demonstrate ability to compute eigenvalues, eigenvectors and factorize a matrix into the products of matrices.
- To learn linear transformations from to , vector space, subspace, rank and nullity, inner products, their uses and apply to some relevant problems.
- To comprehend the Euclidean n-space, vector spaces, subspaces, linear span, and determine the basis and dimension of vector spaces.

#### **20.113.7. Knowledge required**

Familiarity with basic properties of matrix and determinants, fundamental concepts of set theory, real and complex number system, and preliminary knowledge of geometry and precalculus.

#### **20.113.8. Course Outcomes**

CO No.	CO Statement After undergoing this course, students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	Understand the fundamental concepts and methods of Matrix Algebra to solve linear and non-linear system of equations.	-	C2	Lectures, Homework	Written exams; assignment
CO 2	Apply the idea of rank and nullity, eigen values and eigen vector space and matrix factorization in real- life situations.	-	C3	Lectures, Homework	Written exams; assignment
CO 3	Explain vector space, subspace, linear transformations (Kernel and Range), inner product space, their uses and apply to some relevant problems.	-	C2	Lectures, Homework	Written exams; assignment

**20.113.9.** Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√	√							√						√				
CO 2		√	√		√					√									√	
CO 3		√	√							√									√	

### 20.113.10. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment on any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

### 20.113.11. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

### 20.113.12. Textbooks

- Elementary Linear Algebra: Applications Version by Howard Anton and Chris Rorres.
- Introduction of linear Algebra by Gilbert Strang.

### 20.113.13. Reference Books

- Theory and Problems of Linear Algebra (Schaum's Outline Series) by Seymour Lipschutz.
- Advanced Engineering Mathematics, Erwin Kreyszig, Herbert Kreyszig and Edward J. Norminton.
- Matrices and Linear Transformation by Mohammad Iman Ali.

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

### 20.113.14. Lecture Plan

Weekly Schedule: For Linear Algebra

Weekly plan for course content and mapping with COs		
Weeks	Topics	COs
Week-1 to 2	Introduction to vectors, their products, matrices and systems of linear equations.	CO1
Week-3 to 5	Solving linear equations: Gaussian elimination, inverse and transpose of a matrix, factorization into $A = LU$	CO1, CO2
Week- 6 to 7	Vector spaces and subspaces: four fundamental subspaces, solving $Ax = 0$ and $Ax = b$ .	CO3
Week-8	Class Test	
Week-9 to 10	Orthogonality: orthogonality of the four subspaces, projections, least squares, orthonormal bases and Gram-Schmidt.	CO2, CO3
Week-11 to 12	Singular value decomposition (SVD): bases and matrices in the SVD, geometry of the SVD; Linear transformations: the matrices of linear transformations	CO3
Week-13	Complex numbers, polar coordinates, Hermitian and unitary matrices; Applications of linear algebra in computer science and engineering.	CO2
Week-14	Class Test	

## 20.114 Description of Course MATH 241

### PART A: General Information

<b>20.113.1.</b> Course Number	MATH 241
Course Title	Advanced Calculus
Credit (Contact) Hours	3.0 (3.0)
<b>20.113.2.</b> Level and Term (Section)	Level-2, Term-1
Academic Session	July 2022
<b>20.113.3.</b> Type of Course	Core Course
Offered to	Department of Computer Science and Engineering
<b>20.113.4.</b> Pre-requisite Course(s)	None

### PART B: Course Details

#### 20.113.5. Course Content (As approved by the Academic Council)

Vector Calculus: Vector and scalar fields; Differentiation and integration of vectors; Gradient of a scalar field: directional derivative; Divergence and curl of a vector field; Vector calculus identities: Jacobian, Hessian, Laplacian; Line integrals.

Complex Calculus: Functions of a complex variable; Limits and continuity of functions of complex variables; Complex differentiation: analytic functions, Cauchy-Riemann equations; Elementary complex functions; Line integral of a complex function.

Partial Differential Equations (PDE): Introduction and formation of PDE; Solution of linear and non-linear PDE of order one; Second order linear PDE: classifications to standard forms; Parabolic, elliptic, hyperbolic; Solution of second order linear PDE by separation of variables.

#### 20.113.6. Course Objectives

- To establish sufficient knowledge to deal with different complex and vector function for solving engineering problems.
  - To apply fundamental concept of complex analysis.
- To explain the basic concept of differential equations and their solutions along with their physical significance.

#### 20.113.7. Knowledge required

Fundamental concepts of differential calculus, integral calculus and geometry.

**20.113.8. Course Outcomes**

CO No.	CO Statement After undergoing this course, students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1	Describe complex number system function of complex variable, vector algebra and vector valued function.	-	C2	Lectures, Homework	Written exams; assignment
CO 2	Explain different operations with complex variables, differentiation and integration of complex and vector function.	-	C2	Lectures, Homework	Written exams; assignment
CO 3	Apply the concepts of differentiation and integration of complex and vector function for solving different type of problems.	PO1	C3	Lectures, Homework	Written exams; assignment

**20.113.9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

COs	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√														√				
CO 2		√																	√	√
CO 3		√	√						√	√					√				√	√

**20.114.14. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment on any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.

- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

#### 20.114.15 Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

#### 20.114.16. Textbooks

- Advanced Engineering Mathematics by Erwin Kreyszig
- Schaum's Outline of Theory and Problems of Vector Analysis by Murray R. Spiegel
- Complex Variables and Application by Ruel V. Churchill/James Ward Brown.
- Schaum's Outline of Theory and Problems of Complex Variables by Murray R. Spiegel.
- Calculus: Early Transcendentals by Howard Anton, Irl Bivens and Stephen Davis.

#### 20.114.17. Reference Books

- Vector Analysis with Applications by Md. Ali Ashraf and Md. Abdul Khaleq Hazra.
- Complex Variables: Harmonic and Analytic Functions by Francis J. Flangian.
- Function of Complex Variable by M.L. Khanna.
- Introduction to Partial Differential Equations and Boundary Value Problems by Rene Denemeyer.

#### 20.114.18. Lecture Plan

Weekly schedule: For Vector Calculus

Week	Topics	COs
Week-1	Differentiation and integration of vectors.	CO1
Week-2	Solving problems related to Differentiation and integration of vectors functions.	CO2
Week-3	Gradient of scalar functions. Divergence and curl of vector functions.	CO3
Week-4	Physical significance of gradient, divergence and curl.	CO2
Week-5	Integral forms of gradient, divergence and curl.	CO3
Week-6	Line integrals.	CO2
Week-7	Solving problems related to Line integrals.	CO3
Week-8	Class Test 1	
Week-9	Green's theorem and Solving problems related to this theorem.	CO3
Week-10	Surface and volume integrals.	CO3
Week-11	Gauss's theorem and Solving problems related to this theorem.	CO3
Week-12	Stokes theorem.	CO3
Week-13	Stokes theorem and solving problems related to this theorem.	CO3
Week-14	Class Test 2	

Weekly schedule: For Complex Calculus

Week	Topics	COs
Week-1	Complex number system.	CO1
Week-2	General functions of complex variables.	CO2
Week-3	Limits and continuity of functions of complex variables and related theorems.	CO2
Week-4	Class Test 1 Complex differentiation and the Cauchy-Riemann equations.	CO2
Week-5	Infinite series and their convergence.	CO2
Week-6	Line integral of complex functions.	CO3
Week-7	Cauchy's integral formula.	CO2
Week-8	Class Test 2	
Week-9	Liouville's theorem, Taylor's and Laurent's theorem.	CO3
Week-10	Singular points.	CO1
Week-11	Residues and Cauchy's residue theorem.	CO3
Week-12	Review class.	
Week-13	Review class.	
Week-14	Class Test	

Weekly schedule: For Partial Differential Equations

Week	Topics	COs
Week-1	Introduction to partial differential equations.	CO2
Week-2	Introduction to partial differential equations.	CO2
Week-3	First order Linear partial differential equations.	CO2
Week-4	First order Linear partial differential equations.	CO3
Week-5	First order Non-linear partial differential equations.	CO3
Week-6	First order Non-linear partial differential equations.	CO3
Week-7	Class Test	
Week-8	Linear equations of higher order.	CO2
Week-9	Linear equations of higher order.	CO3
Week-10	Second order PDE with variable coefficient.	CO1
Week-11	Wave equations.	CO3
Week-12	Particular solutions with boundary and initial conditions.	CO3
Week-13	Particular solutions with boundary and initial conditions.	CO3
Week-14	Class Test	

## 20.115 Description of Course MATH 243

### PART A: General Information

20.115.1. Course Number	MATH 243
Course Title	Probability and Statistics
Credit (Contact) Hours	3.0 (3.0)
20.115.2. Level and Term (Section)	Level-2, Term-2
Academic Session	July 2022
20.115.3. Type of Course	Core Course
Offered to	Department of Computer Science and Engineering
20.115.4. Pre-requisite Course(s)	None

### PART B: Course Details

#### 20.115.5. Course Content (As approved by the Academic Council)

Introduction to Statistics: variability in data, populations and samples, descriptive statistics, inferential statistics and probability, sampling procedures; Measures of location: mean, median; Measures of variability: standard deviation, variance; Higher moments: skewness, kurtosis; Graphical representation of data: scatter plot, stem and leaf plot, histogram, box plot; Probability: sample space and events, rules of probability, conditional probability, independence, Bayes' rule; Random variables: discrete and continuous probability distributions, joint probability distributions, marginal distributions and independence; Expectations, variance and covariance of random variables and their properties, Chebyshev's theorem; Discrete probability distributions: Bernoulli, binomial, multinomial, Poisson distributions and their properties; Continuous probability distributions: uniform, Gaussian (normal), chi-square distributions and their properties; Sampling distributions: sample mean, central limit theorem, sample variance, t-distribution, F-distribution, quantile and probability plots; Statistical inference: parameter estimation, confidence intervals; Hypothesis testing: null and alternative hypotheses, test statistic, P-values and significance levels, Z-test, t-test, goodness-of-fit test; Regression and correlation: least squares, coefficient of determination, correlation coefficient; Analysis of variance (ANOVA).

#### 20.115.6. Course Objectives:

To understand fundamental concepts in probability and statistics.

