NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

CURRICULUM

OF

BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND ENGINEERING

2017 ONWARD UNDERGRADUATE ADMISSION BATCH

V0:

Resolution of 50th Senate	18-05-2018	Item no: 50.7
Resolution of 51st Senate	04-10-2018	Item no: 51.2
Resolution of UGAC meeting	10-05-2019	
Final approval in 53rd Senate	13-05-2019	Item no: 52.3
Publication date	30-05-2019	

V1:

Incorporation of new elective subjects	27-06-2019

V2:

Rectification of minor errors	UGAC 31-08-2022

Final Approval in 67th Senate dated 20/09/2022 vide Item no: # 67.3

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Program Name: Bachelor of Technology in Computer Science & Engineering

DETAILED CURRICULUM

CURRICULUM OF 2021 ONWARD UNDERGRADUATE ADMISSION BATCH FOR COMPUTER SCIENCE & ENGINEERING- B.TECH.

L= Lecture hour/ week; T= Tutorial hour/ week; S= Sessional/ practical hour/ week

C= Subject credit point; H= Subject contact hour/ week.

Semester - I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31
Semester - II							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

Semester - III							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC331	Mathematics - III	3	1	0	4	4
2	CSC301	Discrete Mathematics	3	0	0	3	3
3	CSC302	Digital Logic Design	3	0	0	3	3
4	CSC303	Data Structures and Algorithms	3	1	0	4	4
5	PHC331	Physics of Semiconductor Devices	3	0	0	3	3
6	PHS381	Semiconductor Devices Laboratory	0	0	3	1.5	3
7	CSS351	Digital Logic Design Laboratory	0	0	3	1.5	3
8	CSS352	Data Structures and Algorithms Laboratory	0	0	4	2	4
9	XXS381	Co-curricular Activities - III (Optional)	0	0	0	0	0
		TOTAL	15	2	10	22	27
Semester - IV							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CSC401	Computer Organization and Architecture	3	1	0	4	4
2	CSC402	Theory of Computation	3	0	0	3	3
3	CSC403	Design and Analysis of Algorithms	3	1	0	4	4
4	CSC404	Object Oriented Programming	2	1	0	3	3
5	CSC405	Signals and Systems	3	0	0	3	3
6	YYO44*	Open Elective - 1	3	0	0	3	3
7	CSS451	Computer Organization Laboratory	0	0	3	1.5	3
8	CSS452	Object Oriented Programming Laboratory	0	0	3	1.5	3
9	CSS453	Signal Processing Laboratory	0	0	3	1.5	3
	XXS481	Co-curricular Activities - IV (Optional)	0	0	0	0	0
		TOTAL	17	3	9	24.5	29
Semester - V							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CSC501	Operating Systems	3	0	0	3	3
2	CSC502	Database Management System	3	1	0	4	4
3	CSC503	Compiler Design	3	0	0	3	3
4	CSC504	Embedded Systems	3	0	0	3	3
5	YYO54*	Open Elective - 2	3	0	0	3	3
6	CSS551	Design and Analysis of Algorithms Laboratory	0	0	3	1.5	3
7	CSS552	Embedded Systems Laboratory	0	0	3	1.5	3
8	CSS553	Operating Systems Laboratory	0	0	3	1.5	3
9	XXS581	Co-curricular Activities - V (Optional)	0	0	0	0	0
		TOTAL	15	1	9	20.5	25

Semester - VI							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	HSC631	Economics and Management Accountancy	3	0	0	3	3
2	CSC601	Software Engineering	3	0	0	3	3
3	CSC602	Data Communication and Computer Networks	3	1	0	4	4
4	CSE610 --	Depth Elective - 1	3	0	0	3	3
5	CSE610 --	Depth Elective - 2	3	0	0	3	3
6	CSS651	Compiler Laboratory	0	0	3	1.5	3
7	CSS652	Data Communication and Computer Networks Laboratory	0	0	3	1.5	3
8	CSS653	Database Management System Laboratory	0	0	3	1.5	3
9	XXS681	Co-curricular Activities - VI (Optional)	0	0	0	0	0
		TOTAL	15	1	9	20.5	25
Semester - VII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MSC731	Principles of Management	3	0	0	3	3
2	CSE710 --	Depth Elective – 3	3	0	0	3	3
3	CSE710 --	Depth Elective - 4	3	0	0	3	3
4	CSE710 --	Depth Elective - 5	3	0	0	3	3
5	YYO74*	Open Elective - 3	3	0	0	3	3
6	CSS751	Software Engineering Laboratory	0	0	3	1.5	3
7	CSS752	Modelling and Simulation Laboratory	0	1	3	2.5	4
8	CSS753	Vocational Training / Summer Internship and Seminar	0	0	2	1	2
9	CSS754	Project - I	0	0	3	1	3
		TOTAL	15	1	11	21	27
Semester - VIII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	CSE810 --	Depth Elective - 6	3	0	0	3	3
2	YYO84*	Open Elective - 4	3	0	0	3	3
3	YYO85*	Open Elective - 5	3	0	0	3	3
4	CSS851	Project - II	0	0	15	5	15
5	CSS852	Project Seminar	0	0	0	1.5	0
6	CSS853	Viva Voce	0	0	0	1	0
		TOTAL	9	0	15	16.5	24

CREDIT UNIT OF THE PROGRAM:

Semester	I + II	III	IV	V	VI	VII	VIII	TOTAL
Credit Unit	45	22	24.5	20.5	20.5	21	16.5	170

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT.

6th Semester

	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
CSE612	System Software
CSE613	Internet and Web Technologies
CSE614	Advanced Computer Architecture
CSE615	Optimization Techniques
CSE616	Artificial Intelligence
CSE617	Advanced Algorithms
CSE618	Information Coding Theory
CSE619	Computer Graphics
CSE620	Game Theory and its Applications
CSE621	Digital Systems Testing
CSE622	Soft Computing
CSE623	Advanced Database Systems

7th Semester

	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
CSE710	Machine Learning
CSE711	Graph Theory
CSE712	Electronic Design Automation
CSE713	Natural Language Processing
CSE714	Data Warehousing and Data Mining
CSE715	Digital Image Processing
CSE716	Data Analytics
CSE717	Biometrics
CSE718	Cryptography and Network Security
CSE719	Multimedia Information Systems

CSE720	Cellular Automata and its Application
CSE721	Computational Geometry
CSE722	Complex Network Theory
CSE723	Pattern Recognition
CSE724	Semantic Web Technology
CSE725	Human Computer Interaction
CSE726	Incentive Mechanism in Computer Science

8th Semester

	DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
CSE811	Distributed Systems
CSE812	Computer Vision
CSE813	Optical Networks
CSE814	Internet of Things
CSE815	Cloud Computing
CSE816	Mobile Computing
CSE817	Expert Systems
CSE818	Ethics Society and Computer Science
CSE819	Knowledge Management

DETAILED SYLLABUS

FIRST SEMESTER

Semester - I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
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9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC 01</td><td>MATHEMATICS - I</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic concepts of function, limit, differentiation, and integration.</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: To introduce the fundamentals of differential calculus of single and several variables
• CO2: To develop the basic concepts of integral calculus including multiple integrals and its application in finding area, volume, centre of mass, centre of gravity etc.
• CO3: To introduce the fundamental concepts of vector calculus
• CO4: To develop the concept of convergence</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Functions of Single Variable: Rolle’s Theorem and Lagrange’s Mean Value Theorem (MVT), Cauchy's MVT, Taylor’s and Maclaurin’s series, Asymptotes & Curvature (Cartesian, Polar form). (8)
Functions of several variables: Function of two variables, Limit, Continuity and Differentiability, Partial derivatives, Partial derivatives of implicit function, Homogeneous function, Euler’s theorem and its converse, Exact differential, Jacobian, Taylor's & Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof), Stationary points, Lagrange’s method of multipliers. (10)</td></tr>
</table>

	Sequences and Series: Sequences, Limit of a Sequence and its properties, Series of positive terms, Necessary condition for convergence, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Mean value theorems of integral calculus, Improper integral and it classifications, Beta and Gamma functions, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms. (12) **Multiple Integrals:** Double integrals, Evaluation of double integrals, Evaluation of triple integrals, change of order of integration, Change of variables, Area and volume by double integration, Volume as a triple integral. (10) **Vector Calculus:** Vector valued functions and its differentiability, Line integral, Surface integral, Volume integral, Gradient, Curl, Divergence, Green's theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their applications. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10th ed., Wiley India Ed. (2010). 2. Daniel A. Murray, Differential, and Integral Calculus, Fb & c Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11th Ed., Addison Wesley.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC01	CO1	2	3	2	3	1	1	-	-	1	1	1	2
	CO2	2	3	2	3	-	1	-	-	1	1	2	2
	CO3	2	3	2	3	-	1	1	-	-	2	2	2
	CO4	3	3	2	3	1	1	-	1	-	2	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC01	**Engineering Physics**	**PCR**	**2**	**1**	**0**	**3**	**3**
Pre-requisites:		Course Assessment methods: (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	CO1: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems.						

	CO2: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. CO3: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. CO4: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.
Topics Covered	**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and forced vibrations, Equation of motion, Amplitude resonance, Velocity resonance, Quality factor, sharpness of resonance, etc. [8] **Wave Motion** - Wave equation, Longitudinal waves, Transverse waves, Electro-magnetic waves. [3] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis of polarized lights. [5] **Laser and Optical Fiber** - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5]
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. A Text Book of Oscillations and Waves, M. Goswami and S. Sahoo, Scitech Publications 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 2. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 3. Fundamental of Optics, Jankins and White, McGraw-Hill 4. Optics, A. K. Ghatak, Tata McGraw-Hill 5. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 6. Lasers and Non-linear Optics, B. B. Laud , New Age International Pvt Lt

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC01	CO1	3	2	1	1	1	-	-	1	-	-	-	1
	CO2	3	2	-	2	-	-	-	-	-	-	-	1
	CO3	3	2	2	2	1	1	1	1	1	-	1	1
	CO4	3	2	2	2	1	1	1	-	1	-	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC 01	Engineering Chemistry	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes	• CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption, and catalytic processes for engineering applications • CO2: To learn fundamentals of polymer chemistry and petroleum engineering. • CO3: Introduced to basic spectroscopic techniques for structure determination and characterization. • CO4: To study few inorganic and bioinorganic compounds of industrial importance.						
Topics Covered	**ORGANIC CHEMISTRY** i. Fundamentals of organic reaction mechanisms; Few important reactions and their mechanism along with their applications; Robinson annulation, Hydroboration reaction, Organometallic reagents (Gilman reagents), Metathesis using Grubb's catalyst and Wittig reaction. (3) ii. Fundamental concept on stereochemistry and application: Conformation and configuration of organic compounds, Diastereo-selective, enantio-selective, regio-selective, stereo-specific, and stereo-selective reactions. (3) iii. Polymer chemistry and polymer engineering: Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber, and plastic materials. Conducting polymer. (2) iv. Petroleum Engineering and oil refinery: origin of mineral oils, separation principle and techniques of distillation of crude oil, Uses of different fractions, octane number, cetane number, Knocking, anti-knock compounds, and Bio-Fuel. (2) v. Structure elucidation of organic compounds by modern spectroscopic methods; Application of UV-Visible and FT-IR spectroscopy. (3) **INORGANIC CHEMISTRY** i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, Jahn-Teller distortion, pseudo Jahn-						

	Teller distortion, Isomerism, and stereochemistry. (5) ii. **Bioinorganic Chemistry:** Heme and non-heme O_2 transport protein (Haemoglobin, Myoglobin), Chlorophyll and photosynthesis. (3) iii. **Inorganic Materials:** Introduction towards industrially important inorganic materials like cementing material, refractory material, fertiliser, inorganic polymer. (2) iv. **Organometallic Chemistry:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes. (4) **PHYSICAL CHEMISTRY** i. **Thermodynamics:** 2nd law of thermodynamics, entropy, free energy, Gibbs Helmholtz equation, change of phase. Cryogenics: joule Thomson experiment. (4) ii. **Chemical Kinetics:** 2nd and 3rd order rate expression, Reversible reaction, Chain reaction, Consecutive reaction, Temp effect on reaction rate. (4) iii. **Electrochemistry:** Electrochemical cell, Effect of pH, precipitation, and complex formation on EMF of oxidation/reduction processes. (2) iv. **Absorption:** Physical and Chemical absorption, Absorption isotherms. (1) v. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis. (2)
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press (ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYC 01	CO1	1	2	-	-	-	-	-	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	1	2	1	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	-	2	-	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>XEC01</td><td>ENGINEERING MECHANICS</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Acquire knowledge of mechanics and ability to draw free body diagrams.
• CO2: Apply knowledge of mechanics for solving special problems like truss and frame analysis.
• CO3: Ability to calculate centroid, moments of inertia for various shapes.
• CO4: Learn momentum and energy principles.
• CO5: Knowledge on virtual Work Principle and its application</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Engineering Mechanics; measurement and SI units. [1]
Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2]
Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to different types of constraints; simple space problems of rigid bodies. [4]
Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5]
Simple trusses; analysis of trusses by method of joints and method of sections. [5]
Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4]
Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6]
Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12]
Principle of Virtual Work, Solution of Problems on Mechanics using Principle of Virtual Work [3]</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">1) S P Timoshenko and D H Young, Engineering Mechanics, 5th Edition
2) J L Meriam and L G Kraige, Engineering Mechanics, 5th Edition, Wiley India
3) F P Beer and E R Johnston, Vector Mechanics for Engineers
4) I H Shames, Engineering Mechanics</td></tr>
</table>

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC01	CO1	1	-	-	-	-	-	-	-	-	-	-	1
	CO2	1	1	1	1	-	-	-	-	-	-	-	1
	CO3	1	1	-	-	-	-	-	-	-	-	-	1
	CO4	1	2	-	-	-	-	-	-	-	-	-	1
	CO5	-	2	2	2	2	1	-	-	-	1	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
ESC01	**Environmental Science**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	• CO1: Understand the importance of environment and ecosystem. • CO2: Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. • CO3: Understand the scientific basis of local and as well as global issues. • CO4: Apply of knowledge to develop sustainable solution.						
Topics Covered	**Introduction:** Multidisciplinary nature of Environmental Studies; Basic issues in Environmental Studies. [2] Human population and the Environment. [1] Social issues and the Environment. [1] **Constituents of our Environment & the Natural Resources:** Atmosphere– its layers, their characters; Global warming, Ozone depletion, Acid rain, etc. [5] Hydrosphere - Its constituents, Oceans, Groundwater, Surface waters; Hydrological cycle. [4] Lithosphere - constituents of lithosphere; Rock and Mineral resources; Plate Tectonic Concept and its importance. [5] Biosphere– its components; Ecosystems and Ecology; Biodiversity; Biomes. [5] Natural disaster and their management – Earthquakes, Floods, Landslides, Cyclones. [3] **Pollution:** Pollutants and their role in air and water pollution. [2]						
Text Books, and/or reference material	1. Environmental Studies – Benny Joseph – Tata McgrawHill-2005 2.Environmental Studies – Dr. D.L. Manjunath, Pearson Education-2006. 3.Principles of Environmental Science and Engineering – P. V. Rao, PHI. 4. Environmental Science and Engineering – Meenakshi, Prentice Hall India. 5.Environmental studies – R. Rajagopalan – Oxford Publication - 2005. 6. Text book of Environmental Science & Technology – M. A. Reddy – BS Pub.						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ESC01	CO1	3	-	-	-	-	-	2	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	2	-	-	-	-	-	2	-	-	-	-	-
	CO4	1	-	3	-	-	2	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**ENGINEERING GRAPHICS**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Ability of mental visualization of different objects • CO2: Theoretical knowledge of orthographic projection to solve problems on one/two/three dimensional objects • CO3: Able to read/interpret industrial drawing and to communicate with relevant people						
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1st, 2nd, 3rd and 4th quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3] Freehand graphics. [3]						
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… Engineering Drawing – N D Bhat 3)… Practical Geometry and Engineering Graphics – W Abbott						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES51	CO1	1	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	1	-	-	-	-	-	-	-	-	-	-
	CO3	1	-	1	-	-	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSS51	Professional Communication Lab	PCR	1	0	2	3	2

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
None	CT+EA

Course Outcomes	• CO1: Improvement in linguistic proficiency of the learners • CO2: Improvement in communicative ability of the learners • CO3: Improvement in social connectivity skill
Topics Covered	1. Professional Communication: Introduction (1) 2. Technical Writing: Basic Concepts (2) 3. Style in Technical Writing (3) 4. Technical Report (2) 5. Recommendation Report (2) 6. Progress Report (1) 7. Technical Proposal (3) 8. Business Letters (3) 9. Letters of Job Application (2) 10. Writing Scientific and Engineering Papers (3) 11. Effective Use of Graphic Aids (2) 12. Presentation Techniques (6) 13. Group Discussion (6) 14. Interview Techniques (6)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana& Savitha (Cambridge UP) **Reference Books:** 1. English for Engineers -Sudharshana & Savitha (Cambridge UP) 2. Effective Technical Communication-M A Rizvi (McGraw Hill Education) 3. References to relevant NPTEL, MOOC, SWAYAM courses be given by the Instructor

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSS51	CO1	1	_	_	1	_	1	_	1	2	3	1	_
	CO2	1	_	_	1	_	2	_	2	2	3	2	_
	CO3	_	_	_	1	_	3	_	3	3	3	2	_

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHS51	Physics Laboratory	PCR	0	0	2	2	1

Pre-requisites	Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))
NIL	CE+EA

Course Outcomes	CO1: To realize and apply different techniques for measuring refractive indices of different materials. CO2: To realize different types of waveforms in electrical signals using CRO. CO3: To understand charging and discharging mechanism of a capacitor. CO4: To understand interference, diffraction and polarization related optical phenomena. CO5: To acquire basic knowledge of light propagation through fibers.
Topics Covered	1. Find the refractive index of a liquid by a travelling microscope. 2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster's law/Malus' law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton's ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.
Text and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Mazumdar and B. Ghosh 2) Practical Physics – Worsnop and Flint

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHS51	CO1	3	2	1	-	-	-	-	-	2	1	-	1
	CO2	3	2	1	-	-	1	-	-	2	1	-	1
	CO3	3	1	-	-	-	-	-	-	2	1	-	1
	CO4	3	2	-	1	-	1	1	-	2	1	-	1
	CO5	3	2	1	-	1	1	1	-	2	1	-	1

Correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn basic analytical techniques useful for engg applications. • CO2: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. • CO3: Learn chromatographic separation methods. • CO4: Applications of spectroscopic measurements.						
Topics Covered	i. Experiments based on pH metry: Determination of dissociation constant of we acids by pH meter. ii. Experiments based on conductivity measurement: Determination of amou of HCl by conductometric titration with NaOH. iii. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry iv. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, Fe(acac cis-bis(glycinato)copper (II) monohydrate and their characterization by m. p FTIR etc. vi. Synthesis and charact. of organic compounds: e.g.Dibenzylideneacetone. vii. Synthesis of polymer: polymethylmethacrylate viii. Verification of Beer-Lamberts law and determination of amount of iron prese in a supplied solution. ix. Chromatography: Separation of two amino acids by paper chromatography x. Determination of saponification value of fat/ vegetable oil						
	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu&Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYS51	CO1	2	1	-	1	-	-	-	-	-	-	-	-
	CO2	-	1	-	1	1	2	-	-	-	-	-	-
	CO3	2	-	-	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	1	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Title of the course</th><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><th colspan="4">Total Number of contact hours</th><th rowspan="2">Credit</th></tr>
<tr><th>Lecture (L)</th><th>Tutorial (T)</th><th>Practical (P)#</th><th>Total Hours</th></tr>
<tr><td>WSS51</td><td>WORKSHOP PRACTICE</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Study and practice on machine tools and their operations
• CO2: Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
• CO3: Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
• CO4: Develop basic electrical engineering knowledge for house wiring practice</td></tr>
<tr><td>Topics Covered</td><td colspan="7">M/c shop & Carpentry shop -- 3X3= 9hrs.
• Introduction on machining process.
• Introduction to machine tools- Lathe, Shaper, Milling and Drill machine.
• Introduction to woods- Types, structure, disease and defect of wood.
• Introduction to wood working machines and tools.
• Making of dovetail joint and bridle joint.
Welding Shop & Sheet metal -- 3X3= 9hrs.
• Introduction to welding.Safety and precautions in welding.
• Formation of weld bead by SMAW on mild steel flat.
• Formation of weld bead by oxy-fuel welding on mild steel flat.
• Introduction to sheet Metal works.
• Tools and Machines used in sheet metal works.
• Concept of development, marking out of metal sheets.
• Cutting and joining of metal sheets.
• Safety precautions, General warning needed in the shop floor.
Black smithy & Foundry -- 3X3= 9hrs.
• Introduction Smithing and Forging- Tools, Machines, Furnaces and its accessories, fuels.
• Safety and precautions in blacksmithy.
• Making of bars of different cross-sections.
• Making of hexagonal headed bolts.
• Forge welding.
• Introduction to Foundry Technology.
• Preparation of sand mould using Solid/Split Pattern.
Fitting & Electrical shop -- 3X3= 9hrs.
• Introduction to hand metal cutting tools with specifications, nomenclature and their use.
• Marking tools, measuring tools and their use.
• Fitting of joints of mild steel flats.</td></tr>
</table>

	• Introduction to electrical hazards and safety precaution. • Wire jointing and soldering. • PVC Conduit Wiring controlled by separate single way switches. • PVC Cashing Capping Wiring for two-way switches. • Conduit wiring for the connection of a Calling Bell with In& Out Indicators. • Batten Wiring and Cleat Wiring. • Tube Light Connection. • Insulation Resistance Testing of 1ph / 3ph Motor and House Wiring. • Earth Resistance Testing. • DOL Starter Connection. **Viva voce -- 1X3= 3hrs.**
Text Books, and/or reference material	1. Workshop Technology Part I and Part II by W. A. J. Chapman 2. Elements of Workshop Technology S. K. Hazra Chowdhury, A. K. Hazra Chowdhury and Nirjhar Roy 3. Mechanical Workshop Practice by K. C. John

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
WSS51	CO1	2	-	-	-	-	1	-	-	-	1	-	-
	CO2	1	-	1	-	-	1	-	-	-	1	-	-
	CO3	1	-	2	-	-	1	-	-	-	1	-	-
	CO4	1	-	-	-	-	2	-	-	-	1	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXS-51	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Introduction of Yoga. • Sitting Posture/Asanas- Padmasana, Vajrasana, Ardhakurmasana, Ustrasana, Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar.						

	• Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra. • Laying Posture/Asanas- PavanaMuktasana, UttanaPadasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani. • Meditation- Yognidra, Om chant, Pray chant. • Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardhachandrasana, Trikonasana, Utkatasana, Padahastasana. • Pranayama- Deep breathing, AnulomVilom, Suryabhedi, Chandrabhedi. • Kriya- Kapalbhati, Trataka. **ATHLETICS** • Introduction of Athletic. • Starting Technique for Track events- Standing start, Crouch & Block start. • Finishing Techniques. • Relay Race- 4×100m, 4×400m & Baton Exchange Technique & Rules. • Track Marking with Fundamentals- 200m, 400m and Diagonal Distance Radius, Straight Distance, Staggers of Different Lanes & Curve Distance. **BASKETBALL** • Introduction and Players stance and ball handling. • Passing- Two hand chest pass, two hand bounce pass, One hand baseball pass, Side arm pass, Overhead pass, Hook pass. • Receiving- Two hand receiving, one hand receiving, receiving in stationary position, Receiving while jumping and Receiving while running. • Dribbling- Dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Introduction of Volleyball • Service- Underarm service, Sidearm service, Tennis service, Floating service, Jump service. • Pass: Underarm pass- Ready position, Teaching stage of underarm pass and Upper hand pass- Volley pass, Back pass, Short set, Jump set & Underarm set. • Rules and their interpretation. **FOOTBALL** • Introduction of Football • Push pass- Instep inside, Instep outer side. • Kicking- Spot kick, Instep kick, Lofted kick. • Dribbling- One leg, Both legs, Instep. • Trapping- Rolling ball sole trapping, High ball sole trapping, High ball chest trapping, High ball thigh trapping. • Throwing- Standing throw, Running throw, Seating throw. • Goal Keeping- Griping the ball, Full volley, Half volley, Drop Kick. • Rules and their interpretation. **CRICKET**

	• Introduction of Cricket • Batting gripping & Stance, Bowling gripping technique. • Batting front foot defense& Drive. • Batting Back foot defense& Drive. • Batting Square cut. • Bowling medium pace, Bowling off break. • Fielding drill, Catching (Short & High). • Rules & Regulation. **BADMINTON** • Basic introduction about Badminton and Badminton court. • Racket parts, Racket Grip, Shuttle Grip. • Basic stance, Basic Footwork, Shadow practice (Full court movement). • Strokes services: Forehand- Overhead & Underarm, Backhand- Overhead & Underarm. • Match practice (Single & Double). • Rules & Regulation. **TABLE TENNIS** • Introduction of Table Tennis. • Basic Stance and Grip (Shake hand & Pen hold). • Service Basic. • Stroke: Backhand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Stroke: Forehand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-1 General Introduction and words of command. • FD-2 Attention, Stand at ease and Stand easy, Turning and inclining at the halt. • FD-3 Sizing, Forming up in three Ranks Numbering, Open and Close order March and Dressing. • FD-4 Saluting at the halt, Getting on parade, Dismissing and falling out. • FD-5 Marching, Length of pace and Time of Marching in quick time and Halt, Slow March and Halt. • FD-7 Turning on the March and Wheeling. • FD-12 Parade practice. **TAEKWONDO** • Introduction about Taekwondo- Meaning of Taekwondo, Korean language of dress, Fighting area, Punch, Block, Kicks etc. • Stance- Ready stance, Walking stance, Fighting stance, Front stance, Back stance, Cat stance etc. • Punch Technique- Front fist punch, Rear fist punch, Double fist punch, With stance etc. Blocks- Upper blocks, Middle block, Side block, Suto etc. • Foot Technique (Balgisul)- Standing kick (Saseochagi), Front kick (Abchagi),

	Doliyo (Chagi), Abdalchagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus. • Unnat Bharat Abhiyaan • MatribhashaSaptah celebration

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS51	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SECOND SEMESTER

Sl. No	Code	Subject	L	T	S	C	H
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	The Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

<table>
<tr><td colspan="7">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC 02</td><td>MATHEMATICS - II</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="4">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic concepts of set theory, differential equations, and probability.</td><td colspan="4">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Develop the concept of basic linear algebra and matrix equations so as to apply mathematical methods involving arithmetic, algebra, geometry to solve problems.
• CO2: To acquire the basic concepts required to understand, construct, solve and interpret differential equations.
• CO3: Develop the concepts of Laplace transformation & Fourier transformation with its property to solve ordinary differential equations with given boundary conditions which are helpful in all engineering & research work.
• CO4: To grasp the basic concepts of probability theory.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Elementary algebraic structures: Group, subgroup, ring, subring, integral domain, and field. (5)
Linear Algebra: Vector space, Subspaces, Linear dependence and independence of vectors, Linear span, Basis and dimension of a vector space. Rank of a matrix, Elementary transformations, Matrix inversion, Solution of system of Linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization of matrices. (15)</td></tr>
</table>

	Ordinary Differential Equations: Existence and uniqueness of solutions of ODE (Statement Only), Equations of first order but higher degree, Clairaut's equation, Second order differential equations, Linear dependence of solutions, Wronskian determinant, Method of variation of parameters, Solution of simultaneous equations. (12) **Fourier series:** Basic properties, Dirichlet conditions, Sine series, Cosine series, Convergence. (4)
	Laplace and Fourier Transforms: Laplace transforms, Inverse Laplace transforms, Convolution theorem, Applications to Ordinary differential equations. Fourier transforms, Inverse Fourier transform, Fourier sine and cosine transforms and their inversion, Properties of Fourier transforms, Convolution. (10) **Probability:** Historical development of the subject and basic concepts, Axiomatic definition of probability, Examples to calculate probability, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10thed, Wiley India Ed. (2010). 2. Gilbert Strang, Linear algebra and its applications (4th Ed), Thomson (2006). 3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Ed (2017). **Reference Books:** 1. S. Kumaresan, Linear algebra - A Geometric approach, PHI (2000). 2. C. Grinstead, J. L. Snell, Introduction to Probability, American Math. Society.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC02	CO1	3	3	2	1	2	-	2	-	-	-	1	2
	CO2	3	3	2	2	2	-	2	-	-	1	-	2
	CO3	3	3	2	2	3	1	1	-	1	1	1	2
	CO4	3	2	1	3	2	1	1	1	1	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC01	**INTRODUCTION TO COMPUTING**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic knowledge of computer.		CT+MT+EA					
Course Outcomes	CO1: Recognize the changes in hardware and software technologies with respect to the evolution of computers and describe the function of system software's						

	(operating Systems) and application software's, languages, number system, logic gates. CO2: Illustrate the flowchart and inscribe an algorithm for a given problem Inscribe C programs using operators. CO3: Develop conditional and iterative statements to write C programs. CO4: Exercise user defined functions to solve real time problems CO5: Inscribe C programs that use Pointers to access arrays, strings and functions. CO6: Exercise user defined data types including structures and unions to solve problems.
Topics Covered	Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers 2L Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. [2] Languages: Assembly language, high level language, compiler, and assembler (basic concepts) [1] Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates. [2] Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart. [1] C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements. [2] Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence, and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. [8] Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels. [5] Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register Variables, scope rules, recursion, function prototypes, C pre-processor, command line arguments. [5] Arrays and Pointers: One-dimensional, two-dimensional arrays, pointers and functions, multi-dimensional arrays. [10] Structures Union and File: Structure, union, structures and functions, arrays of structures, file read, file write.[5]
Text Books, and/or reference material	Text Books: 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie Reference Books: 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC01	CO1	3	1	2	1	-	-	-	-	-	-	-	-
	CO2	-	2	1	2	1	-	-	-	-	-	-	-
	CO3	1	2	-	-	3	-	-	-	-	-	-	-
	CO4	1	3	1	2	3	-	-	-	-	-	-	1
	CO5	2	1	-	-	3	-	-	-	-	-	-	-
	CO6	2	-	3	-	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC01	**Basic Electronics**	PCR	2	1	0	3	3
Pre-requisites			Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))				
(10+2) level mathematics and physics			CT+MT+EA				
Course Outcomes	• CO1: Knowledge of Semiconductor physics and devices. • CO2: Have an in depth understanding of basic electronic circuit, construction, operation. • CO3: Ability to make proper designs using these circuit elements for different applications. • CO4: Learn to analyze the circuits and to find out relation between input and output.						
Topics Covered	1. **Semiconductors** 1.1. Concept of band formation in solids; Fermi-Dirac distribution function, concept of Fermi level, invariance of Fermi level in a system under thermal equilibrium 1.2. Definitions of insulator, conductor and semiconductor using band diagram 1.3. Crystalline structure of semiconductor 1.3.1. Covalent bond 1.3.2. Generation of holes and electrons 1.3.3. Effect of temperature on semiconductor 1.4 Intrinsic semiconductor 1.5 Doping and Extrinsic semiconductor 1.5.1 n-Type semiconductor and band diagram 1.5.2 p-Type semiconductor and band diagram 1.5.3 Mass-action law of semiconductor 1.6. Conductivity of semiconductor (including mathematical expression) 1.7 Carrier transport phenomenon. (03 hrs.) 2. **Diodes** 2.1. Construction						

	2.2. Unbiased diode; Depletion layer and Barrier potential; junction capacitance (expression only) 2.3. Principle of operation with forward biasing and reverse biasing 2.4. Characteristics 2.5 Diode's three models/equivalent circuits.(02 hrs.) 3.**Diode Circuits** 3.1 Diode rectifier 3.1.1 Half wave rectifier 3.1.2 Full wave rectifier:centre tap and bridge rectifier 3.1.3 Capacitive filter and DC power supply (Numerical problems) 3.2 Special Diodes 3.2.1 Zenerdiode: Avalanche breakdown and Zener breakdown and characteristics. 3.2.2 Zener diode as a voltage regulator 3.2.3 Displaydevices: LED and LCD. (03 hrs.) 4.**Bipolar Junction Transistor (BJT)** 4.1 n-p-n and p-n-p transistor and their constructions 4.2 Principle of operation 4.3 Transistor configuration: common base, common emitter, and common collector 4.4 Transistor characteristics: input and output characteristics of CB and CE configurations 4.5 DC load line: quiescent (Q) point; cut-off, active, and saturation region 4.6 Amplifier: Principle of operation 4.7 Transistor as a switch. (04 hrs.) 5.**Transistor Biasing** 5.1 Need of biasing 5.2 Methods of biasing: base resistor or fixed bias, emitter feedback, voltage divider biasing 5.3 Stability of Q-point (qualitative discussions) 5.4 (Numerical problems). (02 hrs.) 6.**Single Stage Amplifier:** classification of amplifiers (voltage amplifier, current amplifier, power amplifier etc.) Class-A CE Amplifier with coupling and bypass capacitors, Qualitative discussions of magnitude characteristics of frequency response (graph only) (02 hrs.) 7.**Feedback Amplifier** 7.1 Positive and negative feedback 7.2 Deduction of gain with negative feedback, explanation of stability of gain with negative feedback, other effects of negative feedback (no deduction), numerical problems. (03 hrs.) 8.**Other Semiconductor Devices** 8.1 JFET: Construction, principle of operation, characteristics 8.2 MOSFET: Construction, principle of operation, characteristics 8.3 Power Electronic Device-SCR: Brief discussions. (02 hrs.) 9.**Operational Amplifier** 9.1 Characteristics of ideal operational amplifier 9.2 Pin Configuration of IC 741,

	9.3 Analysis of simple operational amplifier circuits: concept of virtual ground; noninverting amplifier and inverting amplifier. 9.4 Applications: voltage follower, summer, differentiator, integrator, and comparator (04 hrs) 10.**Oscillator** 10.1 Positive feedback and condition of oscillation 10.2 R-C phase-shift oscillator, Wien bridge oscillator.(02 hrs.) 11.**Boolean Algebra** 11.1 Boolean algebra, De Morgan's theorem, simplification of Boolean expressions 11.2 Number system, range extension of numbers, overflow 11.3 Different codes: gray code, ASCII code and BCD codes and them Applications. (01 hrs.) 12. **Logic Gates** 12.1 NOT, OR, AND, NOR, NAND, EX-OR, EX-NOR gates 12.2 Simplification of logic functions 12.3 Realizations of logic expressions using logic gates. (01 hrs.) 13. CRO and its applications and other test and measurement instruments. (01 hrs.)
Text Books, and/or reference material	Text Books: 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad & Nashelsky 2. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bates, 7/e. Reference Books: 1. Integrated Electronics by Millman, Halkias and Parikh, 2/e, McGrawHill. 2. ELECTRONICS Fundamentals and Applications by Chattopadhyay and Rakshit,15/e, New Age Publishers. 3. The Art of Electronics by Paul Horowitz, Winfield Hill, 2/e, Cambridge University. 4. Electronics - Circuits and Systems by Owen Bishop, 4/e, Elsevier. 5. Electronics Fundamentals: Circuits, Devices & Applications by Thomas L. Floyd & David M. Buchla, 8/e, Pearson Education.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECC01	CO1	2	3	2	2	-	1	-	-	-	-	-	1
	CO2	3	2	1	2	2	1	-	2	2	-	-	1
	CO3	3	2	2	2	3	-	-	-	2	-	-	1
	CO4	3	3	2	2	-	-	-	-	2	-	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEC01</td><td>ELECTRICAL TECHNOLOGY</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), Mid Term (MT), and end assessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CT+MT+ EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">Upon successful completion of this course, the student should be able to
• CO1: learn the fundamentals of Electric Circuits and Network theorems and analysis of electrical network based on these concepts.
• CO2: develop an idea on Magnetic circuits, Electromagnetism and learning the working principles of some fundamental electrical equipment’s
• CO3: learn about single phase and poly-phase AC circuits and analysis of such circuits based on these concepts.
• CO4: introduce the basic concept of single-phase transformer.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction: Overview of Electrical power generation systems (2)
Fundamentals of Electric Circuits: Ohm’s laws, Kirchhoff’s laws, Independent and Dependent sources, Analysis of simple circuits. (4)
Network theorems: Superposition Theorem, Thevenin’s Theorem, Norton’s Theorem, Maximum Power Transfer Theorem (4)
Magnetic circuits: Review of fundamental laws of electromagnetic induction, transformer and rotational emfs, Solution of magnetic circuits. Analysis of coupled circuits (self-inductance, mutual inductance, and dot convention)(8)
Transients with D.C. excitation for R-L and R-C circuits. (3)
Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behavior of A.C. circuits, Resonance in series and parallel R-L-C circuits. AC Network: Superposition theorem, Thevenin’s theorem, Norton’s theorem, maximum power transfer theorem, solution of networks with AC sources. (10)
Single-Phase Transformer, equivalent circuits, open circuit and short circuit tests (6)</td></tr>
<tr><td>Textbooks/Reference material</td><td colspan="7">Textbooks:
1. Electrical & Electronic Technology by Hughes, Pearson Education India
Reference Books:
1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd
2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Edu India</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	1
CO2	3	3	3	3	2	1	2	1	1	1	1	1
CO3	3	3	3	3	3	2	2	1	1	1	1	1
CO4	3	3	3	3	3	2	2	1	1	1	1	1
CO5	3	3	2	2	2	1	1	1	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
BTC01	LIFE SCIENCE	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	CO1: Basic understanding of basic cellular organization of organisms and cellular communications, structure and functions of the macromolecules and their biosynthesis and cata--bolism. CO2: To give an understanding of the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa CO3: To introduce molecular biology to understand biological processes in various applications. CO4: To provide a foundation in immunological processes and an overview of the interaction between the immune system and pathogens. CO5: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them CO6: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them						
Topics Covered	**1. Cell Biology (4)** a) Introduction to life science: prokaryotes & eukaryotes Definition; Difference b) Introduction to cells - Define cell, different types of cell c) Cellular organelles - All organelles and functions in brief d) Cellular communications Introduction to basic signaling; endocrine, paracrine signaling; concepts of receptor, ligand, on-off switch by phosphorylation/dephosphorylation **2. Biochemistry (4)** a) Biological function of carbohydrate and lipid - Introduction, structure and function b) Biological function of nucleic acids and protein - structure and function c) Catabolic pathways of Macromolecules - Introduction to catabolism, hydrolysis and condensation reactions; Catabolism of glucose- Glycolysis,						

	TCA; overall degradation of proteins and lipids d) Biosynthesis of Macromolecules Generation of ATP (ETS), Generation of Glucose (Photosynthesis) **3. Microbiology (5)** a) Types of microorganisms and their general features - Bacteria, Yeast, Fungi, Virus, Protozoa- general introduction with practical significance and diseases b) Microbial cell organization - Internal and External features of cell- bacterial cell wall, viral capsule, pilus etc, c) Microbial nutritional requirements and growth - Different Sources of energy; growth curve d) Basic microbial metabolism - Fermentation, Respiration, Sulfur, N_2 cycle **4. Immunology (5)** a) Basic concept of innate and adaptive immunity - Immunity-innate and adaptive, differences, components of the immune system b) Antigen and antibody interaction - Antigen and antibody, immunogen, factors affecting immunogenicity, basic antigen-antibody mediated assays, introduction to monoclonal antibody c) Functions of B cell - B cell, antibody production, memory generation and principle of vaccination d) Role of T cell in cell-mediated immunity - Th and Tc, functions of the T cell with respect to different pathogen and cancer cell **5. Molecular Biology (5)** a) Prokaryotic Genomes (Genome organization & structure) - Nucleoid, circular or linear b) Eukaryotic Genomes (Genome organization & structure) - Intron, exon, packaging, chromatin c) Central Dogma (Replication, Transcription and Translation) d) Applications of Molecular Biology (Diagnostics, DNA-fingerprinting, Recombinant products etc.) - Introduction to Recombinant DNA, fingerprinting, cloning **6. Bioprocess Development (5)** a) Microbial growth kinetics - Batch, fed-batch and continuous systems, Monod Equation b) Enzyme kinetics, kinetics of enzyme inhibition and deactivation Definition of enzymes, activation energy, Concepts of Km, Vmax, Ki c) Microbial sterilization techniques and kinetics Introduction to sterilization, dry and moist sterilization d) Thermodynamics of biological system - Concepts of Enthalpy, Entropy, favorable reactions, exergonic and endergonic reactions e) Material and energy balance for biological reactions - Stoichiometry
Text Books, and/or reference material	1. Biotechnology 01 Edition, authored by U. Satyanarayana, BOOKS & ALLIED (P) LTD. 2. Biochemistry by Lehninger. McMillan publishers 3. Microbiology by Pelczar, Chan and Krieg, Tata McGraw Hill 4. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992 5. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition,

	Freeman, 2002. 6. Bioprocess Engineering: Basic Concepts (2nd Ed), Shuler and Kargi, PHI.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BTC01	CO1	2	1	1	-	1	-	-	-	-	-	-	-
	CO2	2	1	1	-	1	-	1	-	-	-	-	-
	CO3	2	1	1	-	1	-	-	-	-	-	-	-
	CO4	2	1	1	-	1	-	-	1	-	-	-	1
	CO5	2	1	1	-	1	1	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXC01	The Constitution of India and Civic Norms	PCR	1	0	0	1	1
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	CO1: Elementary understanding of the evolution of historical events that led to the making of the Indian constitution, the philosophical values, basic structure and fundamental concerns enshrined in the Constitution of India. CO2: Aware of the fundamental rights and duties as a citizen of the country. CO3: Enable to know the civic norms to be followed according to the Indian constitution						
Topics Covered	**1.** Historical background of the Making of Indian Constitution (1 Hour) **2.** Preamble and the Philosophical Values of the Constitution (1 Hour) **3.** Brief Overview of Salient Features of Indian Constitution (1 Hour) **4.** Parts I & II: Territoriality and Citizenship (1 Hour) **5.** Part III: Fundamental Rights (2 Hours) **6.** Part IV: Directive Principles of State Policy (1 Hour) **7.** Part IVA: Fundamental Duties (1 Hour) **8.** Union Government: President, Prime Minister and Council of Ministers (2 Hours) **9.** Parliament: Council of States and House of the People (1 Hour) **10.** State Government: Governor, Chief Mister and Council of Ministers (1 Hour) **11.** State Legislature: Legislative Assemblies and Legislative Councils (1 Hour) **12.** Indian Judiciary: Supreme Court and High Courts (1 Hour) **13.** Centre-State Relations (1 Hour) **14.** Reservation Policy, Language Policy and Constitution Amendment (1 Hour)						

Text Books, and/or reference material	Primary Readings: 1) P. M. Bakshi, *The Constitution of India*, 18th ed. (2022) 2) Durga Das Basu, *Introduction to the Constitution of India*, 25th ed. (2021) 3) J.C. Johari, *Indian Government and Politics*, Vol. II, (2012) Secondary Readings: Granville Austin, *The Indian Constitution: Cornerstone of a Nation* (1966; paperback ed. 1999); Granville Austin, *Working a Democratic Constitution: The Indian Experience* (1999; paperback ed. 2003).