- To apply rules and algorithm of probability and statistics in various logical problems.
- To enable students maneuver mathematical probabilistic models for different problems, to analyze them and to interpret the results.

#### 20.115.7. Knowledge required

Familiarity with basic properties of set, real number system and function, fundamental concepts of pre-calculus, and preliminary knowledge to solve algebraic equations.

**20.115.8. Course Outcomes**

CO No.	CO Statement After undergoing this course, students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
1	Demonstrate the idea of frequency distribution, mean, median, mode, and other measures of central tendency.	-	C3	Lectures, Homework	Written exams; assignment
2	Understand the preliminary concept of standard deviation, moments, skewness, kurtosis, and other measures of dispersion for statistical data.	-	C2	Lectures, Homework	Written exams; assignment
3	Apply the probability theory including discrete probability distribution and continuous probability distributions in real-life problem.	PO1	C3	Lectures, Homework	Written exams; assignment
4	Explain the basic idea of sampling theory including estimation, hypothesis testing, regression analysis, and correlation coefficients.	-	C2	Lectures, Homework	Written exams; assignment voce; presentation; assignment

**20.115.9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

C Os	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
CO 1		√														√				
CO 2		√	√							√	√				√				√	√
CO 3		√	√						√	√					√				√	√
CO 4		√	√													√			√	√

**20.115.10. Assessment Strategy**

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

**20.115.11. Distribution of Marks**

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

**20.115.13. Textbooks**

- Probability and Statistics for Engineers and Scientists by Walpole, Myers, and Ye, Pearson Education, Inc.
- Elements of Probability and Statistics by Frank L. Wolf.

**20.115.14. Reference Books**

- Probability and Statistics with Applications by Y. Leon Maksoudian.
- Probability and Statistics for Engineers by Erwin Miller and John E. Freund.

N. B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**20.115.15. Lecture Plan**

Weekly schedule: For Probability and Statistics

Week	Topics	COs
Week-1	Course introduction, Concepts of statistics and probability, sample space, population, Experiments, Events, Sure, Impossible, Complementary, and mutually exclusive events, Frequency distribution.	CO3
Week-2	Treatment of Grouped sample data, Descriptive Statistics, Measures of central tendency.	CO2
Week-3	Computing AM, GM, HM, median and mode for group and ungrouped data, Measures of Dispersion and related topics including CV.	CO1
Week-4	Shape characteristics, moments, skewness and kurtosis, regression analysis and correlation coefficients.	CO4
Week-5	Probability theory, Conditional probability, partitions, total probability, Bayes' theorem.	CO3
Week-6	Random Variables and related probability distribution, Discrete random variables, Mathematical expectation, variance, standard deviation; binomial distribution, use of statistical tables.	CO4
Week-7	Poisson distribution, Multinomial distribution, Continuous random variables, probability density function, cumulative distribution function, expected values.	CO3
Week-8	Class Test	
Week-9	Normal distribution, the normal approximation to binomial.	CO1

Week	Topics	COs
Week-10	Functions of random variables, expected value, variance, standard deviation, Two dimensional random vectors.	CO2
Week-11	Joint-distribution functions, Marginal distributions, Conditional distributions.	CO3
Week-12	Covariance, correlation, conditional expectation, central limit theorem.	CO4
Week-13	Special mathematical expectations, properties of variances, Sampling theory, sampling distribution, sampling with and without replacement, hypothesis testing	CO3
Week-14	Class Test	

Weekly plan for course content and mapping with Cos		
Weeks	Topics	COs
Week-1 to 2	Limits, Continuity, and differentiability.	CO1
Week-3 to 4	Successive differentiation of various types of functions.	CO4
Week-5 to 8	Leibnitz's theorem. Rolle's theorem. Mean value theorem. Taylor's and Maclaurin's theorems in finite and infinite forms. Lagrange's form of remainders. Cauchy's form of remainders.	CO3
Week -9 to 10	Expansion of functions. Evaluation of indeterminate forms by L'Hospitals rule. Partial differentiation. Euler's theorem.	CO2
Week-11 to 12	Tangent and Normal. Subtangent and subnormal in Cartesian and polar co-ordinates.	CO2
Week-13 to 14	Determination of Maximum and minimum values of functions with applications.	CO4

## 20.116 Description of Course MATH 441

### PART A: General Information

<b>20.116.1. Course Number</b>	MATH 441
<b>Course Title</b>	Mathematical Optimization
<b>Credit (Contact) Hours</b>	3.0 (3.0)
<b>20.116.2. Level and Term (Section)</b>	Level-4, Term-1
<b>Academic Session</b>	July 2022
<b>20.116.3. Type of Course</b>	Optional Course
<b>Offered to</b>	Department of Computer Science and Engineering
<b>20.116.4. Pre-requisite Course(s)</b>	None

**PART B: Course Details**

**20.116.5. Course Content (As approved by the Academic Council)**

Introduction; Classical methods with single and multi-variables; Basics of mathematical programming; Linear programming; Graphical method with mathematical definitions and theorems; Nonlinear programming: one dimensional problems by elimination and interpolation methods; Unconstrained and constrained techniques; Geometrical programming, stochastic programming; Calculus of variations; Optimality and relaxation, Lagrangian relaxation; Convexity and subgradient Optimization; Subgradient optimization for the Lagrangian dual.

**20.116. 6. Course Objectives**

To learn the fundamental concepts and methods of mathematical, linear and nonlinear programming.

- To grasp and apply the idea of optimization.
- To solve constrained and unconstrained problems for optimization as well as relaxation.

**20.116.11. Knowledge required**

Familiarity with basic linear algebra, vector calculus and ordinary differential equations.

**20.116.7. Course Outcomes**

CO No.	CO Statement After undergoing this course, students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Understand</b> the fundamental concepts and methods of mathematical, linear and nonlinear programming.	-	C2	Lectures, Homework	Written exams; assignment
CO 2	<b>Apply</b> the idea of optimization formula	PO1	C3	Lectures, Homework	Written exams; assignment
CO3	<b>Analyse</b> constrained and unconstrained problems for optimization as well as relaxation	PO2	C4	Lectures, Homework	Written exams; assignment

**20.116.8. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities**

C Os	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
C O1		√	√						√			√			√	√				
C O2		√	√			√			√		√				√				√	√

C Os	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
C O3		√	√						√		√				√				√	√

### 20.116.9. Assessment Strategy

- **Class Participation:** Class participation and attendance will be recorded in every class.
- **Continuous Assessment:** Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- **Final Examination:** A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

### 20.116.10. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

### 20.116.11. Textbooks

- Introduction to Operations Research (Tenth Edition), By Frederick S. Hillier and Gerald J. Lieberman.
- Practical Mathematical Optimization: Basic Optimization Theory and Gradient-Based Algorithms, Volume 133 of Springer Optimization and Its Applications by Jan A Snyman, Daniel N Wilke.

### 20.116.12. Reference Books

- Mathematical Optimization in Computer Graphics and Vision by Luiz Velho, Paulo Carvalho, Jonas Gomes, Luiz de Figueiredo.

**N.B.** Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

### 20.116.13. Lecture Plan

#### Weekly Schedule: For Mathematical Optimization

Week	Topics	COs
Week-1	Introduction; Classical methods with single and multi variables.	CO1
Week-2	Basics of mathematical programming; Linear programming.	CO1
Week-3	<b>Class Test</b> , Basics of mathematical programming; Linear programming.	CO1
Week-4	Graphical method with mathematical definitions and theorems.	CO2
Week-5	Nonlinear programming: one dimensional problems by elimination and interpolation methods.	CO1

Week	Topics	COs
Week-6	<b>Class Test</b> , Nonlinear programming: one dimensional problems by elimination and interpolation methods.	CO1
Week-7	Unconstrained and constrained techniques.	CO3
Week-8	Geometrical programming, stochastic programming.	CO2
Week-9	<b>Class Test</b>	
Week-10	Calculus of variations.	CO3
Week-11	Optimality and relaxation, Lagrangian relaxation.	CO2
Week-12	Convexity and subgradient Optimization.	CO3
Week-13	Subgradient optimization for the Lagrangian dual.	CO3
Week-14	<b>Class Test</b>	

## 20.117 Description of Course MATH 443

### PART A: General Information

<b>20.117.1. Course Number</b>	MATH 443
<b>Course Title</b>	Game Theory
<b>Credit (Contact) Hours</b>	3.0 (3.0)
<b>20.117.2. Level and Term (Section)</b>	Level-4, Term-1
<b>Academic Session</b>	July 2022
<b>20.117.3. Type of Course</b>	Optional Course
<b>Offered to</b>	Department of Computer Science and Engineering
<b>20.117.4. Pre-requisite Course(s)</b>	None

### PART B: Course Details

#### 20.117.5. Course Content (As approved by the Academic Council)

Introduction to game theory and its applications; Solution concepts: dominant strategies, pure and mixed strategies, Nash equilibrium; Zero sum games: two-player zero-sum games, existence of Nash equilibria, computation by linear programming, multiplayer zero-sum games; Learning in games: existence fictitious play, multiplicative weights updates; Price of anarchy: congestion games, potential games, of equilibria; Market equilibria: Arrow-Debreu existence theorem; Mechanism design: Vickrey auction, social choice theory, Arrow's impossibility theorem, Vickrey-Clarke-Groves (VCG) mechanism, application of the VCG mechanism in routing, Myerson auction; Evolutionary game theory.