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**GRAPHICAL ANALYSIS USING CAD**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Introduction to graphical solution of mechanics problems • CO2: Knowledge on graphical solution methods for solving equilibrium in coplanar force system • CO3: Introducing Maxwell diagram and solution of plane trusses by graphical method • CO4: Determination of centroid of plane figures by graphical method • CO5: Exposure to AutoCAD software for computer aided graphical solution						
Topics Covered	• Graphical analysis of problems on statics. [14] • Graphical solution of engineering problems using CAD (with the help of "AutoCAD") [14]						
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 3)… Practical Geometry and Engineering Graphics – W Abbott						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES52	CO1	2	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	2	-	-	-	-	-	-	-	-	-	-
	CO3	2	1	-	-	-	-	-	-	-	-	-	-
	CO4	2	1	-	-	-	-	-	-	-	-	-	-
	CO5	1	-	-	-	2	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**COMPUTING LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of operators, loops, branching statements, function, recursion, arrays, pointer, parameter passing techniques • CO2: To detail out the operations of strings • CO3: To understand structure, union • CO4: Application of C-programming to solve various real time problems						
Topics Covered	**List of Experiments:** 1. Assignments on expression evaluation 2. Assignments on conditional branching, iterations, pattern matching 3. Assignments on function, recursion 4. Assignments on arrays, pointers, parameter passing 5. Assignments on string using array and pointers 6. Assignments on structures, union						
Text Books, and/or reference material	**Text Books:** 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie **Reference Books:** 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS51	CO1	3	-	1	-	-	-	-	-	-	-	-	-
	CO2	-	2	1	3	-	-	-	-	-	-	-	-
	CO3	-	1	-	2	1	-	-	-	-	-	-	-
	CO4	-	-	3	2	-	-	1	-	-	-	2	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS 51	**Basic electronics Lab**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Acquire idea about basic electronic components, identification, and behavior. • CO2: To determine IV characteristics of these Circuit elements for different applications. • CO3: Learn to analyze the circuits and observe and relate input and output signals.						
Labs Conducted.	1. To know your laboratory: To identify and understand the use of different electronic and electrical instruments. 2. To identify and understand name and related terms of various electronics components used in electronic circuits.: Identify different terminals of components, fid their values and observe numbering associate with it. 3. Use of oscilloscope and function generator: Use of oscilloscope to measure voltage, frequency/time and Lissajous figures of displayed waveforms. 4. Study of half wave and Full-wave (Bridge) rectifier with and without capacitor filter circuit. 5. Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates from TTL ICs 6. Regulated power supply: study LM78XX and LM79XX voltage regulator ICs 7. Transistor as a Switch: study and perform transistor as a switch through NOT gate 8. Zenner diode as voltage regulator 9. To study clipping and Clamping circuits 10. To study different biasing cirtis. 11. Study of CE amplifier and observe its frequency response.						
Text Books, and/or reference material	Text Books: 1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul MalvinoDr., David J. Bates, et al. Reference Books: 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bates						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECS51	CO1	3	2	1	2	2	1	-	-	2	-	-	-
	CO2	3	2	2	2	3	-	-	-	2	-	-	-
	CO3	3	3	2	2	-	-	-	-	2	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES51	ELECTRICAL TECHNOLOGY LABORATORY	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	Upon successful completion of this course, the student should be able to • CO1: understand the principle of superposition. • CO2: understand the principle of maximum power transfer • CO3: understand the characteristics of CFL, incandescent Lamp, carbon lamp. • CO4: understand the calibration of energy meter. • CO5: understand open circuit and short circuit test of single-phase transformer. • CO6: analyze RLC series and parallel circuits • CO7: understand three phase connections. • C08: understand determination of B-H curve
Topics Covered	**List of Experiments:** 1. To verify Superposition and Thevenin's Theorem. 2. To verify Norton and Maximum power transfer theorem 3. Characteristics of fluorescent and compact fluorescent lamp 4. Calibration on energy meter 5. To perform the open circuit and short circuit test on single phase transformer 6. To study the balanced three phase system for star and delta connected load 7. Characteristics of different types of Incandescent lamps 8. Study of Series and parallel R-L-C circuit 9. Determination of B-H Curve for magnetic material
Textbooks, and/or reference material	Textbooks: 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru (Author), J M Chuma (Author), H U Ezea (Author) 2. Laboratory Courses in Electrical Engineering (5th Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand Publications)

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	2	2	2	3
CO2	3	3	3	3	3	1	1	1	2	2	2	3
CO3	3	3	3	3	3	1	1	1	2	2	2	3
CO4	3	3	3	3	3	1	1	1	2	2	2	3
CO5	3	3	3	3	3	1	1	1	2	2	2	3
CO6	3	3	3	3	3	1	1	1	2	2	2	3
CO7	3	3	3	3	3	1	1	1	2	2	2	3
CO8	3	3	3	3	3	1	1	1	2	2	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
XXS-52	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: (Continuous evaluation((CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Sitting Posture/Asanas- Gomukhasana, Swastikasana, Siddhasana, Ustrasana, Janusirsasana, ArdhaMatsyendrasana (Half-Spinal Twist Pose), Paschimottanasana, Shashankasana, Bhadrasana. • Mudra- Vayu, Shunya, Prithvi, Varuna, Apana, Hridaya, Bhairav mudra. • Laying Posture/Asanas- Shalabhasana (Locust Posture), Dhanurasana (Bow Posture), ArdhaHalasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, SuptaVajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- ArdhaChakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), ParshwaKonasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadisodha, Shitali, Ujjayi, Bhastrika, Bhramari. • Bandha- Uddiyana Bandha, Mula Bandha, Jalandhara Bandha, Maha Bandha. • Kriya- Kapalabhati, Trataka, Nauli. **ATHLETICS** • Long Jump- Hitch kick, Paddling, Approach run, Take off, Velocity, Techniques, Flight & Landing • Discus throw, Javelin throw and Shot-put- Basic skill & Technique, Grip, Stance, Release & Follow through. • Field events marking. • General Rules of Track & Field Events. **BASKETBALL** • Shooting- Layup shot, Set shot, Hook shot, Jump shot. Free throw. • Rebounding- Defensive rebound, Offensive rebound. • Individual Defensive- Guarding the man without ball and with ball.						

	• Pivoting. • Rules of Basketball. • Basketball game. **VOLLEYBALL** • Spike- Straight spike, Body turn spike, Tip spike, Back attack, Slide spike, Wipe out spike. • Block- Single block, Double block, Triple block, Group block. • Field Defense- Dig pass, Double pass, Roll pass. • Rules and their interpretation. **FOOTBALL** • Dribbling- Square pass, Parallel pass, Forward pass. • Heading (Standing & Running)- Fore head, Side fore head, Drop heading, Body covering during heading. • Kicking- Full volley, Half volley, Drop kick, Back volley, Side volley, Chiping (lobe). • Tackling: Covering the angle, Chessing time sliding chese, Heading time shoulder tackle etc. • Feinting- Body movement to misbalance the opponent and find space to go with ball. • Rules of Football. **CRICKET** • Batting straight drive. • Batting pull shot. • Batting hook shot. • Bowling good length, In swing. • Bowling out swing, Leg break, Goggle. • Fielding drill. • Catching (Long & Slip). • Wicket keeping technique. • Rules & Regulation. **BADMINTON** • Net play- Tumbling net shot, Net Kill, and Net Lift. • Smashing. • Defensive high clear/Lob. • Half court toss practice, Cross court toss drop practice, Full court Game practice. • Player Positioning, Placements. • Rules & Regulation. • Doubles & Mixed doubles match practice. **TABLE TENNIS** • Stroke: Backhand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin. • Stroke: Forehand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin. • Stroke- Backhand lob with rally, Backhand lob with sidespin, Forehand lob with rally, Forehand lob with sidespin. • Service: Backhand/Forehand- Push service, Deep push service, Rally service.

	• Service: Backhand sidespin (Left to right & Right to left). • Service: Forehand- High toss backspin service, High toss sidespin service, High toss reverse spin service. • Rules and their interpretations. • Table Tennis Match (Singles & Doubles). **NCC** • FD-6 Side pace, Pace Forward and to the Rear. • FD-7 Turning on the March and Wheeling. • FD-8 Saluting on the March. • FD-9 Marking time, Forward March and Halt in Quick Time. • FD-10 Changing step. • FD-11 Formation of Squad and Squad Drill. • FD-12 Parade practice. **TAEKWONDO** • Poomsae (Forms)- Jang, Yi Jang. • Self Defense Technique- Self defense from arms, Fist and Punch. • Sparring (Kyorugi)- One step sparring, Two step sparring, Fight (Free sparring). • Combination Technique- Combined kick and punch. • Board Breaking (Kyokpa)- Sheet breaking. • Interpretation Rules above Technique of Taekwondo. **NSS** • No Smoking Campaign • Anti- Terrorism Day Celebration • Any other observation/celebration proposed by Ministry/institute • Public Speaking • Discussion on Current Affairs • Viva voce

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS52	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

THIRD SEMESTER

MAC331 MATHEMATICS-III 3-1-0 4 Credit 4 Hrs

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MAC331</td><td>MATHEMATICS-III</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3">Basic knowledge of topics included in MAC01 & MAC02</td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Acquire the idea about mathematical formulations of phenomena in physics and engineering.
● CO2: To understand the common numerical methods to obtain the approximate solutions for the intractable mathematical problems.
● CO3: To understand the basics of complex analysis and its role in modern mathematics and applied contexts.
● CO4: To understand the optimization methods and algorithms developed for solving various types of optimization problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="7"><u>Partial Differential Equations (PDE):</u> Formation of PDEs; Lagrange method for solution of first order quasilinear PDE; Charpit method for first order nonlinear PDE; Homogenous and Nonhomogeneous linear PDE with constant coefficients: Complimentary Function, Particular integral; Classification of second order linear PDE and canonical forms; Initial & Boundary Value Problems involving one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation. [14]
<u>Numerical Methods:</u> Significant digits, Errors; Difference operators; Newton's Forward, Backward and Lagrange’s interpolation formulae; Numerical solutions of nonlinear algebraic/transcendental equations by Bisection and Newton-Raphson methods; Trapezoidal and Simpson’s 1/3 rule for numerical integration; Euler’s method and modified Eular's methods for solving first order differential equations. [14]
<u>Complex Analysis:</u> Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation and Bilinear transformation; Complex integration; Cauchy’s integral theorem; Cauchy’s integral formula; Taylor’s theorem, Laurent’s theorem (Statement only); Singular points and residues; Cauchy’s residue theorem. [17]
<u>Optimization:</u>
Mathematical Preliminaries: Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra. [2]
Linear Programming Problem (LPP): Introduction; Formulation of linear programming problem (LPP); Graphical method for its solution; Standard form of LPP; Basic feasible solutions; Simplex Method for solving LPP. [9]</td></tr>
</table>

Text Books, and/or reference material	**Text Books:** 1. An Elementary Course in Partial Differential Equations-T. Amarnath 2. Numerical Methods for scientific & Engineering Computation- M.K.Jain, S.R.K. Iyengar & R.K.Jain. 3. Foundations of Complex Analysis- S. Ponnuswami 4. Operations Research Principles and Practices- Ravindran, Phillips, Solberg 5. Advanced Engineering Mathematics- E. Kreyszig **Reference Books:** 1. Complex Analysis-L. V. Ahfors 2. Elements of partial differential equations- I. N. Sneddon 3. Operations Research- H. A. Taha

Mapping of CO (Course outcome) and PO (Programme Outcome)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 301 Discrete Mathematics 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 301	Discrete Mathematics	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					

Course Outcomes	● CO1: Remember the basic terms, definitions and concepts of mathematics. ● CO2: Students will be able to understand the key concepts of discrete mathematics such as functional mapping, mathematical logic, counting principles, generating functions, algebraic structures and graph theory. ● CO3: Students will be able to apply the learned concepts to solve various problems. ● CO4: Students will be able to differentiate or relate the various ideas with respect to problems. ● CO5:Students will be able to judge the formulas and ideas to be applicable to a problem.
Topics Covered	**Set Theory:** Definition of Sets, Venn Diagrams, complements, cartesian products, power sets, counting principle, cardinality and countability (Countable and Uncountable sets), proofs of some general identities on sets, pigeonhole principle. (3L)

	Relation: Definition, types of relation (reflexive, symmetric, transitive, antisymmetric, Equivalence, partial ordering relations), composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, Partial Order, Lattice, Hasse Diagram. (6L) **Function:** Definition and types of function, composition of functions, recursively defined functions, Surjection, Injection, Bijection, Composition of Function, Asymptotic notations: big-Oh, Theta, big-Omega. (4L) **Propositional logic:** Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification. Notion of proof: proof by implication, converse, inverse, contrapositive, negation, and contradiction, direct proof, proof by using truth table, Proof by Well ordering principle. (6L) **Combinatorics:** Mathematical induction, recursive mathematical definitions, basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relation using G.F, solution of combinatorial problem using G.F.). (8L) **Algebraic Structure:** Binary composition and its properties definition of algebraic structure; Semi group, Monoid, Groups, Abelian Group, properties of groups, Permutation Groups, Sub Group, Cyclic Group. (6L) **Graphs:** Graph terminology, types of graph, connected graphs, components of graph, Euler graph, Hamiltonian path and circuits, Degree Sequence, Radius, Diameter, Center of a graph, Graph coloring, Chromatic number. Planarity of a graph: K(3,3) and K(5). Clique, Independent set, bipartite graph, Tree: Definition, types of tree (rooted, binary), properties of trees. (9L)
Text Books, and/or reference material	**Text Books:** 1. C. L. Liu, Elements of Discrete Mathematics, Tata McGraw Hill. 2. Norman L. Biggs, Discrete Mathematics, Oxford. 3. Douglas B. West, Introduction to Graph Theory, Prentice Hall, India. **Reference Books:** 1. Ronald L. Graham, Donald E. Knuth and O. Patashnik, Concrete Mathematics, Pearson Education.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	-	-	1	2
CO2	3	3	2	2	2	-	-	-	-	-	2	2
CO3	3	3	2	2	2	-	-	-	-	-	2	2
CO4	3	3	2	2	2	-	-	-	-	-	2	2
CO5	3	3	2	2	2	-	-	-	-	-	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC302 Digital Logic Design 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 302	Digital Logic Design	PCR	3	0	0	3	3
Pre-requisites:		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					

Course Outcomes	At the completion of this course students will be able to: ● CO1: Realize the various logic gates and laws of Boolean algebra. Analyze different types of digital electronic circuit using various mapping and logical tools. ● CO2: Design and analyses the various combinational circuits. ● CO3: Design and analyze the various sequential circuits. ● CO4: Design and analyze combinational and sequential logic circuits through HDL models. ● CO5: Synthesis the various logic using ASM charts.
Topics Covered	**UNIT-I**: **Switching Circuits,** Various number system and their conversions: Arithmetic of these number systems, Complements, Data Representation: Binary numbers, binary codes, fixed point representation, floating point representation, Code and their conversions, Addition and Subtraction on Codes, Error Detection codes (Hamming code etc), representation of signed binary number in Fixed and Floating Points. (5L) **UNIT-II**: **Boolean algebra**, logic gates, and switching functions, truth tables and switching expressions, minimization of completely and incompletely specified switching functions, Karnaugh map and Quine-McCluskey method, multiple output minimization, representation and manipulation of functions using BDDs, two-level and multi-level logic circuit synthesis. (10L) **UNIT-III**: **Combinational logic circuits**: Realization of Boolean functions using AND/NOR Gates, Decoders, multiplexers. Logic design using ROMs, PLAs and FPGAs. Case Studies.

	(8L) **UNIT-IV**: **Sequential circuits:** Clocks, flip-flops, latches, counters and shift registers, finite-state machine model, synthesis of synchronous sequential circuits, minimization and state assignment, asynchronous sequential circuit synthesis. (12L) **UNIT-V**: FSM and **ASM charts**: Representation of sequential circuits using FSM and ASM charts, synthesis of output and next state functions, data path control path partition-based Design. (7L)
Text Books, and/or reference material	**Text Books:** 1. Digital Logic Design, M. Morris Mano, Michael D Cilleti, PHI. **Reference Books:** 1. Digital Principles & Application, 5th Edition, Leach & Malvino, McGraw Hill Company. 2. Modern Digital Electronics, 2nd Edition, R.P. Jain. Tata Mc Graw Hill Company Limited.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	3	-	-	-	-	-	1	2
CO2	3	2	2	3	1	-	-	-	-	-	2	2
CO3	3	2	2	3	1	-	-	-	-	-	2	2
CO4	3	2	2	3	2	-	-	-	1	-	2	2
CO5	3	2	2	3	3	-	-	-	1	-	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC303 Data Structures and Algorithms 3-1-0 4 Credits 4 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 303	Data Structures and Algorithms	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
CSC-01 (Introduction to Computing)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding the fundamental concepts of data, data types and abstract data types. ● CO2: Implementation of different abstract data types using different data structures. ● CO3: Apply different types of data structures to implement different					

	application problems. ● CO4: Different searching and sorting techniques. ● CO5: Analysis of the suitability/compatibility of different data structures based on the types of applications. ● CO6: Design and development of algorithms for real-life applications.
Topics Covered	Introduction to problem solving through computer, Design of algorithm to solve a problem, Concept of static and dynamic memory allocation, Algorithms and data structures, Concept of Abstract Data Type (ADT) with examples. (3L) Efficiency of an algorithm, Asymptotic notations, Time and space complexities, Analysis of algorithms, Comparing asymptotic running times, Impact of data structure on the performance of an algorithm. (4L) Array, Single and multi-dimensional array, Memory representation (row major and column major) of array, Insertion, and deletions in array, Advantages and disadvantages of array. (3L) Linked list as an ADT, Memory allocation and deallocation for a linked list, Linked list versus array, Types of linked lists: singly linked list, doubly linked list and circular linked list, Operations on linked list: creation, display, insertion and deletion (in different positions), summation, average, maximum, minimum etc. Application of linked list: representations and operations on polynomials, sparse matrices. (7L) Stack as an ADT, Main operations (push and pop), auxiliary operations and axioms, Array implementation of stack, Limitation of array implementation, Linked list implementation of stack, Applications of stack: Recursion, Function call, Evaluation of postfix expression using stack, Conversion of infix to postfix using stack. (6L) Queue as an ADT, Main operations (enqueue and dequeue), Auxiliary operations and axioms, Array implementation of queue, Limitation of array implementation and Circular queue, Linked list implementation of queue, Double ended queue (dequeue) Priority queue and its applications. (5L) Binary Tree, Definition and properties, Representation of binary tree in memory: linked representation, array representation, Binary tree traversal, Preorder, Inorder and Postorder, Expression tree, Heap and its applications. (5L) Search trees: Binary search tree, Balanced binary search tree, AVL tree, Red Black tree, M-way tree, M-way search tree, B tree, B+ Tree. (7L)

	Searching: Linear search and binary search. (3L) Sorting: Bubble, selection, insertion, Quick sort, Merge sort, Heap sort, Radix sort. (7L) Graphs: Mathematical Properties, Degree, Connectedness, Representation using matrix, Adjacency list, Directed Graphs, Directed Acyclic Graph. (2L) Hashing: Hash functions. Collision, Collision resolution techniques: linear probing, quadratic probing, double hashing, chaining, Rehashing. (4L)
Text Books, and/or reference material	**Text Books:** 1. R. F. Gilberg and B. A. Forouzan, "Data Structures: A pseudocode approach with C", 2nd Edition, CENGAGE Learning. 2. A. V. Aho, J. D. Ullman and J. E. Hopcroft, "Data Structures and Algorithms", Addition Wesley. 3. Lipschutz, "Data Structures (Schaum's Outline Series)", Tata Mcgraw Hill. 4. E. Horowitz, S. Sahni, S. Anderson-Freed, "Fundamentals of Data Structures in C", Universities Press; Second edition (2008). **Reference Books:** 1. Y. Langsam, M. J. Augenstein and A. N. Tanenbaum, "Data Structures using C and C++", Pearson, 2006. 2. Knuth, Donald E. The Art of Computer Programming. 3rd ed. Vols 1&2. Reading, MA: Addison-Wesley, 1997. ISBN: 0201896834. ISBN: 0201896842. ISBN: 0201896850. 3. Kleinberg and Eva Tardos. Algorithm Design. Addison-Wesley 2005 ISBN-13: 978-0321295354.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	1	-	-	-	-	-	-	-	-	-
CO2	2	-	3	1	-	-	-	-	-	-	-	-
CO3	3	-	3	1	-	-	-	-	-	-	-	-
CO4	3	2	3	1	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

PHC331 PHYSICS OF SEMICONDUCTOR DEVICE 3-0-0 3 Credits 3 Hrs

Course Code	Title of the course	Program Core (PCR) / Electives (PCR)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC331	Physics of Semiconductor Devices	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous (CT), mid-term (MT) and end assessment (EA))					
PHC 01 in 1st year.		CT+MT+EA					
Course Outcomes	At the end of the course, a student will be able to: CO1.Describe the different electronic properties of semiconductor materials. CO2. Understand the working principal of electronic devises (PN Diode, Photodetector, Solar cell, Light- Emitting Diodes, Laser Diodes, JFET, MOSFET, Tunnel Diode, Gunn Diode, IMPATT Diode, TRAPATT Diode and semiconductor memory). CO3. Apply the knowledge of memory expansion to design required expanded memory for specific application.						
Topics Covered	**Fundamentals of Semiconductor & Semiconductor Devices Fabrication:** Introduction to crystal growth, Intrinsic and extrinsic semiconductors, Fermi level, Conductivity, Mobility and its temperature dependence, Energy bands of semiconductors, Direct and indirect semiconductor, Variation of energy band with alloy composition, III-V and II-VI alloy semiconductor, Homo and hetero-structure semiconductor, Effective masses of carriers in semiconductor, Fermi-Dirac distribution function, Density of states, Carrier concentrations at equilibrium, Calculation of number density of carriers and their temperature dependence, Effects of temperature on carrier concentrations, High field effects, Hall effect, Lithography, Optical lithography and Electron beam lithography. [14] **Junction-Diode & Optoelectronic Devices:** P-N junction, Contact potential, Band diagram, Degenerate semiconductors, Photodetector, Solar cell, Light-Emitting Diodes, Internal and external quantum efficiency etc., Semiconductor Lasers, Population inversion at a junction, Emission spectra for P-N junction Lasers. [3] **Negative Conductance Microwave Devices:** Materials for negative conductance devices, The Gunn effect and related devices, The transferred electron mechanism, Transit time devices, The IMPATT Diode, the TRAPATT Diode,Tunnel Diode. [10] **JFET and MOSFET:** Junction Field Effect Transistors (JFET), Operation, I-V Characteristics etc., MOS structure, Different MOS structures, Operation of MOS at high and low frequency, Accumulation, Inversion, strong inversion regions, Metal-Oxide Semiconductor Field Effect Transistors (MOSFET), MOSFET as a Capacitor,						

	MOSFET as a resistor and related circuits. [9] **Semiconductor Memory Device:** Semiconductor memory organization, Random Access Memory (RAM) (static and dynamic), CMOS memory circuits, Charge Coupled Devices (CCD). [6]
Text Books, and/or reference material	**Text Books** 1. Physics of Semiconductor Devices, S M SZE. 2. Solid State Electronic Devices, Ben G Streetman & Banerjee 3. Microwave Solid-State Devices, S Y Liao **References:** 1. Semiconductor Physics and Devices, Donald A. Neamen. 2. Microwave Engineering, David M.Pozar. 3. Integrated Electronics, Millman-Halkias.