#### 20.117.6. Course Objectives

- To learn different strategies of Nash equilibrium in strategic games

- To apply appropriate solution concepts of games
- To design and analyse game theoretic solutions to solve real-world problems

### 20.117.7. Knowledge required

Familiarity with Calculus, Linear Algebra and Probability

### 20.117.8. Course Outcomes

CO No.	CO Statement After undergoing this course, students should be able to	Corresponding PO(s)*	Domains and Taxonomy level(s)	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO 1	<b>Understand</b> and <b>analyse</b> different strategies of Nash equilibrium in strategic games	PO2	C4	Lectures, Homework	Written exams; assignment
CO 2	<b>Apply</b> different solution concepts of games	PO1	C3	Lectures, Homework	Written exams; assignment
CO 3	<b>Design</b> and <b>analyse</b> game theoretic solutions to solve real-world problems	PO2 and PO3	C6	Lectures, Homework	Written exams; assignment

### 20.117.9. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

C Os	K 1	K 2	K 3	K 4	K 5	K 6	K 7	K 8	P 1	P 2	P 3	P 4	P 5	P 6	P 7	A 1	A 2	A 3	A 4	A 5
C O1		√	√						√	√					√	√			√	√
C O2		√	√		√				√	√	√				√	√			√	√
C O3		√	√		√				√	√					√	√			√	√

### 20.117.10. Assessment Strategy

- **Class Participation:** Class participation and attendance will be recorded in every class.
- **Continuous Assessment:** Continuous assessment for any of the activities such as quizzes, assignment, presentation etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- **Final Examination:** A comprehensive term final examination will be held at the end of the term following the guideline of academic council.

### 20.117.11. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

**20.117.12. Textbooks**

- Game Theory: A Multi-Levelled Approach by Hans Peters,
- Game Theory with Engineering Applications, SIAM Series: Advances in Design and Control 2016 by Bauso, Dario,
- Evolutionary dynamics-exploring the equation of life, Harvard University Press, 2006 by Martin A. Nowak.

**20.117.13. Reference Books**

- Game Theory by Michael Maschler, Eilon Solan, and Shmuel Zamir
- Algorithmic Game Theory, Cambridge University, 2007 by Nisan, Roughgarden, Tardos/Vazirani (eds)

N.B. Besides going through relevant topics of the textbook, it is strongly advised that the students follow the class lectures and discussions regularly for a thorough understanding of the topics.

**20.117.14. Lecture Plan**

Weekly Schedule:

<b>Week</b>	<b>Topics</b>	<b>COs</b>
Week-1	Introduction to game theory and its applications;	CO1
Week-2	Solution concepts: dominant strategies, pure and mixed strategies, Nash equilibrium;	CO1
Week-3	Solution concepts: dominant strategies, pure and mixed strategies, Nash equilibrium;	CO1
Week-4	Zero sum games: two-player zero-sum games, existence of Nash equilibria, computation by linear programming, multiplayer zero-sum games;	CO1
	<b>Class Tests</b>	
Week-5	Zero sum games: two-player zero-sum games, existence of Nash equilibria, computation by linear programming,	CO1
Week-6	Multiplayer zero-sum games;	CO2
Week-7	Learning in games: existence fictitious play, multiplicative weights updates;	CO2
Week-8	Price of anarchy: congestion games, potential games, of equilibria;	CO2
	<b>Class Tests</b>	
Week-9	Market equilibria: Arrow-Debreu existence theorem;	CO2
Week-10	Mechanism design: Vickrey auction, social choice theory,	CO3
Week-11	Arrow's impossibility theorem, Vickrey-Clarke-Groves (VCG) mechanism, application of the VCG mechanism in routing, Myerson auction;	CO3
	<b>Class Tests</b>	
Week-12	Evolutionary game theory.	CO3
Week-13	Evolutionary game theory.	CO3

Week	Topics	COs
Week-14	Class Tests	

## 20.118 Description of Course ME 165

### PART A: General Information

20.118.1.	Course Number	ME 165
	Course Title	BASIC MECHANICAL ENGINEERING
	Credit (Contact) Hours	3.0 (3.0) hours
20.118.2.	Level and Term (Section)	L-1, T-1 (A, B)
	Academic Term	July 2021 (L1/T1)
20.118.3.	Type of Course	Non-departmental
	Offered to	Department of Computer Science and Engineering
20.118.4.	Pre-requisite Course(s)	N.A.

### PART B: Course Details

#### 20.118.5. Course Content (As approved by the Academic Council)

Sources of Energy: Conventional and Renewable, Introduction to IC Engines, Refrigeration Air-conditioning Systems. Statics of particles and rigid bodies; Forces in trusses and frames; Relative motion, Kinematics of particles-Newton's Second Law of motion Kinematics of rigid bodies. Introduction to robotics; Plane, Rotational and Spatial motion with applications to manipulators, Geometric configurations: structural elements, linkages, arms and grippers; Motion characteristics.

#### 20.118.6. Course Objectives

- Know about various energy sources, harnessing method and merits of one of them over the other.
- Classify internal combustion engines, refrigeration and air-conditioning.
- Explain robotics, electromechanical systems and relevant cutting-edge branches.
- Interpret real-world applications of mechanics.

#### 20.118.7. Knowledge required

#### 20.118.8. Course Outcomes

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**
1	<b>Understand</b> the basics of using mechanical engineering knowledge in practical fields.	<b>PO(1)</b>	<b>C1</b>
2	<b>Recognize</b> various mechanical systems and processes like refrigeration and internal combustion engines	<b>PO(1)</b>	<b>C1</b>
3	<b>Develop</b> the ability to create electromechanical systems that solves problems		<b>C4</b>

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**
4	<b>Apply</b> the concepts mechanics to solve real world problems		<b>C3</b>
5	<b>Describe</b> various energy sources and their utilization.	<b>PO(1)</b>	<b>C2</b>

#### 20.118.9. Lecture Plan

Lecture	Lecture Topics	References	Corresponding CO(s)
1-3	Statics of particles	Ref. [1], Ref. [2]	CO1, CO4
4-8	Statics of rigid bodies	Ref. [1], Ref. [2]	CO1, CO4
9-12	Forces in trusses and frames	Ref. [1], Ref. [2]	CO1, CO4
12-14	Kinematics of particles	Ref. [1], Ref. [2]	CO1, CO4
15-18	Kinematics of rigid bodies	Ref. [1], Ref. [2]	CO1, CO4
19-21	Sources of Energy	Lecture notes	CO1, CO5
22-26	Refrigeration and Air-Conditioning systems	Ref. [3], Ref. [4]	CO1, CO2
27-32	IC Engines	Ref. [5]	CO1, CO2
33-36	Robotics	Ref. [6], Lecture notes	CO1, CO3

#### 20.118.10. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Examination: A comprehensive term final examination will be held at the end of the Term following the guideline of academic Council.

#### 20.118.11. Distribution of Marks

Class Participation	10%
Continuous Assessment	20%
Final Examination	70%
Total	100%

**20.118.12. Textbook**

1. Vector Mechanics for Engineers (Statics & Dynamics) - Ferdinand P. Beer and E. Russell Johnston
2. Engineering Mechanics (Statics & Dynamics) - R. C. Hibbeler
3. Thermodynamics: An Engineering Approach -Yunus A. Cengel, Michael A. Boles
4. Refrigeration and air-conditioning – Wilbert F. Stoecker, Jerold W. Jones
5. Internal Combustion Engines - J. Wiley & Sons
6. Introduction to Robotics: Analysis, System and Application – Saeed B. Niku, Ferguson & Kirkpatrick

**20.119 Description of Course ME 174****PART A: General Information**

<b>20.119.1.</b> Course Number	ME 174
Course Title	Mechanical Engineering Drawing and CAD
Credit (Contact) Hours	1.50 (3.00 hr/week) hours
<b>20.119.2.</b> Level and Term (Section)	L1 T2
<b>20.119.3.</b> Type of Course	Sessional
Offered to	Department of Computer Science and Engineering
<b>20.119.4.</b> Pre-requisite Course(s)	-

**PART B: Course Details****20.119.9.** Course Content (As approved by the Academic Council)

Introduction; Instruments and their uses; Third angle projection; Orthographic drawing; Isometric views; Sectional views; Introduction to computer graphic software: Computer aided drawing (CAD).

**20.119.10.** Course Objectives

After attending lecture and studying the assigned materials, the student will:

- Classify types of projection and perspectives.
- Identify norms and practices of mechanical engineering drawing.
- Interpret different types of lines and their uses in engineering drawings.
- Explain sectional view and its conventional practices.
- Use Computer Aided Design (CAD) software (AutoCAD)

**20.119.11.** Knowledge required -

<b>20.119.12. Course Outcomes</b>					
<b>CO No.</b>	<b>CO Statement</b>	<b>Corresponding PO(s)*</b>	<b>Domains and Taxonomy level(s)**</b>	<b>Delivery Methods</b>	<b>Assessment Tools</b>
1	<b>Describe</b> standards, norms, practices, and techniques of engineering drawing	PO(1)	C1	Lectures, Tutorial	Class Performance, Assignment, Quiz
2	<b>Learn</b> to draw different types of lines, angles, and shapes to construct geometric figures using various drawing tools and construction techniques	PO(1)	C3	Lectures, Tutorial	Class Performance, Assignment, Quiz
3	<b>Understand</b> the principle of projection and sectioning	PO(1)	C4	Lectures, Tutorial	Class Performance, Assignment, Quiz

CO No.	CO Statement	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Methods	Assessment Tools
4	Employ AutoCAD to draw engineering figures	PO(1)	P1	Lectures, Tutorial	Class Performance, Assignment, Quiz

#### 20.11813. Lecture Plan

Lectures	Topics	Reference	COs
1	Introduction: Basic drawing concepts and practice	TB-1,2, Ref. [i],[ii]	CO1
2	Orthogonal views of simple block with holes	TB-1,2, Ref. [i],[ii]	CO1, CO2
3	Orthogonal views with rounds and fillets	TB-1,2, Ref. [i],[ii]	CO1, CO2
4	Sectional views with conventional practices	TB-1,2, Ref. [i],[ii]	CO3
5	Viva, Isometric views	TB-1,2, Ref. [i],[ii]	CO2, CO3
6	Isometric views with holes	TB-1,2, Ref. [i],[ii]	CO1, CO2
7	Midterm quiz		
8	Introduction to AutoCAD	TB-1,2, Ref. [i],[ii]	CO1
9	Orthographic views in AutoCAD	TB-1,2, Ref. [i],[ii]	CO1, CO2
10	Sectional and Auxiliary views in AutoCAD	TB-1,2, Ref. [i],[ii]	CO1, CO2
11	Final quiz		

#### 20.119.14. Assessment Strategy

- Class Participation: Class participation and attendance will be recorded in every class.
- Continuous Assessment: Continuous assessment any of the activities such as quizzes, assignment, presentation, etc. The scheme of the continuous assessment for the course will be declared on the first day of classes.
- Final Quiz: A comprehensive quiz based on the classes will be held at the end of the session.