Mapping of CO (Course outcome) and PO (Programme Outcome)

POs COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	2	1	-	1	1	1	-	-	-	2	-	-	1
CO2	3	2	1	1	1	1	1	1	1	1	-	2	1	1	1
CO3	3	3	2	1	1	1	1	1	1	1	1	1	2	2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

PHS381 SEMICONDUCTOR DEVICES LABORATORY 0-0-3 1.5 Credits 3 Hrs

Course Code	Title of the course	Program Core (PCR) / Electives (PCR)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHS381	Semiconductor Devices Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
PHS 51 in 1st year.		CE+EA					
Course Outcomes	At the end of the course, a student will be able to: • CO1. Calculate different characteristic parameter of semiconductor materials. • CO2. Measure and understand different characteristic of semiconductor devices. • CO3. Draw the current-voltage characteristics of solar cell for calculation of conversion efficiency.						
Topics Covered	**List of Experiments:** 1. To determine the energy bandgap of a semiconductor. 2. Measurement of resistivity of semiconductors by four-probe method at different temperatures. 3. Determination of Hall coefficient of a given semiconductor and its temperature						

	dependence. 4. To determine the value of e/m of an electron by using a cathode ray tube and a pair of bar magnet. 5. Determination of Stefan's constant. 6. Study of p-n junction diode characteristics. 7. Study of Zener diode characteristics and voltage regulator. 8. Determination of photo conversion efficiency of a Solar cell.
Text Books, and/or reference material	**Text Books** 1. An advanced course in practical physics, Chattapadhyay and Rakshit. 2. Advanced Practical Physics, B. Ghosh and K. G. Mazumdar

Mapping of CO (Course outcome) and PO (Programme Outcome)

POs COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	-	-	-	1	1	1	-	2	1	-	1
CO2	3	2	1	-	-	-	-	1	1	1	-	2	1	-	1
CO3	3	2	1	-	1	1	1	1	1	1	-	2	2	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS351 Digital Logic Design Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS351	Digital Logic Design Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
NIL		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course Outcomes		● CO1: Understand basic gate operations. ● CO2: Realize the boolean function using basic gates in both SOP/POS form. ● CO3: Realize different combinational circuits with basic gates. ● CO4: Understand the basic structure of different digital components- multiplexer, decoder, encoder etc. ● CO5: Verification of state table of different flip flop using NAND/NOR gate.					
Topics Covered		1. Familiarization with IC, study of the data sheet, VCC, Ground. Verification of the truth tables. 2. Implementation of a given Boolean function using logic gates in both SOP and POS forms. Verify the Universal logic gate (NAND, NOR). 3. Verify DE Morgan's law.					

	4. Implement NAND based logic circuit for any Boolean expression. Verify that a Boolean expression, e.g. F= AB + A'C'. is functionally complete. 5. Implement a Full adder using Half Adder. Implement the combinational circuit to realize both Adder and Subtractor together. 6. Implementation and verification of Decoder, Multiplexer, Encoder and Priority Encoder etc. 7. Implement and verify Ripple Carry Adder, Carry Look Ahead Adder and BCD Adder. 8. Verification of state tables of RS, JK, T and D flip-flops using NAND & NOR gates. 9. Implement and verify the 4-bit counter
Text Books, and/or reference material	**Text Books:** 1. Digital Logic Design, M. Morris Mano, Michael D Cilleti, PHI. **Others:** 1. Laboratory Manual.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	2	-	-	-	1	-	-	-
CO2	3	2	1	2	2	-	-	-	1	-	-	-
CO3	3	2	1	2	2	-	-	-	1	-	-	-
CO4	3	2	1	2	2	-	-	-	1	-	-	-
CO5	3	2	1	2	2	-	-	-	1	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS352 Data Structures and Algorithms Laboratory 0-0-4 2 Credits 4 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS352	Data Structures and Algorithms Laboratory	PCR	0	0	4	4	2

Pre-requisites	Course Assessment methods (Continuous Assessment (CT) and End assessment (EA))
CSC-01 (Introduction to Computing), CSS-51 (Computing Laboratory)	CT+EA [CT: 60%, EA (Programming assignment + Viva Voce): 40%]
Course Outcomes	● CO1: Implement linear and non-linear data structures using linked list. ● CO2: Implement stack, queue, tree using array and linked list for problem solving. ● CO3: Implement operations and techniques like insertion and deletion, traversal, searching and sorting on various data structures. ● CO4: Analyze the time and space complexity of the algorithms.

	● CO5: Choose appropriate data structures for representation and manipulation of the data for the given problems.
Topics Covered	1. Insertion and deletion in arrays using dynamic memory allocation. 2. Linear search, Binary search (recursive, non-recursive). 3. Memory allocation and deallocation for linked list. 4. Operations on linked list: creation, display, insertion and deletion (in different positions), summation, average, maximum, minimum etc. 5. Array implementation of stack and queue. 6. Linked implementation of stack and queue. 7. Evaluation of postfix expression using stack. 8. Conversion of infix expression to its postfix version using stack. 9. Linked implementation of binary tree and preorder, inorder and postorder traversal on binary tree. 10. Implementation of binary search tree and operations on it (searching, insertion, deletion). 11. Implementation of height-balanced binary search tree (AVL tree). 12. Implementation of 2-3 tree. 13. Implementation of Chaining. 14. Implementation of sorting algorithms: Selection sort, insertion sort, bubble sort, quick sort, heap sort, merge sort, radix sort. 15. Implementation of few basic graph operations (such as breadth first and depth first traversal, finding minimum spanning tree, shortest path) on graph.
Text Books, and/or reference material	**Text Books:** 1. S. Lipschutz, “Data Structures (Schaum’s Outline Series)”, McGraw Hill Education; First edition (2017). 2. E. Horowitz, S. Sahni, S. Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press; Second edition (2008). 3. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Edu India Private Limited, Seventh edition (2017). **Reference Books:** 1. B. S. Gottfried, "Programming with C", McGraw Hill Education, Fourth ed (2018).

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	-	**2**	-	-	-	-	-	-	-	-	-
CO2	**3**	**2**	**2**	**1**	-	-	-	-	-	-	-	-
CO3	**3**	**2**	**2**	**1**	**2**	-	-	-	-	-	-	-
CO4	**3**	**2**	**2**	**1**	**2**	-	-	-	-	-	-	-
CO5	**3**	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

FOURTH SEMESTER

CSC 401 Computer Organization and Architecture 3-1-0 4 Credits 4 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 401	Computer Organization and Architecture	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Digital Logic Design (CSC302)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Analyze the various parts of a modern computer functional units, bus structure, addressing modes and Computer arithmetic. ● CO2: Identify the process involved in executing an instruction and fetching the word from memory. ● CO3: Design the hardwired and micro-programmed control units and implementation of interrupts. ● CO4: Understand the memory hierarchy and design a memory system. ● CO5: Understand Pipelined execution and instruction scheduling.					
Topics Covered		**UNIT-I**: Introduction: Evolution of computers, Basic Structure of Computers: Basic Operational Concepts, GPR based and stack based organisation. Bus Structures, Performance Measurement: Processor Clock, Basic Performance Equation, Clock Rate, Machine Instructions and Programs: Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Basic Input and Output Operations, Encoding of Machine Instructions (Huffman encoding etc). (12L) **UNIT-II**: Fundamental concepts of the processing Unit: Fetching and Storing words, Register Transfer, Execution of instruction, Arithmetic Operations: Addition and Subtraction of Signed Numbers, Design of Fast Adders, Combinational and Sequential ALU, ALU expansion strategies, Design of Multipliers and Dividers, Wallace tree and Booth's Multipliers, Floating Point Numbers (IEEE754), Floating Point Operations, Multiplication of Positive Numbers, Signed Operand Multiplication (Booth's Multiplication etc.), Fast Multiplication, Integer Division. (10L) **UNIT-III**: Computer Organization and Design (Datapath and control path): Instruction codes, computer registers, computer instructions, timing & control, instruction cycle, memory reference instructions, Hard-wired Control, Micro programmed Control: Micro instruction, Microprogram sequencing, Input/output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, Bus Arbitration schemes, USB. (Brief overview of 8085/8086 microprocessor). (12L)					

	UNIT-IV: Memory System: Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, Cache Memories – Mapping Functions, Replacement Algorithms, page mode access, interleaved access. Performance Considerations, Virtual Memories, Secondary Storage. (12L) **UNIT-V**: Basic concepts of pipelining, the instruction pipeline – pipeline hazards – instruction level parallelism – reduced instruction set –Computer principles – RISC versus CISC. Introduction to GPP, ASIP and ASIC etc. (10L)
Text Books, and/or reference material	**Text Books:** 1. David A Patterson, John L Hennessy, "Computer Organization and Design", (The Hardware/Software Interface) Morgan Kaufmann. 2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: Computer Organization, 5th Edition, Tata McGraw Hill. **Reference Books:** **1. William Stallings, "Computer Organization and Architecture".** 2. Nicholas P Carter, "Computer Architecture & Organisation".

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	1	-	-	-	-	-	1	2
CO2	3	1	2	2	1	-	-	-	-	-	2	2
CO3	3	1	2	2	1	-	-	-	-	-	2	2
CO4	3	2	2	3	2	-	-	-	1	-	2	2
CO5	3	2	2	3	2	-	-	-	1	-	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 402 Theory of Computation 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC402	Theory of Computation	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Discrete Mathematics (CSC 301)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Explain the concept of regular languages through regular expressions and finite automata. ● CO2: Describe context-free languages and context free grammars. ● CO3: Design grammars and automata for various languages. ● CO4: Examine the power of Turing machines and design TM for simple problems. ● CO5: Analyze the concept of undecidability in the context of Turing					

	machine design.
Topics Covered	1. Regular sets and Regular Expression, Non-deterministic and deterministic finite automata and their equivalence, Minimization of deterministic finite automata, Regular expressions to Finite Automata. (10L) 2. Finite Automata with outputs. (2L) 3. Properties of Regular Sets: Pumping Lemma, Closure Properties, Decision algorithms. (5L) 4. Context Free Grammars. Derivations. Ambiguity in grammars**.** **(**3L) 5. Chomsky hierarchy of languages and grammars. Regular grammars. (3L) 6. Normal Forms for Context free grammars. CNF and GNF. Closure properties of context free languages, Pumping lemma for context free languages. Decision Properties. (10L) 7. Pushdown automata. (3L) 8. Turing machines. Unrestricted Grammars. Properties of recursive and r.e. languages, Undecidability. (6L)
Text Books, and/or reference material	**Text Books:** 1. Introduction to Automata Theory, Languages and Computation by J.E.Hopcroft, Rajiv Motwani and J.M.Ullman. Pearson Education. 2. Introduction to Languages and Theory of Computation By John C. Martin McGraw Hill Education **Reference Books:** 1. Elements of the Theory of Computation By Harry R. Lewis and Christos H. Papadimitriou Prentice Hall of India. 2. Theory of Automata and Formal Languages By Anand Sharma University Science Press

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	-	-	-	-
CO2	3	3	3	3	2	-	-	-	-	-	-	-
CO3	3	3	3	3	2	-	-	-	-	-	-	-
CO4	3	3	2	3	1	-	-	-	-	-	-	-
CO5	3	3	1	3	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 403 Design and Analysis of Algorithms 3-1-0 4 Credits 4 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC 403</td><td>Design and Analysis of Algorithms</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="2">Discrete Mathematics (CSC 301), Data Structure and algorithm (CSC 303)</td><td colspan="6">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Students will be able to understand many important concepts such as asymptotic analysis, dynamic programming, recurrences etc.
● CO2: Students will be able to describe the key ideas of different algorithm design paradigms.
● CO3: Can apply different algorithmic ideas efficiently to solve new problems.
● CO4: Students can analyze and understand the time complexity of the algorithms, and its correctness.
● CO5: Can evaluate the hardness of an algorithm if required.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction and basic concepts: Algorithm, Asymptotic notations (big-Oh, big Omega, Theta, small-oh) and their significance, introduction to RAM model of computation, complexity (Time Complexity, Space Complexity) analysis of algorithms, worst case and average case. Solving Recurrences – Substitution method, Recurrence tree method and Master Method, Finding maximum and minimum of n numbers, Finding the second largest of n numbers and exact number of comparisons.
Lower bound: Lower bound for a problem. Computing the lower bound for sorting (comparison based sorting) and computing the lower bound for computing convex hull using the lower bound for sorting problem. (2L)
Amortized complexity analysis: aggregate analysis, accounting method and potential method. Examples: storage allocation problem, binary counting problem and heap sort. (4L)
Using Induction to Design algorithm: The celebrity problem, Majority Finding problem (2L)
Divide and conquer Problem: Multiplication of two n-bit integers, Strassen's Matrix Multiplication problem, Closest pair of points, linear time median finding algorithm, Convex hull and its computation. (6L)
The Greedy Algorithm: Greedy algorithms and their correctness proof: Interval scheduling problem, Interval partitioning problem, Minimizing the Lateness of Intervals problem, Fractional Knapsack Problem. (5L)
Dynamic Programming: Longest Common Subsequence, Matrix Chain Multiplication, 0-1 Knapsack Problem, longest common subsequence problem. (6L)</td></tr>
</table>

	Backtracking Method, Branch and Bound Method. (2L) **Graph Algorithms:** Depth First Search, Breadth First Search, Dijkstra's Single Source Shortest Path algorithm; All pair shortest path algorithm, Minimum Spanning Tree (Prim's and Kruskal's algorithm). (7L) **Randomized Algorithm**: Las Vegas and Monte Carlo; Randomized Quick Sort algorithm and Min Cut problem. (3L) **Reducibility between problems and NP-completeness:** Different class of Problems (P, NP, NP-Hard, NP-Complete), Discussion of different NP-complete problems like satisfiability, clique, vertex cover, independent set, Hamiltonian cycle, set cover, dominating set problem. (6L) **Approximation Algorithm:** Approximation ratio for maximization problem and minimization problem, Constant ratio approximation algorithms for metric travelling salesperson problem (TSP) and vertex cover problem, log n ratio approximation algorithm for Set Cover problem. (6L)
Text Books, and/or reference material	**Text Books:** 1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, by Prentice Hall India. 2. J. Kleinberg and Eva Tardo, Algorithm Design by Pearson Education (Indian edition). 3. S. Dasgupta, C. Papadimitriou and U. Vazirani, Algorithms, by Tata McGraw-Hill. **Reference Books:** 1. Michael T. Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Wiley, 2006. 2. Algorithms: Design Techniques and Analysis Volume 7 of Lecture notes series on computing, World Scientific, 1999. **Others:** Tim Roughgarden's video lectures and notes of CS161 and *CS261; NPTEL's lectures on Design and Analysis of Algorithms; NMEICT video on Design of Algorithms (http://www.nmeict.iitkgp.ac.in/Home/videoLink/10/3gp).*

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	-	-	-	3
CO2	3	3	3	3	2	-	-	-	-	-	-	2
CO3	3	3	3	3	3	1	1	1	1	1	1	3
CO4	3	3	3	3	2	-	-	-	-	-	-	3
CO5	2	3	2	3	2	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 404 Object Oriented Programming 2-1-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 404	Object Oriented	PCR	2	1	0	3	3

	Programming						
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Introduction to Computing (CSC01), Data Structures and Algorithms (CSC303)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding of Object Oriented Design Approach and its real world applications ● CO2: Analyzing problems in terms of object oriented methodologies. ● CO3: Implement programs using concepts of classes and objects. ● CO4: Specify the forms of inheritance and use them in problem solving. ● CO5: Learn and implement different forms of polymorphism. ● CO6: Developing skills to write generic codes					
Topics Covered		**Course Introduction-** Concepts of Object Oriented Programming, Procedural approach, Limitation of Procedural Language, Object concept. (2L) **Object Oriented Terminologies**- Class concept, ADT, encapsulation, Cardinality, Data hiding, Inheritance, Polymorphism, Advantages of OOPs, Advantages of OOPs, difference between Procedural and Object Oriented Language, Evolution of C++. (4L) **Basic Input/Output in C++ -** The 1st C++ Program (temperature conversion), compilation, Input stream and output stream, Advantages of cin a cout over pritnf and scanf. (3L) **Basic C++ features -** Literals, Constants, Manipulators, Assertions, Enumerated Data Types, Scope resolution operator. (4L) **Pointers & References in C++**- Basic operations on pointers, Array of pointers, pointer to an array, self referential structures, References in C++ , use of references. (4L) **Dynamic memory allocation/deallocation**- Use of new and delete operator, multi-dimensional array allocation, Examples. (4L) **Constructor and Destructor**, Various examples of constructors, Constructor Salient Features, Destructors,, Examples. (2L) **Functions in C++; Overloading**- function call, Macros, and it's limitations, Inline function, Function Overloading, Constructor Overloading, Examples, Function with Default arguments, Various Examples of Default arguments. (5L) **Writing C++ Classes-** Class, C++ class vs Structure, This pointer, Memory Layout of C++ program, Static member of class. Static Member Functions, Static Object, Examples. (4L) **C++ Constants Revisited** - Storage Allocation, Constants and References, Constant member data and Functions, Constants Objects, Examples. (2L) **Friend Function & Operator Overloading -** Friend Functions, Use of friend					

	functions, friends as bridges, Various examples, Operator Overloading, examples, advantages of friend functions during overloading. (4L) **Templates in C++**, Generic function and classes, examples, syntax of a template, Template class (4L) **Inheritance in C++**, Derive class, Parameterized constructor in derive class, Protector Specifier, Examples of different types of inheritance, Virtual Base Class, Up casting. Polymorphism and virtual function, Function call finding, Virtual Functions, Examples. Lecture (38): V Table and V pointer, Pure Virtual Function, Examples. Lecture (39-40): Exception Handling in C++ Lecture (41): Unformatted Input/ Output operations, Formatted I/O functions, File handling. 2-3 Lectures are planned for doubt clearance.
Text Books, and/or reference material	**Text Books:** 1. Adam Drosdek, "DATA STRUCTURES AND ALGORITHMS IN C++" , Brooks/Cole Thomson Learning. 2. Bjarne Stroustrup "The C++ Programming Language", Pearson Education. **3. E. Balaguruswamy, "Object Oriented Programming with C++", Tata McGraw Hill.** **Reference Books:** 1. Bruce Eckel, "Thinking in C++", Prentice Hall. 2. S. B. Lippman, J. Lajoie, B. E. Moo, "C++ Primer", Addison-Wesley Professional **3. Bjarne Stroustrup, "Programming: Principles and Practice Using C++", Addison-Wesley Professional.** 4. Effective C++: 50 Specific Ways to Improve Your Programs and Design by Scott Meyers, 1997. 5. More Effective C++ by Scott Meyers, 2002. **Others**: NPTEL course link by Prof. Partha Pratim Das - https://onlinecourses-archive.nptel.ac.in/noc19_cs10/preview

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	2	2	1	-	1	2	1
CO2	3	3	1	3	3	1	-	-	-	1	-	-
CO3	-	3	3	-	3	-	-	-	-	1	1	1
CO4	1	3	2	3	3	1	-	-	-	1	3	1
CO5	1	2	2	3	3	1	-	-	-	1	3	1
CO6	-	-	3	-	3	3	2	-	1	2	2	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 405 Signals and Systems 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC 405</td><td>Signals and Systems</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3">Calculus, Linear algebra</td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">The students, after successfully completing the course, will be able to:
● CO1: Understand the definitions, classifications, properties and applications of signals and systems.
● CO2: Apply Laplace transform, Fourier transform, Z-transform and other mathematical operations for the purpose of analyzing signals and systems.
● CO3: Design and analysis of continuous and discrete time systems.
● CO4: Compare continuous time and discrete time systems in real life applications.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction to Signals and systems, introduction to signals, classification of signals; mathematical operations of signals, some standard signals, generating signals using standard signals.
(6L)

Introduction to systems, classification of systems, Linear Time Invariant (LTI) Systems (continuous-time and discrete-time systems), properties of LTI systems, impulse response, convolution, causality, stability;
(6L)
Impulse response of discrete-time LTI systems, discrete time convolution, difference equations and analysis, developing equivalent discrete-time system from a given continuous-time system and analysis of their stability;
(4L)

Laplace Transform, Properties of Laplace Transform, Inverse Laplace Transform;
(4L)

Applications of Laplace Transforms to design and analyse continuous-time systems, transfer function of continuous-time systems, poles and zeros, stability analysis; (4L)

Introduction to Z-Transform, Properties of z-Transform, Region of Convergence, Inverse z-Transform;
(3L)

Applications of Z-Transforms to design and analyse Discrete Time Systems
(3L)</td></tr>
</table>

	Introduction to Fourier analysis, Fourier series for periodic signals, discrete spectrum of periodic signals; (2L) Introduction to Fourier transform, properties of Fourier transform, energy and power spectral density, frequency response of continuous-time systems, some problem examples; (4L) Fourier analysis of Discrete Signals, Discrete Time Fourier Transform (DTFT), Properties of DTFT, Examples of DTFT, DFT. (4L) Concept of state, state space analysis, state space representation of continuous time systems (2L)
Text Books, and/or reference material	**Text Books:** 1. Signals and Systems, 2nd ed., Simon Heykin and Barry Van Veen, John Wiley & Sons. 2. Signals and Systems, Oppenheim and Willsky, Prentice Hall Signal Processing Series. **Reference Books:** 1. Signal Processing and linear systems, B. P. Lathi, Oxford University Press. 2. Theory and Problems of Signals and Systems, Hsu, Schaum's Outline Series.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	3	3	3	-	-	-	-	-	-	-	2
CO3	2	3	3	3	-	-	-	-	-	-	-	3
CO4	2	2	2	2	-	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 451 Computer Organization Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 451	Computer Organization Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
Digital Logic Design (CSC302), Digital Logic Design laboratory (CSS351)		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course	● CO1: Understand the basic structure of digital computer.						

Outcomes	● CO2: Understand the synchronous / asynchronous logic. ● CO3: Perform different operations with flip-flop. ● CO4: Understand arithmetic and control unit operation. ● CO5: Understand the basic concepts of Memory.
Topics Covered	1. Introduction to Verilog HDL and Implementation of basic logic gates using Verilog. 2. Familiarization of Assembly language programming. 3. Implementation of combinational circuits using Verilog. 4. Implementation of sequential circuits using Verilog. 5. Implementation of Booth's Multiplier circuit. 6. Synthesis of simple data path and Controllers, Processor Design 7. Implementation of Random Access Memory (RAM) to perform both R/W operation. 8. Mini project.
Text Books, and/or reference material	**Text Books:** 1. David A Patterson, John L Hennessy, "Computer Organization and Design", (The Hardware/Software Interface) Morgan Kaufmann. 2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: Computer Organization, 5th Edition, Tata McGraw Hill. **Reference Books:** **1. William Stallings, "Computer Organization and Architecture".** **2. Nicholas P. Carter, "Computer Architecture & Organisation".** **Others: Laboratory Manual**

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2	2	-	-	-	1	-	-	-
CO2	3	2	1	2	2	-	-	-	1	-	-	-
CO3	3	2	1	2	2	-	-	-	1	-	-	-
CO4	3	2	1	2	2	-	-	-	2	-	-	-
CO5	3	2	1	2	2	-	-	-	1	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 452 Object Oriented Programming Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS452	Object Oriented Programming Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
Introduction to Computing (CSC01), Data Structures and		CT+EA [CT: 60%, ET(Laboratory assignment + Viva Voce): 40%]					

Algorithms (CSC303)	
Course Outcomes	● CO1: Understanding existing problems in terms of object oriented methodologies and design codes using OOL syntax ● CO2: Derive solutions using the concepts of classes and objects. ● CO3: Design and implement programs using various forms of inheritance ● CO4: Learn different forms of polymorphism and derive solution for related problems ● CO5: Implementation of templates and exception handling ● CO6: Solving mini projects using the concepts of object oriented technology
Topics Covered	**Assignment 1**: Design codes using OOL syntax; use of manipulators, dynamic allocation, multi-dimensional array writing application like addition, subtraction, multiplication, finding factorial of a large numbers etc. **Assignment 2**: Develop codes involving binary and text files involving string manipulation, graph processing, etc. **Assignment 3**: Design class library for implementing matrix, complex number, string, stack, queue, linked list, heap, binary search tree, polynomial, etc. **Assignment 4**: Develop class library to implement application like hashing, huffman code, expression evaluation using the libraries developed in assignment 3. **Assignment 5**: Enhance the class libraries in assignment 3&4 implementing function overloading. **Assignment 6**: Enhance the class libraries in assignment 3&4 implementing operator overloading. **Assignment 7**: Develop codes using inheritance. **Assignment 8**: Design and develop template classes. **Assignment 9**: Implement exception handling in some existing template classes .
Text Books, and/or reference material	**Text Books:** 1. Bruce Eckel, "Thinking in C++", Prentice Hall. 2. S. B. Lippman, J. Lajoie, B. E. Moo, "C++ Primer", Addison-Wesley Professional 3. Bjarne Stroustrup, "Programming: Principles and Practice Using C++", Addison-Wesley Professional. 4. Effective C++: 50 Specific Ways to Improve Your Programs and Design by Scott Meyers, 1997. 5. More Effective C++ by Scott Meyers, 2002. **Others:** NPTEL course link by Prof. Partha Pratim Das - https://onlinecourses-archive.nptel.ac.in/noc19_cs10/preview

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	1	1	-	-	1	-	1
CO2	-	3	3	3	3	1	2	-	-	-	1	-
CO3	-	3	3	3	3	-	1	-	-	-	1	-
CO4	2	3	3	3	3	-	1	-	-	-	2	-
CO5	-	3	3	3	3	-	-	-	1	1	3	-

CO6	3	3	1	3	2	3	2	3	3	3	3	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 453 Signals and Systems Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 453	Signals and Systems Laboratory	PCR	0	0	3	3	1.5
Pre-requisites:		Course Assessment methods (Continuous (CT) and End assessment (EA))					
MATLAB, Python		CT+EA [CT: 60%, ET(Laboratory assignment + Viva Voce): 40%]					

Course Outcomes	● CO1: Simulate signals and systems using modern computer software packages (Matlab/Python). ● CO2: Apply Laplace transform, Fourier transform, Z-transform and other mathematical operations for the purpose of analyzing signals and systems. ● CO3: Design and analysis of continuous and discrete time systems. ● CO4: Compare continuous time and discrete time systems in real life applications.
Topics Covered	1. Introduction to Computer Software Package Matlab/Python 2. Simulation of standard of signals like a. Unit step b. Unit impulse c. Ramp d. Periodic sinusoidal sequences. 3. Basic operation on signals: Addition, Subtraction, Multiplication, Division, shifting, scaling, etc. 4. Convolve and analyze signals in time domain. 5. Laplace transform and inverse Laplace transform of signals. 6. Convolution of signals in transformed domain and verification of convolution property of Fourier and Z-transform. 7. Study of LTI system and its stability. 8. Design of Stable LTI systems. 9. Design of FIR and IIR systems. 10. Implement Fast Fourier Transform algorithm of a signal.
Text Books, and/or reference material	**Text Books:** 1. Signals and Systems Laboratory with MATLAB, Alex Palamides and Anastasia Veloni, CRC Press, 2011. **Reference Books:** 2. Anywhere-Anytime Signals and Systems Laboratory, Nasser Kehtarnavaz, Fatemeh Saki, Morgan & Claypool, 2017.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	3	-	-	-	-	-	-	2
CO2	2	3	3	3	-	-	-	-	-	-	-	2
CO3	2	3	3	3	-	1	-	-	-	-	-	2
CO4	2	2	2	2	-	1	-	1	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

FIFTH SEMESTER

CSC 501 Operating Systems 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="7">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC 501</td><td>Operating Systems</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="4">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3">Computer Organization and Architecture (CSC401),Introduction to Computing (CSC01), Data Structures and Algorithms (CSC303)</td><td colspan="4">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">● CO1: Explain the functional architecture of an operating system.
● CO2: Design the process control algorithms, solution to deadlocks and multi-threading applications
● CO3: Implement application programs using UNIX system calls.
● CO4: Design and solve control & data access synchronization problems.
● CO5: Explain virtual memory organization and management in OS.
● CO6: Implantation of standard FAT & UNIX file system.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Introductory Concepts: Introduction to Operating System as a whole, memory, CPU(registers and ALU), Evolution of Operating System-types of OS(advantages and drawbacks), Performance measurement metrics. (3L)
Process Data Structures and State transitions: Process management, Basic Definitions, Process table, PCB(process control block), PTE(process table entry), Process states, Transition diagram, context of process-user level, kernel-level and process Level. (3L)
Process Control: Process creation, Parent and Child processes, System calls--fork(), exit(), wait(), kill(), Signal handling, Process scheduling strategies-FCFS, SPN, SRT, Round Robin, HRRN, Fair share scheduling. (5L)
Multi-threading: Threads in OS, thread vs process, ULT & KLT, Applications of threads, Use of POSIX threads library. (3L)
Process synchronization - Race condition, Critical section, Process Sync Solution using Algorithmic approach (Lamport bakery Algorithm), Creating shared memory using POSIX library. (2L)
Semaphore- Binary and Counting semaphore, P() and V() operations, Solving Classical problem using semaphores- Sleeping barber, Producer-consumer, Reader-writer, Dining philosophers’s problem, Posix library for semaphores. (6L)
Monitors - Solving Classical problems using monitors. (3L)
Deadlocks - Necessary and sufficient conditions for deadlocks, approaches to deal with deadlocks, Deadlock Prevention, Avoidance (Banker’s algorithm) and Detection. (3L)</td></tr>
</table>

	Memory organization & management - Virtual memory organization, Pure Paging, Pure Segmentation, Combined Paging-Segmentation, Inverted PMT, Page fault handling algorithms, Working set theory. (7L) **File management**- Directory structure, Storage of files on disks, contiguous and non-contiguous file allocation strategies, Internal and external fragmentation, FAT & Inode Structure, Free Space management, Disk scheduling strategies. (5L) **I/O management concepts** (2L)
Text Books, and/or reference material	**Text Books:** 1. "Operating System Concepts", Silberschatz and Galvin. 2. "Operating Systems: Internals and Design Principles" by William Stalling. 3. "Operating Systems: A Concept-Based Approach" by D M Dhamdhere. **Reference Books:** 1. "Operating System: A Design-oriented Approach" by Charles Crowley. 2. "Operating Systems: A Modern Perspective" by Gary J Nutt. 3. "Design of the Unix Operating Systems" by Maurice Bach. 4. "MODERN OPERATING SYSTEMS" by Andrew S Tanenbaum. **Others:** ● https://nptel.ac.in/courses/106/106/106106144/#Course "Introduction to Operating Systems" by PROF. CHESTER REBERIO, IIT Madras. ● https://nptel.ac.in/courses/106105214/ Course "Operating System Fundamentals" by Prof. Santunu Chattopadhyay, IIT Kharagpur.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	2	2	1	-	1	2	1
CO2	3	3	1	3	3	1	-	-	-	1	-	-
CO3	-	3	3	-	3	-	-	-	-	1	1	1
CO4	1	3	2	3	3	1	-	-	-	1	3	1
CO5	1	2	2	3	3	1	-	-	-	1	3	1
CO6	-	-	3	-	3	3	2	-	1	2	2	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 502 Database Management System 3-1-0 4 Credits 4 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 502	Database Management System	PCR	3	1	0	4	4

Pre-requisites	Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))
Programming knowledge, Data Structures and Algorithms	CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**

Course Outcomes	● CO1: Understand the basic concepts and appreciate the applications of database systems. ● CO2: Comprehend the fundamentals of design principles for logical design of relational databases. ● CO3: Apply the query writing skill and its subsequent optimization. ● CO4: Understand the basic issues of transaction processing and concurrency control.
Topics Covered	**Introduction:** Concept & Overview of DBMS, Applications, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS. (4L) **Entity-Relationship Model:** Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features. (5L) **Relational Model:** Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database. **(7L)** **SQL and Integrity Constraints:** Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers. (7L) **Index Structures:** Necessity of index structures, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree . (4L) **Normalization:** Functional Dependency, Anomalies in a Database, The normalization process: Conversion to first normal form, Conversion to second normal form, Conversion to third normal form and BCNF, Fourth Normal form and fifth normal form, normalization and database design, Denormalization, Loss-less join decomposition, Dependency preservation. (8L) **Transaction processing:** Introduction of transaction processing, advantages and disadvantages of transaction processing system, online transaction processing system, serializability and recoverability, view serializability. (5L) **Concurrency Control:** Serializability: Enforcing, Serializability by Locks, Locking Systems With Several, Lock Modes, Architecture for a Locking Scheduler Managing Hierarchies of Database Elements, Concurrency Control by Timestamps, Concurrency Control by Validation. (5L) **Database recovery management:** Deferred database modification Vs. Immediate

	database modification, Check point technique. (3L) **Query Optimization:** Heuristics in Query Optimization, Converting Query Tree to Query Evaluation Plan. (4L) **Distributed Database (DDB):** Introduction of DDB, DDBMS architectures, Homogeneous and Heterogeneous databases, Distributed data storage, Advantages of Data Distribution, Disadvantages of Data Distribution Distributed transactions, Commit protocols, Data Replication, Data Fragmentation. Distributed database transparency features. (4L)
Text Books, and/or reference material	**Text Books:** 1. "An Introduction to Database Systems", C. J Date, Pearson Education. 2. "DatabaseSystem Concepts", Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGraw-Hill. 3. "Distributed Databases Principles & Systems", Stefano Ceri and Giuseppe Pelagatti, McGraw-Hill International Editions. **Reference Books:** 1. "Fundamentals of Database Systems", Ramez Elmasri and Shamkant B. Navathe, Addison-Wesley. **Others:** https://onlinecourses-archive.nptel.ac.in/noc18_cs15/preview

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	1	1	1	1	1	1	2	2
CO2	3	3	3	3	2	1	1	-	-	2	2	2
CO3	2	3	3	3	2	1	1	-	-	2	2	2
CO4	3	2	2	2	1	1	1	1	1	1	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 503 Compiler Design 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 503	Compiler Design	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Theory of Computing/ Theory of Automata		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course	● CO1: Idea of the difference between Compiler and other various						

Outcomes	Translators, Phases of a Compiler and Bootstrapping. ● CO2: Understand Lexical Analyzer, Transition Diagram of different tokens, Reserved Word Strategy. ● CO3: Idea of Syntax Analyzer, Ambiguity, Parse Tree, Top Down and Bottom Up Parser. ● CO4: Concept of Semantic Analyzer, Semantic Actions, Intermediate Code, Virtual Machine. Lexical and Grammatical Errors. ● CO5: Idea of Code Optimization, Criterion of Optimization, Different Local and Global Optimization Techniques. ● CO6: Idea of Code Generation, Instruction Costs, Code Generation Algorithm, Run Time Store Management.
Topics Covered	Idea of the difference between Compiler and other various Translators, Phases of a Compiler and Bootstrapping. (5L) Understand Lexical Analyzer, Transition Diagram of different tokens, Reserved Word Strategy. (5L) Idea of Syntax Analyzer, Ambiguity, Parse Tree, Top Down and Bottom Up Parser. (6L) Concept of Semantic Analyzer, Semantic Actions, Intermediate Code, Virtual Machine. Lexical and Grammatical Errors. (7L) Idea of Code Optimization, Criterion of Optimization, Different Local and Global Optimization Techniques. (7L) Idea of Code Generation, Instruction Costs, Code Generation Algorithm, Run Time Store Management. (7L) Symbol Table Design, Fixed Length and Variable Length Entry, Symbol Table Actions, Different Searches, Hash Table Organization, Different Deletions of Symbols, Linked List and Tree Representation. (5L)
Text Books, and/or reference material	**Text Books:** 1. Principles of Compiler Design – Alfred V. Aho & Jefrey D. Ullman, Pearson Education. **Reference Books:** 1.Compiler Design in C – Holub, Prentice Hall.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	-	-	-	-	-	-	3
CO2	2	3	3	2	2	-	-	-	-	-	-	3
CO3	2	2	3	2	2	-	-	-	-	-	-	3
CO4	2	2	3	3	2	-	-	-	-	-	-	3
CO5	3	2	3	3	2	-	-	-	-	-	-	3
CO6	3	2	3	3	2	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 504 Embedded Systems 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC504	Embedded Systems	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Computer Organization and Architecture (CSC401)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1:. Understand the Building Blocks of Embedded Systems ● CO2 : Learn to implement circuits using FPGAs and HDL programming ● CO3 :. Learn the working of microcontrollers in building embedded systems. ● CO4 : Understand the importance of power in the design process. ● CO5 : Understand the concepts and constraints of realtime systems. ● CO6 : Learn the techniques of synthesising hardware design from HDL.					
Topics Covered		UNIT-1 Introduction to embedded System, Modular approach to embedded system design using six-box approach: Input devices, output devices, embedded computer, communication block, host and storage elements, and power supply., Processor, General Purpose and ASICs Processor, Designing a single purpose processor, Optimization Issues 6L UNIT-2 Introduction to FPGA, Behavioral synthesis on FPGA using VHDL/Verilog 4L UNIT-3 Microcontroller based embedded system Design, Salient feature of modern microcontroller, Arduino Uno, Serial Communication and Timer, Controller Design using Arduino 5L UNIT-4 Sensors and Signals, Discretization of signals and A/D Converter, Quantization Noise, SNR and A/D converter, 5L UNIT-5 Power Aware Embedded System, SD and DD Algorithm, Parallel operations and VLIW, Code efficiency, DSP Application and address generation Unit 6L UNIT-6					

	Real time operating system, RMS Algorithm, EDF Algorithm and resource constraint issue, Priority inversion and Priority inheritance 5L UNIT-7 Modelling and specification, FSM and state chart, state mate semantics, Program state machine, SDL, Data flow model 5L UNIT-8 Hardware synthesis, Scheduling, Digital camera design, Digital camera-iterative design, HW-SW partitioning, Optimization, Simulation, Formal verification 6L
Text Books, and/or reference material	**Text Books:** 1. Mazidi and Mazidi, Microcontroller and Embedded Systems, Pearson Education. 2. Peter Marwedel, Embedded System Design, Kluwer. 3. Wayne Wolf, Computers as Components: Principles of Embedded Computing Systems Design, Morgan-Kaufmann. 4. Frank Vahid and Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, John Wiley. **Reference Books:** 1. R. Kapadia, 8051 Microcontroller and Embedded Systems, Jaico. 2. Peatman,J.B., "Design with PIC Micro Controllers"PearsonEducation,3rdEdition, 2004. 3. Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	1	-	-	1
CO2	3	3	3	1	1	-	-	-	1	-	-	1
CO3	3	3	3	1	1	-	-	-	-	-	-	-
CO4	3	2	2	1	1	-	-	-	-	-	-	-
CO5	3	3	3	1	1	-	-	-	-	-	-	-
CO6	2	2	1	-	-	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 551 Design and Analysis of Algorithms Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 551	Design and Analysis of Algorithms	PCR	0	0	3	3	1.5

	Laboratory						
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
Design and analysis of Algorithm (CSC 503), Data Structures and Algorithms Laboratory (CSS 352)		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course Outcomes	After completion of this course, the students will be: ● CO1: Able to identify the essence of theory into implementation. ● CO2: Able to interpret the theory efficiently through coding. ● CO3: Able to verify the theory experimentally. ● CO4: Able to explain the behaviour of an algorithm efficiently. ● CO5: Able to compare the efficiency of different algorithms.						
Topics Covered	**Assignment 1:** Exponential versus Polynomial Running time solution of a problem. **Assignment 2:** Heaps and priority queue. **Assignment 3:** Problem based on Linear time sorting algorithm. **Assignment 4:** Problem using Divide and Conquer algorithm. **Assignment 5:** Problem using Greedy algorithm. **Assignment 6:** Problem using Dynamic Programming algorithm. **Assignment 7:** Graph representation and traversal. **Assignment 8:** Problem using Union Find structure. **Assignment 9:** Problem using Interval tree. **Assignment 10:** Convex Hull computation from a given set of n points in 2D and then determining the farthest pair of these point set.						
Text Books, and/or reference material	**Text Books:** 1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, by Prentice Hall India. 2. J. Kleinberg and Eva Tardo, Algorithm Design by Pearson Education (Indian edition). **Reference Books:** 1. Michael T. Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Wiley, 2006. 2. S. Dasgupta, C. Papadimitriou and U. Vazirani, Algorithms, by Tata McGraw-Hill. **Others:** The Algorithm Design Manual 2nd ed. 2008 Edition by Steven S S. Skiena, Springer.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	3	-	-	-	1	1	-	3
CO2	2	2	3	3	3	-	-	1	2	1	1	3
CO3	2	2	2	3	3	-	-	1	1	2	1	3
CO4	2	3	3	2	1	1	-	-	-	3	1	3
CO5	2	2	3	3	3	1	1	2	2	2	1	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 552 Embedded System Design Laboratory 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 552	Embedded Systems Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
CSS 451 Computer Org. Laboratory		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					

Course Outcomes	After the course the students are expected to be able to CO1: Learn the working of microcontroller. CO2 : Understand the Building Blocks of Embedded Systems CO3 : Learn to implement circuits using FPGAs and HDL programming. CO4 : Learn to solve problems using Arduino/Raspberry Pi CO5 : Know the characteristics ARM processor and use it in designing embedded systems.
Topics Covered	List of Experiments: 1. Familiarization with 8051 microcontroller based programming. 2. Interfacing of 8051 Microcontroller with ADC and DAC/LCD Display/Traffic signal Processing etc. 3. Simulating simple circuits using Verilog/VHDL and FPGA kits. 4. LED blink for different amounts of time using Arduino (with/without using delay() function). 5. Controlling the LED blinking using a Potentiometer (Read potentiometer). 6. Interfacing Arduino with simple LED Matrix. 7. Sensing temperature using Raspberry Pi. 8. Familiarization with ARM DEVELOPMENT KIT microcontroller using embedded C program. 9. Develop and verify the interfacing LED and PWM with ARM DEVELOPMENT KIT microcontroller using embedded C program 10. Develop and verify the interfacing of real time clock and serial port with ARM DEVELOPMENT KIT microcontroller using embedded C program. 11. Verify the Interrupt performance characteristics of ARM and FPGA by using embedded C program
Text Books, and/or reference material	**Text Books:** 1. Peatman,J.B., "Design with PIC Micro Controllers"PearsonEducation,3rdEdition, 2004. 2. Programming Arduino: Getting Started with Sketches Book by Simon Monk 3. R. Kapadia, 8051 Microcontroller and Embedded Systems, Jaico.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	1	-	-	1
CO2	2	2	2	2	2	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	1	-	-	-
CO4	3	3	3	3	3	-	-	-	1	-	-	1
CO5	2	2	2	1	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 553 Operating Systems Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 553	Operating Systems Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
Introduction to Computing (CSC01), Data Structures and Algorithms (CSC303)		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course Outcomes		● CO1: Implement elementary UNIX system commands. ● CO2: Devise programs to test synchronization problems. ● CO3: Design and develop user level thread library. ● CO4: Design and implement file system.					
Topics Covered		**Assignment 1**: Getting a feel of race conditions through read/write operations by multiple process (run the same program in four terminals simultaneously) on a single binary file. **Assignment 2**: Design application where the parent process uses fork system call to create multiple child processes in the different given hierarchy and displaying and storing the process hierarchy in a separate file. **Assignment 3**: Design application where parent sync with several child processes using fork & wait system call to solve a particular task (searching, prime number generation, etc.) like parallely also try to understand and change process priorities using system calls. **Assignment 4**: Implement signal handling among parent child processes. **Assignment 5**: Design multithreaded application using POSIX thread library. **Assignment 6**: Create shared memory to be used among a set of concurrent processes using POSIX library. **Assignment 7**: Implement semaphores (named) and solve data access sync					

	problems like (producer/consumer) using multiple processes. **Assignment 8**: Implement semaphores (unnamed) and solve data access sync problems like (producer/consumer) using multiple threads. **Assignment 9**: Use other IPC mechanisms like message queues, named pipe.
Text Books, and/or reference material	**Text Books: "**Beginning Linux Programming", 4th Edition by Richard Stones, Neil Matthew, Wiley Publishing, Inc. **Reference Books: "**Advanced Programming in the UNIX environment", 3rd Edition, W. Richard Stevens and Stephen A. Rago, Addison-Wesley, 2013.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	2	2	1	-	1	2	1
CO2	3	3	3	3	2	1	-	-	-	1	-	-
CO3	-	3	3	-	3	-	-	-	-	1	1	1
CO4	1	3	2	3	2	1	-	-	-	1	3	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SIXTH SEMESTER

HSC 631 Economics and Management Accountancy 3-0-0 3 Credits 3 Hrs

Department of Humanities and Social Sciences							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSC631	Economics and Management Accountancy	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					

Course Outcomes

- CO1 Learners will be able to review basic economic principles.
- CO2 Learners will be introduced to the basic capital appraisal methods used for carrying out economic analysis of different alternatives of engineering projects or works.
- CO3 Learners will gain a good knowledge of financial accounting, enabling them prepare, analyse and interpret financial statements for taking informed decisions.