#### 20.119.15. Distribution of Marks

Class Participation	10%
Continuous Assessment	50%
Final Examination	40%
Total	100%

#### 20.119.16. Textbook

1. Mechanical Engineering Drawing, Dr. Amallesh Chandra Mandal, Dr. Md. Quamrul Islam, ISBN:984-8725-00-8

2. Class lecture materials are also prepared from a variety of sources on the internet, which will be provided during the semester.

References

- (i) Reference 1Jay D. Hesel, (2008). Mechanical Drawing: Board & CAD Techniques.5th Edition. Glencoe/McGraw-Hill. ISBN: 9780078251023
- (ii) Kyles, S. R. (2009). AutoCAD Workbook for Architects and Engineers. Chichester: John Wiley & Sons. 15th Edition. ISBN: 9781444309447

**21. Coverage of all POs through a set of selected courses**

Courses	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CSE 314	√	√	√	√	√	√	√					
CSE 316	√	√	√	√	√	√						
CSE 322	√	√	√		√			√	√		√	
CSE 330	√		√	√	√	√	√	√	√			√
CSE 406	√	√	√	√	√	√	√	√				
CSE 450	√	√	√	√	√	√	√	√	√	√	√	√
CSE 400	√	√	√	√	√	√	√	√	√	√		√

## **Annex A: Definition of terms**

### **Definition**

**Outcome-based education (OBE):** An educational theory that bases each part of an educational system on goals (outcomes).

**Program Educational Objective (PEO):** Broad statements that describe the career and professional accomplishments that the program is preparing the graduates to achieve.

**Program Outcomes (POs):** The narrower statements that describe what students are expected to know and be able to do by the time of graduation.

### **List of abbreviations**

CSE: Computer Science and Engineering

COs: Course Outcomes

EEE: Electrical and Electronic Engineering

ME: Mechanical Engineering

## **Annex B: List of program outcomes**

PO-1: **Engineering knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and computer science and engineering to the solution of complex engineering problems.

PO-2: **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems as well as analyze computational requirements or needs of information systems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO-3: **Design/development of solutions:** Design solutions for complex engineering problems and design computing systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO-4: **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, synthesis of information, and interpret results of computational modules appropriate to computer science and engineering and information technology to provide valid conclusions.

PO-5: **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex computer science and engineering problems, with an understanding of the limitations.

PO-6: **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.

PO-7: **Environment and sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.

PO-8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO-9: **Individual work and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

PO-10: **Communication:** Communicate effectively on complex computer science and engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11: **Project management and finance:** Demonstrate knowledge and understanding of engineering and IT project management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO-12: **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **Annex C: Domains and Taxonomy Levels**

### Domains

#### C-Cognitive:

C1: Knowledge;

C2: Comprehension;

C3: Application;

C4: Analysis;

C5: Synthesis;

C6: Evaluation

#### A-Affective:

A1: Receiving;

A2: Responding;

A3: Valuing;

A4: Organizing;

A5: Characterizing

#### P-Psychomotor:

P1: Perception;

P2: Set;

P3: Guided Response;

P4: Mechanism;

P5: Complex Overt Response;

P6: Adaptation;

P7: Organization

#### K-Knowledge Profile:

K1: A systematic, theory-based understanding of the natural sciences applicable to the discipline;

K2: Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline;

K3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline;

K4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline;

K5: Knowledge that supports engineering design in a practice area;

K6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline;

K7: Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability;

K8: Engagement with selected knowledge in the research literature of the discipline

P-Range of Complex Engineering Problem Solving:

P1: Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach;

P2: Involve wide-ranging or conflicting technical, engineering and other issues;

P3: Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models;

P4: Involve infrequently encountered issues;

P5: Are outside problems encompassed by standards and codes of practice for professional engineering;

P6: Involve diverse groups of stakeholders with widely varying needs;

P7: Are high level problems including many component parts or sub-problems

A-Range of Complex Engineering Activities:

A1: Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies);

A2: Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues;

A3: Involve creative use of engineering principles and research-based knowledge in novel ways;

A4: Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation;

A5: Can extend beyond previous experiences by applying principles-based approaches

## Annex D: Format of the Course Outline



Department of Computer Science and Engineering, BUET



Description of Course CSE nnn

### PART A: General Information

- 1 Course Title :
- 2 Type of Course :
- 3 Offered to :
- 4 Pre-requisite Course(s) :

### PART B: Course Details

1. Course Content (As approved by the Academic Council)

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2. Course Objectives

The students are expected to:

- (I)
- (II)
- (III)

3. Knowledge required.

- Technical

-

- Analytical

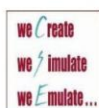
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COURSE OUTLINE

Page 1 of 5

Course No: CSE 423, Level 4/ Term 1, Credit (Contact) Hours: 3 Credits (3hrs/wk)



4. Course Outcomes (COs)

CO No.	CO Statement After undergoing this course, students should be able to:	Corresponding PO(s)*	Domains and Taxonomy level(s)**	Delivery Method(s) and Activity(-ies)	Assessment Tool(s)
CO1					
CO2					
CO3					

\*Program Outcomes (POs)

PO1: Engineering knowledge; PO2: Problem analysis; PO3: Design/development of solutions; PO4: Investigation; PO5: Modern tool usage; PO6: The engineer and society; PO7: Environment and sustainability; PO8: Ethics; PO9: Individual work and teamwork; PO10: Communication; PO11: Project management and finance; PO12: Life-long learning.