Topics Covered

PART 1: Economics

Group A: Microeconomics

Sl. No.	Name	L	T	P	Cr	H
Unit 1:	Economics: Basic Concepts	2	0	0	2	2
Unit 2:	Theory of Consumer Behaviour	3	0	0	3	3
Unit 3:	Theory of Production, Cost and Firms	3	0	0	3	3
Unit 4:	Analyses of Market Structures: Perfect Competition	3	0	0	3	3
Unit 5:	Monopoly Market	2	0	0	2	2
Unit 6:	General Equilibrium & Welfare Economics	2	0	0	2	2
	TOTAL	**15**	**0**	**0**	**15**	**15**

Group B: Macroeconomics

Sl. No.	Name	L	T	P	Cr	H
Unit 1:	Introduction to Macroeconomic Theory	2	0	0	2	2
Unit 2:	National Income Accounting	3	0	0	3	3
Unit 3:	Determination of Equilibrium Level of Income	4	0	0	4	4
Unit 4:	Money, Interest and Income	2	0	0	2	2
Unit 5:	Inflation and Unemployment	2	0	0	2	2
Unit 6:	Output, Price and Employment	2	0	0	2	2
	TOTAL	**15**	**0**	**0**	**15**	**15**

PART 2: Management Accountancy

Sl. No.	Name	L	T	P	Cr	H
Unit 1:	**Introduction to Accounting**: Accounting Environment of Business; Objectives of Accounting; Accounting Equations for Financial Statements. Books of Accounting: Journal, Ledger, Cash book.	3	0	0	3	3
Unit 2:	**Financial Statement Preparation and Analysis:** Preparation of Trial Balance, Trading, Profit & Loss account and Balance Sheet. Case study discussion.	5	0	0	5	5
Unit 3:	**Financial Ratio Analysis:** Common Size Statements; Computation of Financial Ratios; Interpretation and analysis of Financial Ratios with the help of case studies.	4	0	0	4	4
	TOTAL	**12**	**0**	**0**	**12**	**12**

Text Books, and/or reference material

PART 1: Economics

Group A: Microeconomics

1. Koutsoyiannis: Modern Microeconomics
2. Maddala and Miller: Microeconomics
3. AnindyaSen: Microeconomics: Theory and Applications
4. Pindyck&Rubenfeld: Microeconomics

Group B: Microeconomics

1. W. H. Branson: Macroeconomics – Theory and Policy (2nd ed)
2. N. G. Mankiw: Macroeconomics, Worth Publishers
3. Dornbush and Fisher: Macroeconomic Theory
4. Soumyen Sikder: Principles of Macroeconomics

PART 2: Management Accountancy

1. Gupta, R. L. and Radhaswamy, M: Financial Accounting; S. Chand & Sons
2. Ashoke Banerjee: Financial Accounting; Excel Books
3. Maheshwari: Introduction to Accounting; Vikas Publishing
4. Shukla, MC, Grewal TS and Gupta, SC: Advanced Accounts; S. Chand & Co.

CO-PO MAPPING of Economics and Management Accountancy (HSC631)

POs COs	PO 1	PO2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	2	3	2	3	3	3
CO2	3	3	3	3	3	3	2	2	3	3	3	3
CO3	-	-	-	1	-	-	-	-	-	2	3	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 601 Software Engineering 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC 601</td><td>Software Engineering</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3"></td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: How to apply the software engineering lifecycle by demonstrating competence in communication, planning, analysis, design, construction, and deployment.
● CO2:An ability to work in one or more significant application domains to develop and deliver quality software..
● CO3:Demonstrate an understanding of and apply current theories, models, and techniques that provide a basis for the software lifecycle.
● CO4: Demonstrate an ability to use the techniques and tools necessary for software engineering practices.</td></tr>
<tr><td>Topics Covered</td><td colspan="7"><u>Software Paradigm / Introduction</u>: Definition of Information System, software, software engineering paradigms, Software engineering in context of Business Process Engineering, Goal of Software Engineering, Quality focus. (2L)
<u>Software Process Model</u>: Umbrella activities; Waterfall Model, Prototype model, Rapid Application Development Model, Evolutionary Approach in Process model (Spiral Model). (4L)
<u>Requirement Engineering</u>: Requirements Engineering Tasks, Information Modelling (Entity Relationship Model, Extended ER Model), Functional Model (DFD, CFD), Behavioral Model (State Transition Diagram), Petri-net modelling, System Requirement Specification (SRS), Specification Language – Formal Methods, Regular Expression, Decision Tree, Decision Table, SRS Standards. (6L)
<u>Design Principle and Basics</u>: Design level tasks, Problem partitioning, abstraction, top down & bottom up design strategies, refinement techniques, Minor Design principles, Control Hierarchy (Structured Chart), constraint design (Warnier –Orr). (2L)
<u>Design Language basics</u>: Unified Modelling Language – Building Blocks, Well-formedness rule; Use case, structural diagram introduction - Class Diagram, Object Diagram, Sequence diagram, collaboration diagram. (6L)
<u>Modular Design</u>: Concept of module and Modular design, Functional independency, Cohesion, Coupling, measuring cohesion and coupling, Model Driven Architecture. (4L)
<u>Architecture Basic</u>: Software architecture, Functional and extra-functional properties, families of related system, Architectural styles: Data-centric, data-</td></tr>
</table>

	flow, call and Return, layered, enterprise. (2L) *Project Management*: LOClFunction Point Analysis PERT Chart estimation, Different cost estimation: Delphi-empirical-COCOMO estimation. (2L) *Coding Techniques & Standard guidelines*: Rules/guidelines for standard Coding l Gunning Fog Index for documentation. (2L) *Testing strategy 1*– Introduction to Software Testing, Software Testing Terminology and Methodology Verification and Validation, Static Testing: Inspections, Structured Walkthroughs, Technical Reviews l Dynamic Testing: Black-Box Testing Techniques: Boundary Value Analysis (BVA), Equivalence Class Testing, State Table-Based Testing, Decision Table-Based Testing, Cause-Effect Graphing Based Testing, Error Guessing Dynamic Testing : White-Box Testing Techniques: Need of White-Box Testing, Logic coverage Criteria, Basis Path Testing, Graph Matrices, Loop Testing, Data Flow Testing.(6L) *Testing strategy 2*- Validation Activities: Unit Validation Testing, Integration Testing, Function Testing, System Testing, Acceptance Testing lRegression Testing: Progressive vs Regressive Testing, Regression Testability. (2L) *Software & Metrics:* Software Measurement & metrics, Direct and indirect metrics, Size oriented metrics, Function oriented Metrics, Complexity Metrics – McCabe Complexity, McClure Complexity, and Halstead Software Science (4L) Standard Software Engineering Practices: IS 16458 and IS 16443 recommendations. (2L).
Text Books, and/or reference material	**Text Books:** R. S. Pressman -"Software Engineering – Practitioner's Approach"- McGraw Hill International. I. Somerville – "Software Engineering", Addison-Wesley **Reference Books:** Rajib Mal - "Fundamental of Software Engineering", PHI. **Others:** Unified Modelling Language, Object Management Group, http://www.omg.org/spec/UML/

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	1	1	1	1	1	1	2	2
CO2	3	3	3	3	2	2	2	1	1	2	2	2
CO3	3	3	3	3	3	2	1	1	2	2	2	3
CO4	3	2	3	2	1	1	1	1	1	1	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSC 602 Data Communication and Computer Networks 3-1-0 4 Credits 4 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC 602</td><td>Data Communication and Computer Networks</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3">Data Structures and Algorithms, Operating system concepts</td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Understand the basic taxonomy and terminology of the computer networking and enumerate the layers of OSI model and TCP/IP model.
● CO2: Comprehend the fundamentals of Physical layer, and will apply them in real time applications.
● CO3: Identify data link layer concepts, design issues, and protocols.
● CO4: Classify the routing protocols and analyze how to assign the IP addresses for the given network.
● CO5: Acquire knowledge of Application layer and Presentation layer paradigms and protocols.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Overview of Data Communication and Networking: Introduction; Data communications: components, data representation (ASCII,ISO etc.), direction of data flow (simplex, half duplex and full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN,WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study. (4L)

Physical Level: Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit switching: time division & space division switch, TDM bus; Telephone Network. (6L)

Data link Layer: Types of errors, framing (character and bit stuffing), error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, Go-Back- N ARQ, Selective repeat ARQ, HDLC; Medium Access sublayer: Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA, Traditional Ethernet, Fast Ethernet. (12L)

Network layer: Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, subnetting; Routing: techniques, static vs. dynamic routing, Unicast Routing Protocols: RIP, OSPF, BGP; Other</td></tr>
</table>

	Protocols: ARP, IP, ICMP, IPV6, Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm. (14L) **Transport layer:** Process to Process delivery; Socket address, UDP; TCP. (4L) **Application Layer:** Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW. (4L) **Security:** Threats analysis,Cryptography (Public, Private Key based), Digital Signature, authentication, access control, security standards like TLS, IS/ISO 27000 series and IS/ISO 18000 (6L) **Modern topics:** Introduction to Wireless Technology, Introduction to Software Defined networking (SDN). (4L) **Queuing Theory:** Introduction to Queuing Theory and Delay Analysis for networks. (2L)
Text Books, and/or reference material	**Text Books:** 1.B. A. Forouzan – "Data Communications and Networking (3rd Ed.) " – TMH. 2. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI. **Reference Books:** 3. Comer – "Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.)" – Pearson Education/PHI.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	1	1	1	1	2	2	2
CO2	2	2	1	1	1	1	1	1	1	1	2	2
CO3	2	2	3	2	2	1	1	1	1	1	1	2
CO4	3	3	3	3	2	2	2	1	1	2	2	2
CO5	2	2	2	2	2	1	1	2	1	2	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 651 Compiler Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS651	Compiler Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
Compiler Design Theory of Computation CSC402		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course Outcomes		• CO1: To apply the concept of regular expressions in the identification of tokens in a lexical analyzer.					

	• CO2: To explore the use of program generating softwares like LEX and FLEX. • CO3: To generate context -free grammar to represent the syntax of the language. • CO4: To use compiler generators like YACC and BISON. • CO5: To use syntax directed translation to generate intermediate code.
Topics Covered	1. Handle tokens in an input using LEX generated program. 2. Describe class of tokens using regular expressions in LEX. 3. Use context free grammars with YACC to describe simple syntactic structures. 4. Remove ambiguity in if-then-else constructs using YACC's inbuilt features. 5. Use syntax directed translation in YACC to generate simple intermediate code.
Text Books, and/or reference material	**Text Books:** 1. Lex - A Lexical Analyzer Generator ***M. E. Lesk and E. Schmidt*** Online Manual. 2. Yacc: Yet Another Compiler-Compiler ***Stephen C. Johnson*** Online Manual. 3. Lex & Yacc*John R. Levine, Tony Mason, Doug Brown* , O'Reilly & Associates. **Reference Books:** **1. Compilers: Principles, Techniques, and Tools** By Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman. Addison-Wesley Pub Co.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	-	-	-	-
CO2	2	3	3	2	3	-	-	-	-	-	-	-
CO3	3	3	3	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	3	-	-	-	-	-	-	-
CO5	3	2	3	2	3	-	-	-	-	-	-	-

Mapping of CO (Course Outcome) and PO (Programme Outcome)
Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 652 Data Communication and Computer Networks Laboratory 0-0-3 1.5Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 652	Data Communication and Computer Networks Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End					

	assessment (EA))
Operating System Laboratory	CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]
Course Outcomes	● CO1: Develop programs for client-server applications. ● CO2: Perform packet sniffing and analyze packets in network traffic. ● CO3: Implement error detecting and correcting codes.
Topics Covered	Assignment 1 : Packet capturing and analyzing using wireshark packet sniffer tool Assignment 2 : Socket Programming for TCP client server (Iterative server). Assignment 3 : Socket Programming for TCP client server (Concurrent Server). Assignment 4 : Socket programming for UDP client. Assignment 5 : Handling both TCP client and UDP client using select() system call. Assignment 6 : Simplified FTP implementation. Assignment 7 : Two player game (Tic Tac Toe) implementation. Assignment 8 : Implementation of CRC and Hamming code for error handling Assignment 9 : RPC (Remote Procedure Call) implementation.
Text Books, and/or reference material	**Text Books:** 1. Richard Stevens, Unix Network Programming, Volume 1 and 2, Addison-Wesley Professional. **Reference Books:** 1. Neil matthew and Richard Stones, Beginning Linux Programming, Wrox Publishers, 4th Edition.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	-	-	1	1	1	2	2
CO2	2	2	2	2	2	-	-	1	1	1	2	2
CO3	2	2	2	2	2	-	-	1	1	1	2	2

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 653 Database Management System Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 653	Database Management System Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
Programming knowledge, Data structure knowledge		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					

Course Outcomes	● CO1: Understand, appreciate and effectively explain the underlying concepts of database technologies. ● CO2: Design and implement a database schema for a given problem-domain. ● CO3: Populate and query a database using SQL DML/DDL commands. ● CO4: Programming PL/SQL including stored procedures, stored functions, cursors, packages.
Topics Covered	**Structured Query Language (SQL):** 1. Creating Database Creating a Database Creating a Table Specifying Relational Data Types Specifying Constraints Creating Indexes. 2. Table and Record Handling INSERT statement Using SELECT and INSERT together DELETE, UPDATE, TRUNCATE statements DROP, ALTER statements. 3. Retrieving Data from a Database The SELECT statement Using the WHERE clause Using Logical Operators in the WHERE clause Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING Clause Using Aggregate Functions Combining Tables Using JOINS Subqueries. 4. Database Management Creating Views Creating Column Aliases Creating Database Users Using GRANT and REVOKE. **PL / SQL:** Decision-control in PL / SQL, Cursors in PL / SQL, Stored Procedures. **Case Studies:** Real-life case studies.
Text Books, and/or reference material	**Text Books:** SQL, PL/SQL the Programming Language of Oracle by Ivan Bayross**,** PHI, 2010. **Reference Books:** SQL The Complete Reference, Groff James, 3rd Edition, Tata McGraw-Hill Education, India.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	2	1	1	1	1	1	1	2
CO2	2	3	3	2	2	1	1	1	1	1	1	2
CO3	2	3	3	2	2	1	1	1	1	1	1	2
CO4	2	3	3	2	2	1	1	1	1	1	1	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Depth Elective – 1, 2

CSE 612 System Software 3-0-0 3 Credits 3Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE612	System Software	PEL	3	0	0	3	3
Pre-requisites: Programming		Course Assessment methods (Continuous Assessment (CA), Mid-					

Language Paradigms, Theory of Computing, Computer Architecture, Operating Systems, Compilers	Term (MT), End Term (ET))
	CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**
Course Outcomes	● CO1: To introduce the students to the collection of programs and procedures which constitute the system software of a computer platform. ● CO2: To allow the students to understand & acknowledge the main objectives, problems faced and programming techniques used by a system programmer in designing and implementing system software. ● CO3: To emphasize on the conceptual framework in which the system software is developed and used rather than a broad overview of programs which belong to the system software running on a particular computer platform. ● CO4: To enable the students to deduce the logical relationship between the software components of any software system. ● CO5: To enable students to understand the mechanism of Integration of different System Software components.
Topics Covered	Part I: The Methodology ● The fundamental objective of this part is to develop a concept of a System. ○ Concept is to be built upon both Mathematical construction(Algebraic and Logic Systems) as well as around construction based on Abstract Machines. (3L) ● Programs and documents that are part of System Software are to be defined. (1L) ● A structuring of System Software Components are to be defined and built. ○ Vertical Structuring: Components of the system software are layered on a hierarchy of levels. The hardware system is taken as the first level of this hierarchy. The interface relationship between the components of the system software vertical hierarchy is then established. (2L) ○ Horizontal Structuring: Each level of the system software vertical hierarchy is discussed as a horizontal structure. The elements of this horizontal structure (formal definitions will also be given) are specific software components of the system software organized as software systems. (2L) ● The specific problems posed by the interaction between the software system components of a horizontal level of the system software hierarchy are discussed and illustrated. The problems raised by the **reliability, efficiency, convenience**, and evolution of a system software are introduced and illustrated. (2L) Part II: Programming Support Environment: ● of a System Software is to be discussed as the collection of tools offered by a computer platform to computer users to help them use the computer to develop programs that solve their problems. (2L) ● Detailed discussions on Topics like: Language, Translators, Interpreters, Mechanism of target machine code generation; proper emphasis on

	distinguishing between Compilers, Assemblers, Linker/Loaders, and Interpreters will be there. Interfacing users with the Operating System environment as tolls from the support environment is to be discussed. (6L) ● Case study of JVM, GNU GCC implementation of the Linux Assembler, Linker and Loader will be dealt with in detail, introducing implementation of symbol tables. (7L) Part III: Execution Support Environment: ● A software system that manages computer resources of the computer platform and the processes running on the computer platform will be introduced and illustrated by the operating system. (3L) ● The components of the operating system itself are layered on the levels of a hierarchy. (2L) ● The mechanism of a system call (system function call) will be discussed as a tool for implementing this hierarchy relation. (2L) ● The following layers of an operating system will be discussed with a practical illustration with the Linux kernel, with mechanisms of designing system programs developed with and for the support of: (10L) ○ Interrupt System ⇔ designing interrupt handlers. ○ Process Management System ⇔ designing schedulers. ○ Memory Management System ⇔ designing page-fault exception handlers ○ Input/Output Management System ⇔ designing device drivers ○ Information Management System (File System) ⇔ examining ext2/ext3/ext4.
Text Books, and/or reference material	**Text Books:** 1. System Software and Software Systems: Systems Methodology for Software, Tudor Rus, World Scientific Press, 1993. 2. System Software: An Introduction to Systems Programming, leyland L. Beck, 1996. 3. System Programming with C and Unix, Adam Hoover, Adison Wesley 2010. **Reference Books:** 1. Understanding the Linux Kernel, Daniel P. Bovet, Marco Cesati, O'Reilly Pub Date:November 2005. Available online at: http://johnchukwuma.com/training/UnderstandingTheLinuxKernel3rdEdition.pdf

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	2	-	-	-	-	-	-	-
CO2	2	3	3	3	3	-	-	-	-	-	-	-
CO3	2	2	-	3	2	-	-	-	-	-	-	-
CO4	-	3	-	3		-	-	-	-	-	-	-
CO5	-	3	-	2	3	-	-	-	-	2	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 613 Internet and Web Technologies 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 613	Internet and Web Technology	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Programming Fundamentals, Data Structure and Algorithms, Operating Systems, Data networks (may be carried out simultaneously)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding the fundamental concepts of Internet Structure and Protocols. ● CO2: Using TCP/IP protocols and Internet programming using SOCKET API. ● CO3: Understanding HTTP protocol and Structures of Web Programming. ● CO4: Designing and developing Web applications with security enhancement. ● CO5: Understanding Semantic Web and Applying Web Analytics over Semantic Web.					
Topics Covered		INTERNET TECHNOLOGY: Brief review of Data Networking; data transmission, links and MACs, Forwarding and Routing, TCP-IP layered network concepts. (3L) Internet specific issues like scalability, inter-operability. (1L) Internet Structures – logical and physical grouping with sub-netting and super netting. (3L) Review of TCP-IP protocols – processing, performance and variations. (3L) Security Implementations - secured IP, Transport Layer security. (3L) Quality of Service Issues and their Application in Internet. (2L) SOCKET PROGRAMMING: Introduction to SOCKET API; Client programming; Server programming – sequential, concurrent and multi-threaded; P2P application Programming. (4L)					

	HTTP: Requests and Responses - Message Formats, Headers and Fields; TCP Keep-alive and pipe-lining concepts; Server Architecture ,Performance and Deployment. (3L) WEB PROGRAMMING: Document Object Model; Client side scripting fundamentals: Server Side Scripting and Programming – Data base connectivity, session management and security enhancement; Introduction to Web Application Development Platforms – JavaEE, Dzango. (7L) XML: DTD and Schema; Visualisation using XSLT; Web Application using XML; Service Oriented Architecture and Web services based application development and deployment; Xquery and SOA based application development platforms. (6L) SEMANTIC WEB: General Concept of Semantic Web and linked Data; RDF based relation description; Web Ontology concepts and use; Putting XML, RDF and Ontology together to develop semantic web applications; Capturing Information from semantic web pages; Data analytics over semantic and linked Web. (7L)
Text Books, and/or reference material	**Text Books:** 1. B. A. Forouzan, "TCP/IP Protocol Suite", 4th Edition, 2010, McGrawHIll Publishers. 2. P. Deitel, H. Deitel, A Deitel, "Internet and World Wide Web – How to Program", Pearson. 3. G. Antoniou, P. Groth, F. Harmelen and R. Hoekstra, "A Semantic Web Primer" Prentice Hall India. **Reference Books:** 1. D. E. Comer and D L Stevens, "Internetworking with TCP/IP vol.II", Pearson.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	3	2	1	1	2	-	-	1
CO2	2	2	-	-	3	1	-	-	1	-	-	-
CO3	1	1	-	-	3	2	2	2	3	1	1	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	2	3	2	-	2	3	-	-	2

Mapping of CO (Course Outcome) and PO (Programme Outcome)
Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 614 Advanced Computer Architecture 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSE 614</td><td>Advanced Computer Architecture</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="2">Digital Electronics, Computer Organisation</td><td colspan="6">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● ·CO1: Understand classes of computers and interpret the performance of a processor based on different metrics.
● CO2: Design and describe pipeline data-path for performance enhancement.
● CO3: Understanding the challenges in realizing different levels of parallelism and leverage them for performance enhancement.
● CO4: Design of memory hierarchy for efficient memory design.
● CO5: Appreciate and evaluate the new trends and developments in computer architecture.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">OVERVIEW OF VON NEUMANN ARCHITECTURE: Instruction set architecture; The Arithmetic and Logic Unit, The Control Unit, Memory and I/O devices and their interfacing to the CPU; Measuring and reporting performance; CISC and RISC processors. (4L)

PIPELINING: Pipelining fundamentals, Linear and Nonlinear Pipeline Processors, Arithmetic and instruction pipelining, Pipeline hazards, Techniques for overcoming or reducing the effects of various hazards, superscalar and super pipelined and VLIW architectures.
(8L)

INSTRUCTION –LEVEL PARALLELISM (ILP): Concepts and challenges of ILP; Compiler Techniques for exposing ILP; Branch costs reductions - Static and Dynamic predictions; Hardware-based speculation.
(8L)
MEMORY HIERARCHY DESIGN: Introduction; Memory technology and optimizations, Virtual memory, Cache memory, Cache performance; Cache Optimizations, Cache coherence, Cache coherence protocols – snoop based and directory based protocols, Advanced optimizations of cache performance.
(10L)</td></tr>
</table>

	MULTIPROCESSORS ARCHITECTURES: Introduction; Taxonomy of parallel architectures, Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. (8L) INTERCONNECTION NETWORKS: Topology, Different interconnection Networks, Routing Mechanism. (4L)
Text Books, and/or reference material	**Text Books:** 1. Computer Architecture, A Quantitative Approach – John L. Hennessey and David A. Patterson; 4th edition, Morgan Kaufmann. 2. Advanced Computer Architecture Parallelism, Scalability, Programmability – Kai Hwang; Tata Mc-Graw Hill. **Reference Books:** 1. Computer architecture and parallel processing – Kai Hwang and FayéAlayé Briggs; McGraw-Hill. 2. Parallel Computer Architecture, a Hardware / Software Approach – David E. Culler, Jaswinder Pal Singh, Anoop Gupta; Morgan Kaufman. 3. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill. 4. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House. **Others:** NPTEL/MOOC Courses materials.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	-	1	-	-	-	-	1
CO2	3	3	3	2	2	-	1	-	-	-	-	1
CO3	3	3	2	3	3	-	1	-	-	-	-	2
CO4	2	3	3	2	3	-	2	-	-	-	-	1
CO5	3	3	3	3	3	-	-	-	-	-	-	3

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 615 Optimization Techniques 3-0-0 3 Credits 3 Hours*

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE615	Optimization Techniques	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Engineering Mathematics, Discrete Mathematics		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: To understand the Basic principles of optimization. ● CO2: To able to formulate optimization problem mathematically. ● CO3: To know various solution methods in optimization Problems. ● CO4: Able to perform sensitivity analysis and post processing of optimal solutions. ● CO5: Able to explore a wide range of engineering optimization problems.					
Topics Covered		Introduction to Optimization- Development, mathematical problem formulation, engineering applications of optimization, classification of optimization problems. (3L) Classical Optimization of Single and Multi variable- Optimality criterion for single and multi-variable method, Region elimination methods, Gradient based methods for single variable and Multivariable, unidirectional search, direct search methods. (10L) Linear Programming- Standard form of linear programming (LP) problem, Graphical method, Simplex algorithm, Simplex criterion, Duality in LP, Sensitivity or post optimality analysis, Transportation Problem and Assignment Problem. (12L) Dynamic Programming- Introduction, Sequential optimization, computational procedure, discrete versus continuous dynamic programming, curse of dimensionality. (3L) Integer Programming- Introduction, Linear and Nonlinear integer programming, Methods for integer programming. (2L) Non-Linear Programming- Introduction, examples of non-linear programming, types of non-linear programming, Constraint and Unconstrained optimization, methods of nonlinear programming. (7L) Modern Optimization- Multi-objective optimization, many optimization, Genetic					

	Algorithms, Particle Swarm Optimization, Differential Evolution, CMA-ES, applications in engineering optimization problems. (5L)
Text Books, and/or reference material	**Text Books:** 1. S. S. Rao, Engineering Optimization: Theory and Practice, New Age International. 2. K. Deb, Optimization for Engineering Design, Prentice Hall of India. 3. A. Ravindran, K. M. Ragsdell and G. V. Reklaitis, Engineering Optimization: Methods and Applications, Wiley. 4. Hillier & Lieberman, Introduction to Operations Research, TMH. **Reference Books:** 1. S. M. Sinha, Mathematical Programming, Elsevier. 2. Handy Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi. 3. R. Fletcher, Practical Methods of Optimization, Wiley.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	-	-	-	2	3
CO2	2	3	2	3	1	-	-	-	-	-	3	3
CO3	3	3	3	2	1	-	-	-	-	-	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 616 Artificial Intelligence 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 616	Artificial Intelligence	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Data Structure and Algorithm, DBMS, Object Oriented Programming		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Learns Concepts of Intelligence, Artificial Intelligence, Problem Representation and Characterization. ● CO2: Conceptualizes Intelligent Search, different heuristics. ● CO3: Understands Knowledge Representation Techniques and Uncertainty Managements. ● CO4: Learns Semantic Knowledge, Semantic Net and Frame. ● CO5: Learns Game Playing Program Design.					

	● CO6: Learns Expert Systems and Various Machine Learning Systems. ● CO7: Learns Neural Networks.
Topics Covered	Introduction to Artificial Intelligence (AI): Features of natural intelligence, Definition of Artificial Intelligence (AI), Turing Test. (4L) Problem Representation and Characterization: State Space Representation, Production Systems, Search, Problem Characterization. (5L) Intelligent Search Techniques: Search Classifications, Heuristic Function, Various Types of Heuristic Search Techniques, Performance Measure of Heuristic Search with Penetrance. (5L) Knowledge Representation Methodologies: Types of Knowledge, Propositional vs. Predicate Logic, Resolution Proof, Logic Programming, Knowledge representation using Rules, Declarative and Procedural Representation, Uncertainty Management in Knowledge Representation, Certainty Factors in facts and rules, Concept of Fuzzy Logic. (5L) Semantic Knowledge Representation: Syntactic vs. Semantic Knowledge, examples of Semantic Knowledge, Semantic Net, Frame, OOP, Property Inheritance, Tangled Hierarchies. (4L) Game Playing: Game Tree, Minimax Search, Search Reduction by alpha and beta cutoffs. Planning: Introduction to Planning, Goal Stack Planning, Nonlinear, Hierarchical and Reactive Planning. (4L) Learning: Learning and Intelligence, Learning Spectrum, Various Types of Learning Techniques and Systems. (5L) Expert Systems (ES) and ES Shells: Definition of Expert Systems, Components of Expert Systems. Types of ES – Manual, Semi-automatic, and Automatic ES, Techniques of Knowledge Acquisition (KA) for ES.-- ES Shell. Advantages and disadvantages of ES Shell over ES. (5L) Neural Networks: Symbolic vs. Neural Network AI, Hofield Network, Perceptron as a model of neuron, Single and multiplayer Perceptron for classification and knowledge representation, Back propagation Network, Supervised, Reinforcement and Unsupervised Learning. AI standardization: Needs for standardization, Data quality analysis standards, bias compliance standard, standardization efforts underISO/IEC/ CD 42000 series

	and ISO/IEC CD 5200X series. (5L)
Text Books, and/or reference material	**Text Books:** 1. Artificial Intelligence -- Rich and Knight. -- Tata McGraw Hill. 2. Artificial Intelligence – A New Synthesis – Nilsson. -- Morgan Kaufmann Publishers. **Reference Books:** 1. Artificial Intelligence and Expert Systems -- Paterson. -- PHI. 2. Artificial Neural Networks – B. Yegnanarayanana. PHI.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	-	-	-	3
CO2	3	3	2	2	2	-	-	-	-	-	-	3
CO3	3	2	2	3	2	-	-	-	-	-	-	3
CO4	3	2	2	3	2	-	-	-	-	-	-	3
CO5	3	3	3	3	2	-	-	-	-	-	-	3
CO6	3	3	3	3	2	-	-	-	-	-	-	3
CO7	3	2	3	3	2	-	-	-	-	-	-	3

Mapping of CO (Course Outcome) and PO (Programme Outcome)
Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 617 Advanced Algorithms 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 617	Advanced Algorithms	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
CSC 303, CSC 403		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1. Can have the efficiency in the complexity analysis of the algorithms. ● CO2. Detecting and applying the algorithmic structures in many different fields of engineering. ● CO3. Will have the knowledge for state of the art development in the field of algorithms. ● CO4. Can have the proficiency of coding and comparing different algorithms.					
Topics Covered		**Revisit:** Different Complexity analysis and Algorithm's correctness by Loop-Invariant techniques.					

	(2L) **Data Structures:** van Emde Boas Trees, Dynamic graphs, Bloom filters, Hashing (Open addressing). (5L) **Randomized Algorithm-** Las Vegas and Monte Carlo algorithms, Essential mathematical tools for Randomized algorithms: Linearity of expectation, Markov inequality, Chebyshev's inequality, Chernoff bound, and Union bound with examples to Randomized algorithm design. Examples and analysis of: Hiring Assistant Problem, Randomized selection, Skip list. (4L) **Network Flow -** Flow networks, Augmenting paths, Ford- Fulkerson Algorithm, Edmonds - Karp algorithm, Max flow min-cut theorem, Push-relabel algorithm, Maximum bipartite matching, Some applications of network flow. (5L) **Linear Programming:** Introduction, algorithms, and its applications, Linear programming duality. (4L) **Parallel Algorithms** – Multithreaded Algorithms: Multithreaded matrix multiplication, Multithreaded merge sort. (3L) **Online Algorithms:** Overview, Online scheduling and online Steiner tree, Online Bipartite matching,Online learning and multiplicative weights algorithm. (5L) **NP- Completeness** - Reduction revisited; NP-Completeness proof of different problems: CLIQUE, VERTEX COVER, INDEPENDENT SET, SET COVER. (4L) **Approximation Algorithms** - Constant factor approximation algorithm: VERTEX COVER and TSP; Christofides algorithm on TSP with 1.5 approximation factor; SET-COVER problem with log n factor approximation algorithm; PTAS and FPTAS, Linear programs and approximation algorithms. (7L) **Semidefinite Programming:** Introduction with the problem: The Maximum Cut Problem and Semidefinite Programming. (2L) **Overview of some Special Topics:** Communication complexity, Spectral graph theory, Compressive sensing . (1L)

Text Books, and/or reference material	**Text Books:** 1. Rajeev Motwani and Prabhakar Raghavan, Randomized Algorithms, 2nd Edition, Cambridge University press, Cambridge, MA, 1995. 2. Thomas H. Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein. Introduction to Algorithms. 3rd ed. MIT Press, 2009, ISBN: 9780262033848. 3. S. G. Akl, The Design and Analysis of Parallel Algorithms, Prentice-Hall, 1989. 4. M. J. Quinn, Designing Efficient Algorithms for Parallel Computers, McGraw Hill Higher Education, 1987, ISBN: 978-0070510715. 5. J. Kleinberg and E. Tardos, Algorithm Design, Pearson. 6. D. V. Williamson and D. B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press. 7. S. Arora and B. barak, Computational Complexity: A Modern Approach, Cambridge University Press. **Reference Books:** 1. Dimitri P. Bertsekas and John N. Tsitsiklis, Introduction to Probability, 2nd Edition, Athena Scientific, July 2008. 2. M. Mitzenmacher and E. Upfal, Probability and Compuitng: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press. 3. T. Roughgarden, CS261: A Second Course in Algorithms (Stanford University), 2016. 4. T. Roughgarden, CS168: Modern Algorithmic Toolbox (Stanford University), 2017. **Others:** *NMEICT video on:* *Design of Algorithms(http://www.nmeict.iitkgp.ac.in/Home/videoLink/10/3gp)*

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	1	2	2	-	-	-	2	2
CO2	3	2	3	3	2	2	2	1	1	1	2	2
CO3	3	2	3	3	2	2	2	1	-	1	2	3
CO4	2	2	3	3	3	2	2	2	2	2	2	2

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 618 Information Coding Theory 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 618	Information	PEL	3	0	0	3	3

	coding theory						

Pre-requisites	Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))
Probability and statistics, linear algebra, calculus.	CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**
Course Outcomes	• CO1: Understanding definition and measurement of information. • CO2: Understanding source coding and Design and analysis of data compression techniques. • CO3: Understanding Channel coding theory • CO4: Design and analysis of Error correction coding
Topics Covered	Introduction, Mathematical Measure of Information, Average and Mutual Information and Entropy, Properties of Entropy, Discrete memoryless sources (DMS), Extension of DMS, Markov sources, Source coding theorem, Fixed length and variable length coding, Kraft inequality, Properties of prefix codes. (8L) Source Coding: Lossless entropy encoding, Huffman code, Huffman code applied on the symbols of extended sources, Shannon-Fano coding, efficiency calculations, Lempel-Ziv codes, arithmetic coding, Rate distortion Theory. (8L) Lossless and lossy predictive coding and decoding, Quantization, PCM, DM, ADM, DPCM. (6L) Channels and Channel Capacity: Discrete memoryless channel model, Binary symmetric channels and channel capacity, entropy rate and channel coding theorem, information capacity theorem. (6L) Error correction codes: Introduction, Basic concepts of linear algebra including group, ring, field, vector space etc. (3L) Block codes: Introduction, single parity check codes, product codes, repetition codes. (3L) Linear Codes: Definition, encoding and decoding of linear codes, generator matrix, error detection and correction, Perfect codes, Hamming codes. (5L) Cyclic codes: Definition, polynomials, encoding and decoding techniques, cyclic redundancy check. (3L)
Text Books, and/or reference material	**Text Books:** 1. Information Theory and Coding Hardcover by Norman Abramson, McGraw-Hill. 2. Elements of Information Theory (Wiley Series in Telecommunications and Signal Processing) by Thomas M. Cover, Joy A. Thomas, Wiley-Blackwell. 3. Error Control Coding by Shu Lin, Daniel J. Costello, Pearson. **Reference Books:** 1. Coding and Information Theory by Steven Roman, Springer-Verlag. 2. Error Control Coding by Peter Sweeney, John Wiley & Sons.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	-	-	-	-	-	-	3
CO2	2	3	3	2	-	-	-	-	-	-	-	3
CO3	3	3	3	2	-	-	-	-	-	-	-	3
CO4	2	3	3	2	-	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 619 Computer Graphics 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE619	Computer Graphics	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Introduction to Computing		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes	After completing the course, the students will be able to: ● CO1: Understand Graphics Hardware, Software. ● CO2: Learn various 2D algorithms and 3D algorithms. ● CO3: Learn and analyze scan conversion - lines, circles, ellipses, filling polygons, clipping algorithms, solid modeling, visible surface algorithms. ● CO4: Learn Illumination and Shading Models, Plane Curves and Surfaces. ● CO5: Apply different algorithms to solve real life problems.						
Topics Covered	**Section 1** Introduction to Computer Graphics, Graphics Application and Software, Description of some graphics devices, Active and Passive Graphics Devices, Display Technologies, LCD displays. (6L) **Section 2** Two-Dimensional Transformations and Matrices, Transformation Conventions, 2D Transformations, Rotation, Reflection, Scaling. (6L) **Section 3** Three-Dimensional Transformations Introduction, Three-Dimensional Scaling, Three-Dimensional Shearing, Three-Dimensional Rotation, Three-Dimensional Reflection, Three-Dimensional Translation. (6L) **Section 4** Filling polygons and clipping algorithms, Clipping Lines algorithms– Cyrus-Beck, Cohen-Sutherland and LiangBarsky, Clipping Polygons. (6L) **Section 5** Visible-Surface Determination Techniques, Categories of algorithms, Back face removal, The z-Buffer Algorithm, Scan-line method, Painter's algorithms (depth sorting), Area sub-division method, BSP trees. (6L) **Section 6** Illumination and Shading Illumination and Shading Models for Polygons, Reflectance properties of surfaces, Ambient, Specular, and Diffuse reflections, Atmospheric attenutation, Phong's model, Gouraud shading, some examples. (6L) **Section 7** Plane Curves and Surfaces Curve Representation, Parametric Representation of a Circle, Ellipse, Parabola, Hyperbola, Space Curves, Cubic						

	Splines, Bezier Curves, B-spline Curves, B-spline Curve Fit, B-spline Curve Subdivision. (6L)
Text Books, and/or reference material	**Text Books:** 1) J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Computer Graphics - Principles and Practice, Second Edition in C, Pearson Education, 2003. 2) D. F. Rogers and J. A. Adams, Mathematical Elements for Computer Graphics, 2nd Edition, McGraw-Hill International Edition, 1990. **Reference Books:** 1) D. Hearn and M. Pauline Baker, Computer Graphics (C Version), Pearson Education, 2nd Edition, 2004. 2) F. S. Hill Jr., Computer Graphics using OpenGL, Pearson Education, 2003. **Others:** NPTEL Course: https://nptel.ac.in/courses/106106090/

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	-	-	-	-	-	1	2
CO2	3	2	3	3	1	-	-	-	-	-	1	2
CO3	3	3	3	3	3	1	-	-	-	-	1	2
CO4	3	2	3	3	2	1	-	-	-	-	1	2
CO5	3	2	3	3	3	1	-	1	2	1	1	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 620 Game Theory and its Applications 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 620	Game Theory and its Applications	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous (CT), Mid-Term (MT) end assessment (EA))
1. MAC 01: Mathematics - I 2. MAC 02: Mathematics - II 3. MAC 331 : MAC 01: Mathematics - III	CT: 15%, MT: 25%, EA: 60%