\*\*Domains

C-Cognitive: C1: Knowledge; C2: Comprehension; C3: Application; C4: Analysis; C5: Synthesis; C6: Evaluation

A-Affective: A1: Receiving; A2: Responding; A3: Valuing; A4: Organizing; A5: Characterizing

P-Psychomotor: P1: Perception; P2: Set; P3: Guided Response; P4: Mechanism; P5: Complex Overt Response; P6: Adaptation; P7: Organization

5. Mapping of Knowledge Profile, Complex Engineering Problem Solving and Complex Engineering Activities

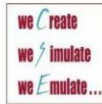
COs	K1	K2	K3	K4	K5	K6	K7	K8	P1	P2	P3	P4	P5	P6	P7	A1	A2	A3	A4	A5
CO1																				
CO2																				
CO3																				

K-Knowledge Profile:

K1: A systematic, theory-based understanding of the natural sciences applicable to the discipline; K2: Conceptually based mathematics, numerical analysis, statistics and the formal aspects of computer and information science to support analysis and modeling applicable to the discipline; K3: A systematic, theory-

COURSE OUTLINE

Course No: CSE 423, Level 4/ Term 1, Credit (Contact) Hours: 3 Credits (3hrs/wk)



based formulation of engineering fundamentals required in the engineering discipline; **K4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline; **K5:** Knowledge that supports engineering design in a practice area; **K6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline; **K7:** Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the engineer's professional responsibility to public safety; the impacts of engineering activity; economic, social, cultural, environmental and sustainability; **K8:** Engagement with selected knowledge in the research literature of the discipline

**P-Range of Complex Engineering Problem Solving:**

**P1:** Cannot be resolved without in-depth engineering knowledge at the level of one or more of K3, K4, K5, K6 or K8 which allows a fundamentals-based, first principles analytical approach; **P2:** Involve wide-ranging or conflicting technical, engineering and other issues; **P3:** Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models; **P4:** Involve infrequently encountered issues; **P5:** Are outside problems encompassed by standards and codes of practice for professional engineering; **P6:** Involve diverse groups of stakeholders with widely varying needs; **P7:** Are high level problems including many component parts or sub-problems

**A-Range of Complex Engineering Activities:**

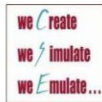
**A1:** Involve the use of diverse resources (and for this purpose resources include people, money, equipment, materials, information and technologies); **A2:** Require resolution of significant problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues; **A3:** Involve creative use of engineering principles and research-based knowledge in novel ways; **A4:** Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation; **A5:** Can extend beyond previous experiences by applying principles-based approaches

**6. Lecture/ Activity Plan**

Week	Lecture Topics	Corresponding CO(s)
Week 1		
Week 2		
Week 3		
Week 4		
Week 5		
Week 6		
Week 7		
Week 8		
Week 9		

**COURSE OUTLINE**

Course No: CSE 423, Level 4/ Term 1, Credit (Contact) Hours: 3 Credits (3hrs/wk)



Week	Lecture Topics	Corresponding CO(s)
Week 10		
Week 11		
Week 12		
Week 13		
Week 14		

**7. Assessment Strategy**

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**8. Distribution of Marks**

Attendance:  
Class Tests/Assignments/Projects:  
Final Exam:  
Total:

**9. Textbook/ Reference**

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**10. Student Code and Policies**

A student at BUET campus is a member of a University community of which all members have at least the rights and responsibilities common to all citizens, free from institutional censorship. Affiliation with the University as a student does not diminish the rights or responsibilities held by a student or any other community member as a citizen of larger communities of the state, the nation, and the world. All the students must adhere to the rights or responsibilities.

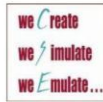
**11. Academic Integrity**

All students are expected to abide by the campus regulations on academic integrity. These standards will be enforced and infractions of these rules will not be tolerated in this course. Sharing, copying, or providing any part of a homework solution or code is an infraction of the University's

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rules on academic integrity. We will be actively looking for violations of this policy in homework and project submissions. Any violation will be punished as severely as possible with sanctions and penalties typically ranging from a failing grade on this assignment up to a failing grade in the course, including a letter of the offending infraction kept in the student's permanent university record. Again, a good rule of thumb: Keep every typed word and piece of code your own. If you think you are operating in a gray area, you probably are. If you would like clarification on specifics, please contact the course instructor(s).

**12. Disability Accommodations**

Students with learning, physical, or other disabilities requiring assistance should contact the instructor(s) as soon as possible. If you are unsure if this applies to you or think it may, please contact the instructor(s) as soon as possible.

**Course Teacher(s):**

Name:	Office/Room:	E-mail and Telephone:

<b>Prepared by:</b>