Course Outcomes	After completion of this course, the students: ● CO1: Can have the efficiency to remember concepts to act in a strategic situation. ● CO2: Can analyse the strategic interactions among agents. ● CO3: Can understand modern state of the art in Game Theory. ● CO4: Will have the knowledge of related area where Game Theory can be

	applied.
Topics Covered	**Introduction:** Motivation to the course. (2L) **Non-Coperative Game Theory:** Introduction to Game Theory, Extensive Form Games, Strategic Form Games, Dominat Strategy Equllibria, Pure Strategy Nash Equlibrium, Mixed Strategy Nash Equlibrium, Fixed Point Theorem and Existence of Nash Equillibrium, Computation of Nash Equillibrium, Complexity of Computing Nash Equillibrium, Matrix Games (Two Players Zero sum Games), Bayesian Games, Subgame Perfect Equlibrium. (10L) **Mechanism Design without Money**: One sided and two sided matching with strict preferences, Voting theory, and Participatory democracy. (4L) **Mechanism Design with Money:** Auction basics, sponsored search auctions, Revenue optimal auctions, VCG Mechanisms. (5L) **Cooperative Game Theory**: Correlated Strategies and Correlated Equilibrium, Two Person Bargaining Problem, Coalitional Games, The Core, and The Shapley Value. (5L) **Repeated Games:** Introduction to repeated games and its Applications. (4L) **Applications:** Incentive Study in - P2P Networks, Crowdsourcing, Digital currency. (5L) **Some Special Topics**: Fair Division, Price of Anarchy, Scoring rules, Learning in Auction, Synergies between Machine Learning & Game Theory. (7L)
Text Books, and/or reference material	**Text Books:** 1. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani. Algorithmic Game Theory. Cambridge University Press, New York, NY, USA, 2007, ISSN: 978-0521872829. 2. M. Maschler, E. Solan, and S. Zamir. Game Theory, Cambridge University Press; 1st Edition, ISSN: 978-1107005488, 2013. 3. Y. Narahari. Game Theory and Mechanism Design. World Scientific Publishing Company Pte. Limited, 2014, ISSN: 978-9814525046. 4. T. Roughgarden, Twenty Lectures on Algorithmic Game Theory, Cambridge University Press, 2016, ISSN: 978-1316624791. **Reference Books:** 1. T. Roughgarden, CS364A: Algorithmic Game Theory Course (Stanford University), 2013. 2. T. Roughgarden, CS269I: Incentives in Computer Science Course (Stanford University), 2016. 3. S. Barman and Y. Narahari, E1:254 Game Theory Course (IISc Bangalore), 2012.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2	2	3	2	1	-	-	-	-	-	1	2
CO2	2	3	3	3	2	1	-	-	-	-	1	2
CO3	3	2	3	3	2	1	-	-	-	-	1	3
CO4	3	2	3	3	3	1	1	1	2	2	1	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 621 Digital Systems Testing 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE621	Digital Systems Testing	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Digital Logic Design, Computer Organisation		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes	● CO1: To explain and exemplify basic and advanced concepts of Testing of Digital Circuits. ● CO2: To understand fault modeling and test generation. ● CO3 : To fully appreciate the need for testability measures in the design stage of circuits. ● CO4: To understand the use of built in testing measures for online testing. ● CO5: To appreciate the different testing strategies for memory based devices.						
Topics Covered	Introduction to VLSI testing and verification. Logic and Event Driven Simulation. (2L) Fault Modeling. Single Stuck-at Fault model. Fault Collapsing. Fault Equivalence. Fault Domination. Checkpoint Theorem. (8L) Fault Simulation. Serial, Parallel, Deductive and Concurrent. (3L) Test Generation. Boolean Difference Method. D-Algorithm. PODEM. FAN. (8L) Testability Analysis (3L) Design for Testability. Adhoc approaches. Scan based Design. Random Scan. Scan FF design. LSSD. Scan-Hold FF. (8L) Built-in Self Test. Pseudo-Random Pattern Generation. LFSR (8L) Memory testing. (2L)						
Text Books, and/or reference material	**Text Books:** 1. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits. Bushnell and Agrawal. Kluwer Academic Publishers. 2. Digital Systems Testing and Testable Design. Abramovici et.al. Jaico Publications. **Reference Books:** **1.**VLSI Test Principles and Architectures. LT Wang et.al. Morgan Kaufman.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	2	-	-	-	-	-
CO2	3	3	3	2	2	-	-	-	-	-	-	-
CO3	3	3	3	2	3	-	-	-	-	-	-	-
CO4	3	3	3	3	3	-	-	-	-	-	-	-
CO5	3	3	3	3	3	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 622 Soft Computing 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 622	Soft Computing	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Introduction to computing, Data Structures and Analysis of Algorithms		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: To familiarize with neural networks and learning methods for neural networks and its limitations. ● CO2: To introduce basics of genetic algorithms and their applications in optimization and planning. ● CO3: To introduce the ideas of fuzzy sets, fuzzy logic and fuzzy inference system. ● CO4: To introduce students' tools and techniques of Soft Computing. ● CO5: To develop skills thorough understanding of the theoretical and practical aspects of Soft Computing.					
Topics Covered		**Module I: Introduction** (6L) Introduction and different definitions of Soft Computing, Basic tools/members of Soft Computing: Fuzzy Logic, Neural Network and Evolutionary Computing. **Module II: Fuzzy Logic** (10L) **Fuzzy Logic-I:** Crisp Sets, Fuzzy sets, Fuzzy membership functions, Basic operations on fuzzy sets, Fuzzy relations and Composition of fuzzy relations. **Fuzzy Logic –II (Fuzzy Rules and Approximate Reasoning):** Fuzzy if-then rules: M-A and TSK Rules, Fuzzification, Compositional rule of Inference/Approximate Reasoning, Defuzzification, Applications: Pattern Recognition, Fuzzy c-means Clustering and Control. **Module III: Neural Networks** (10L) **Neural Networks-1 (Introduction & Architecture):** Introduction to neural					

	networks: Artificial Neuron and its model, Activation functions, Neural network architecture, learning algorithms/rules, Training and testing. **Neural Networks-II:** Perceptron model: single layer and multilayer perceptron (MLP), Error back propagation, Radial basis function network (RBFN), Self-organizing map network (SOMN), Recurrent neural network, Applications of ANN. **Module IV: Evolutionary Computing** **(**12L**)** **Genetic Algorithm–I:** Evolutionary Computing, Basic concepts and working principle of simple GA (SGA), Genetic Operators: Selection, Crossover and Mutation, flow chart of SGA, Chromosome Encoding & Decoding, Population Initialization, Objective/fitness Function, variable length Chromosome, Applications: Travelling Salesman Problem (TSP). **Genetic Algorithm–II (Multi-objective Genetic Algorithm (MOGA)):** Conflicting objectives, Objective space and variable space, Domination, Pareto front, Pareto Set, NSGA-II: Non-dominated Sorting, Crowding distance operator, Applications. Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Local Search and Memetic algorithm. **Module V: Hybridization of different Soft Computing Tools** (4L)
Text Books, and/or reference material	**Text Books:** 1. S. Rajsekharanand and Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications", Prentice Hall of India. 2. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press. 3. G. Klir and B. Yuan, "Fuzzy sets and Fuzzy logic", Prentice Hall of India. 4. K. H. Lee., "First Course on Fuzzy Theory and Applications", Springer-Verlag. 5. G. J. Klir and T. A. Folger: Fuzzy Sets, Uncertainty, and Information, PH. 6. J. Yen and R. Langari, "Fuzzy Logic, Intelligence, Control and Information", Pearson Education. 7. D. Goldberg: Introduction to Genetic Algorithm. **Reference Books:** 1. Siman Haykin, "Neural Networks", Prentice Hall of India. 2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India. 3. Kumar Satish, "Neural Networks", Tata Mc. Graw Hill. 4. B. Yegnanarayana , "Artificial Neural Networks" 5. A. Konar, "Computational Intelligence", Springer. 6. Y. H. Pao: Adaptive Pattern Recognition and Neural Networks, Addison-Wesley.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	3	-	-	-	-	-	-	3

CO2	2	3	3	3	3	-	-	-	-	-	-	3
CO3	2	3	3	3	3	-	-	-	-	-	-	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 623 Advanced Database Systems 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 623	Advanced Database Systems	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Fundamentals of DBMS, Data Structures		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Acquire knowledge about the design and application view of DBMS. ● CO2: Able to analyze query expression, specially importance of query optimization. ● CO3: To learn about design, features and operations in the field of DDBMS, OODBMS and DW. ● CO4: To learn the concept of multimedia database as a real-life application.					
Topics Covered		**Unit-1:** Comparison between different databases: Significance of Databases, Database System Applications, Advantages and Disadvantages of different Database Management systems, Comparison between DBMS, RDBMS, Distributed and Centralized DB, Introduction of various types of index structures: Primary, Secondary, Multilevel, Dynamic multilevel (B-tree and B+- tree). (3L) **Unit-2:** Normalization: Functional Dependency, Anomalies in a Database, The normalization process: Conversion to first normal form, Conversion to second normal form, Conversion to third normal form, The boyce-code normal form(BCNF), Fourth Normal form and fifth normal form, normalization and database design, Denormalization, Lossless join decomposition, Dependency preservation. (3L)					

	Unit-3: Transaction processing: Introduction of transaction processing, advantages and disadvantages of transaction processing system, online transaction processing system, serializability and recoverability, view serializability, Transaction management in multi-database system, long duration transaction, high-performance transaction system. (3L) **Unit-4:** Concurrency Control Serializability: Enforcing, Serializability by Locks, Locking Systems With Several, Lock Modes, Architecture for a Locking Scheduler Managing Hierarchies of Database Elements, Concurrency Control by Timestamps, Concurrency Control by Validation, Database recovery management. (3L) **Unit-5:** Query Optimization: Algorithm for Executing Query Operations: External sorting, Select operation, Join operation, PROJECT and set operation, Aggregate operations, Outer join, Heuristics in Query Optimization, Semantic Query Optimization, Converting Query Tree to Query Evaluation Plan, multi-query optimization and application, Efficient and extensible algorithms for multi-query optimization. (5L) **Unit-6:** Query Execution: Introduction to Physical-Query-Plan Operators, One-Pass Algorithms for Database, Operations, Nested-Loop Joins, Two-Pass Algorithms Based on Sorting, Two-Pass, Algorithms Based on Hashing, Index-Based Algorithms, Buffer Management, Parallel Algorithms for Relational Operations, Using Heuristics in Query Optimization, Basic Algorithms for Executing Query Operations. (5L) **Unit-7:** Distributed Database (DDB): Introduction of DDB, DDBMS architectures, Homogeneous and Heterogeneous databases, Distributed data storage, Advantages of Data Distribution, Disadvantages of Data Distribution Distributed transactions, Commit protocols, Availability, Concurrency control & recovery in distributed databases, Directory systems, Data Replication, Data Fragmentation. Distributed database transparency features, distribution transparency. (5L) **Unit–8:** Object Oriented DBMS(OODBMS): Overview of object: oriented paradigm, OODBMS architectural approaches, Object identity, procedures and encapsulation, Object oriented data model: relationship ,identifiers, Basic OODBMS terminology, Inheritance , Basic interface and class structure, Type hierarchies and inheritance, Type extents and persistent programming languages, OODBMS storage issues. (5L) **Unit –9:** XML Query processing: XML query languages: XML-QL, Lorel, Quilt, XQL, XQuery, and Approaches for XML query processing, Query processing on relational structure and storage schema, XML database management system. (4L) **Unit –10:** Data Warehousing: Overview of DW, Multidimensional Data Model, Dimension Modelling, OLAP Operations, Warehouse Schema (Star Schema, Snowflake Schema), Data Warehousing Architecture, Virtual Data, Metadata and Types of Metadata, OLAP Engine, Data Extraction, Data Cleaning, Loading, Refreshing. (4L) **Unit-11:** Database application: Multimedia database, Video database management: storage management for video, video preprocessing for

	content representation and indexing. (2L)
Text Books, and/or reference material	**Text Books:** 1. "An Introduction to Data Base Systems", C. J Date, Pearson Education. 2. "DatabaseSystem Concepts", Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGraw-Hill. 3. "Distributed Databases Principles & Systems", Stefano Ceri and Giuseppe Pelagatti, McGraw-Hill International Editions. **Reference Books:** 1. "Fundamentals of Database Systems", Ramez Elmasri and Shamkant B. Navathe, Addison-Wesley.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	1	1	1	1	1	1	2	2
CO2	2	2	3	2	2	1	1	1	1	1	2	2
CO3	2	2	3	2	2	1	1	1	2	1	2	2
CO4	2	3	3	2	1	1	1	1	1	1	1	2

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SEVENTH SEMESTER

MSC731 PRINCIPLES OF MANAGEMENT 3-0-0 3 Credits 3 Hours

DEPARTMENT OF MANAGEMENT STUDIES							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MSC-731	PRINCIPLES OF MANAGEMENT	PCR	3	0	0	3	3
Prerequisites- NIL		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					

Course Outcomes	• CO1:To make budding engineers aware of various management functions required for any organization • CO2:To impart knowledge on various tools and techniques applied by the executives of an organization • CO3:To make potential engineers aware of managerial function so that it would help for their professional career • CO4:To impart knowledge on organizational activities operational and strategic both in nature • C05: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science and Quantitative Techniques and decision science
Topics Covered	**UNIT I:** Management Functions and Business Environment: Business environment-macro, Business environment -micro; Porter's five forces, Management functions – overview, Different levels and roles of management, Planning- Steps, Planning and environmental analysis with SWOT, Application of BCG matrix in organization **(8)** **UNIT II:** Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis, PERT & CPM as controlling technique (7) **UNIT III:** Creating and delivering superior customer value: Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting & Positioning, Product Life cycle. (8) **UNIT IV:** Behavioral management of individual: Motivation, Leadership, Perception, Learning. (8) **UNIT V:** Finance and Accounting: Basics of Financial management of an organization, Preparation of Financial accounting, Analysis of Financial statements, CVP Analysis, An overview of financial market with special reference to India .(12)
Text Books, and/or reference material	Text Books: 1. Financial Management, 11th Edition, I M Pandey, Vikas Publishing House. 2. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India 3. Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education 4. Organizational Behavior,13 th edition, Stephen P Robbins, Pearson Prentice

	hall India 5. Operations Management, 7th edition (Quality control, Forecasting), Buffa & Sarin, Willey

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 751 Software Engineering Laboratory 0-0-3 1.5 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 751	Software Engineering Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course Outcomes	● CO1: Understand Control Flow Graph (CFG) and CFG based Functional Complexity of the software. ● CO2: Understand the Coverage Criteria (Statement, Branch, Decision). ● CO3: Software modelling through ERD, DFD and ERD for distinct cases. ● CO4: Unified Modelling Language based system Design and code Generation. ● CO5: Understand the basic concepts of Testing and Verification (Decision tree & graph, WBT, BBT, Unit testing).						
Topics Covered	1) Control Flow Graph based problems (Tool: C++/Java Language Compiler). 2) ERD / DFD related problems (Tool: StarUML ER Extension or Other OpenSource Tools). 3) UML based Design problems (Tool: Rational Rose/StarUML). 4) Software Testing related Problems (Tool: Junit) - Implementation Program on Java and testing using Junit. Suggested List of Applications:1. Student Marks Analysing System, 2. online Ticket Reservation System, 3. Payroll System, 4. Course Registration System, 5. Expert Systems, 6. ATM Systems, 7. Stock						

	Maintenance.
Text Books, and/or reference material	**References:** 1. Frances E. Allen, "Control flow analysis", Proceedings of a symposium on Compiler optimization archive, ACM SIGPlan Notices, Pages 1 – 19, 1970 2. Unified Modelling Language, Object Management Group, http://www.omg.org/spec/UML/ 3. JUnit User Guide, https://junit.org/junit5/docs/current/user-guide/

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	2	1	1	1	-	-	1	1
CO2	2	3	3	3	2	1	1	1	-	-	1	2
CO3	2	3	3	3	2	1	1	1	-	-	1	2
CO4	2	3	3	3	2	1	1	1	-	-	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSS 752 Modeling and Simulation Laboratory 0-1-3 2.5 Credits 4 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS 752	Modeling and Simulation Laboratory	PCR	0	1	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and End assessment (EA))					
		CT+EA [CT: 60%, EA(Laboratory assignment + Viva Voce): 40%]					
Course Outcomes		● CO1: Demonstrate the characteristics of mathematical modelling and Python packages. ● CO2: Understand the concepts of mathematical modelling for a problem. ● CO3: Understand the user-friendly editor of Python and various libraries for simulation of the problems. ● CO4: Developed and implement the mathematical problems using Python.					
Topics Covered		1. Study the basic concepts of mathematical formulation for a problem. 2. Study the characteristics and packages of Python programming language. 3. Modeling and simulation of linear programming problems. a) Graphical Method b) Simplex Method 4. Modelling and simulation of Transportation problem. a) Different initialization solution techniques b) Balanced and Unbalanced					

	c) Degenerate problem 5. Modelling and simulation of Assignment problem. 6. Modelling and simulation of travelling salesman problem. 7. Modelling and simulation of network flow problem. 8. Modelling and simulation to find the dual of a primal problem. 9. Modelling and simulation to determine optimal strategy for a two person zero game. a) Pure Strategy b) Mixed strategy
Text Books, and/or reference material	**Text Books:** **1.** Rardin, Optimization in Operation Research, Pearson Publications. **2.** Handy A Taha, Operations Research – An Introduction, Prentice Hall of India, New Delhi. **3.** Hillier & Lieberman, Introduction to Operations Research, TMH.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	3	3	1	1	1	2	1	2	2
CO2	2	3	3	2	1	1	1	1	2	1	2	3
CO3	3	3	3	2	3	1	1	1	1	1	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Depth Elective – 3, 4, 5

CSE 710 Machine Learning 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 710	Machine Learning	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Probability and Statistics, Artificial Intelligence		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding of the basic concepts, fundamental issues and challenges of machine learning. ● CO2: Comprehend the principle and techniques of supervised learning. ● CO3: Explain the basic concepts and techniques of unsupervised learning. ● CO4: Understanding of the basic concepts and challenges of reinforced learning. ● CO5: Ability to apply the concepts of machine learning in different domains.					
Topics Covered		1. Introduction: what is Machine Learning; Human learning and Machine learning; Well-posed learning problem; Types of Machine Learning: Supervised, Unsupervised, and Reinforcement learning; Applications,					

	Issues, and tools of Machine Learning. (3L) 2. Concept Learning: Inductive learning hypothesis, general to specific ordering of hypothesis; FIND-S algorithm; Version space, candidate elimination algorithm; Inductive bias. (4L) 3. Bayesian Learning, Naïve Bayes Classifier, Optimal Classifier. (3L) 4. Supervised learning: Classification- k-Nearest Neighbour, Decision Tree, Support vector machine. Regression- Simple and Multiple linear regression. (9L) 5. Artificial Neural Networks: Biological neuron and artificial neuron, How ANN works, Parallel distributed model of ANN; Activation functions; Perceptron, McCulloch-Pits model, ADALINE network model; Architecture of ANN- single-layer feed forward, multi-layer feed forward, competitive network, recurrent network; Backpropagation algorithm; Basic concept of deep learning. (9L) 6. Unsupervised learning and Clustering: Different clustering techniques- Partitioning methods (k-means, k-medoid), Hierarchical methods (Agglomerative and Divisive techniques, MIN, MAX, Group average, Ward's methods) and Density-based method (DBSCAN). (5L) 7. Dimensionality Reduction: principal component analysis, singular value decomposition, Linear discriminant analysis, Independent conponent analysis, stochastic neighbour embeddingy. (6L) 8. Reinforcement Learning: Basic concept, Model based learning, Temporal difference based learning. (3L)
Text Books, and/or reference material	**Text Books:** 1.Machine Learning by Tom Mitchell [Mc. Graw-Hill]. 2. Pattern Recognition and Machine Learning by Christopher M bishop, Springer. 3.Applied machine Learning by M. Gopal [Mc. Graw-Hill, 2018] 4.NPTEL Course materials. **Reference Books:** 1. Introduction to Machine Learning by Ethem Alpaydin [MIT Press].

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	2	2	1	2	2	3	3
CO2	2	2	3	3	3	2	2	1	2	2	3	3
CO3	2	2	3	3	3	2	2	1	2	2	3	3
CO4	2	2	3	3	3	2	2	1	2	2	3	3
CO5	3	3	3	3	3	1	2	1	3	3	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 711 Graph Theory 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering				
Course	Title of the course	Program Core	Total Number of contact hours	Cred

Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	it
CSE 711	Graph Theory	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Discrete Mathematics and Data Structures		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understand the basic concept of graph and its properties. ● CO2: Apply the basic properties of graph theory to prove different problems ● CO3: Discuss chromatic characteristics and planar graphs. ● CO4: Students can explore knowledge of graph theory to solve technology driven and research oriented problems. ● CO5: Use a combination of theoretical knowledge and mathematical thinking to solve various computer science applications.					
Topics Covered		**Preliminaries:** Graphs, isomorphism, automorphism, components, sub-graphs, degree, operations on graphs, radius, diameter, bipartite graph, Operations on graph: deletion of vertex/edge, fusion, union, intersection, ring sum, decomposition, join, Cartesian product, complement. Self-complementary graphs, circuits. (8L) **Connected graphs and shortest paths:** Walks, trails, paths, connected graphs, distance, cut-vertices, cut-edges, connectivity: edge and vertex connectivity, relationship between edge and vertex connectivity, k-connected graph, Menger's theorem, separable graph, blocks, block-cut vertex tree, block tree, cut vertex tree,1-isomorphism, 2-isomorphism, topological ordering. (8L) **Trees:** Characterizations, number of trees, minimum spanning trees, Distance between spanning tree of a connected graph, eccentricity, Centre(s) of trees and connected graph, diameter of tree and connected graph , nullity of tree, labelled graph. (3L) **Planarity:** Planar graph, Kuratowski's theorem , Euler's formula, Detection of planarity , duality, uniqueness of duality, Homomorphism: subdivision, merging, planarity detection using homeomorphism graphs, five color and four color problem. (5L) **Covering, Independent sets, Dominating Set, Matching:** Basic concepts, vertex and edge covering, minimal covering, independent set, maximal independent set, relationship between covering and independent set, theorems, dominating set, MDS, CDS, matching in bipartite graphs, perfect matching, maximal matching, minimum matching, Hall's theorem. (6L) **Factorization :** Factor, 1-factor, 2-factor Tutte's theorem. (3L)					

	Vertex coloring: Chromatic number and cliques, greedy coloring algorithm, Brook's theorem, chromatic partition, Uniquely colourable graph. (3L) **Edge coloring:** Gupta-Vizing theorem, color edge, equitable edge-coloring. (2L) **Line Graph:** Properties and proof. (2L) **Eulerian graphs:** Characterization, Arbitrarily traceable graph, Fleury's algorithm. (2L)
Text Books, and/or reference material	**Text Books:** 1. Douglas B. West. Introduction to Graph Theory. Pearson Education, Second Edition. 2. R. Deistel. Graph Theory. Springer- Verlag NewYork 1997. 3. R.J. Wilson and J.J. Watkins. Graphs : An Introductory Approach. John Wiley and Sons Inc. **Reference Books:** 1. N. Deo. Graph Theory; With Applications to Engineering and Computer Science. PHI. 2. S. Pirzada. An Introduction to Graph Theory. Orient Blackswan.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	-	2	-	-	-	-	-	-
CO2	2	2	3	2	2	-	2	-	-	-	-	-
CO3	2	2	2	2	-	-	-	-	-	-	-	-
CO4	2	3	3	3	3	3	3	-	-	-	-	2
CO5	2	3	3	3	3	3	3	-	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 712 Electronic Design Automation 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE712	Electronic Design Automation	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Digital Electronics, Computer		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					

Organisation, Algorithm Analysis and Design.	
Course Outcomes	● CO1: To visit the various stages of the VLSI design cycle and appreciate the role of automation therein. ● CO2: To appreciate how High Level Synthesis converts an HDL code into an architecture level design. ● CO3: To discuss the algorithmic approach to physical design. ● CO4: To emphasize the importance to testability measures in the design.
Topics Covered	VLSI Design cycle. Design styles. System packaging styles. Fabrication of VLSI devices. Design rules-overview. (3L) HLS: Scheduling in High Level Synthesis. ASAP and ALAP schedules. Time constrained and Resource constrained scheduling. (4L) HLS: Allocation and Binding. Datapath Architectures and Allocation tasks. (4L) Partitioning. Clustering techniques. Group Migration algorithms. (4L) Floorplanning. Constraint based Floorplanning. Rectangular Dualization. Hierarchical Tree based methods. Simulated Evolution approaches. Timing Driven floorplanning. (5L) Placement. Simulation based placement algorithms. Partitioning based placement algorithms. Cluster Growth. (5L) Global Routing. Maze Routing algorithms. Line probe algorithms. Shortest Path based algorithms. Steiner's Tree based algorithms. (5L) Detailed Routing. Channel Routing Algorithms. Switchbox Routing. Over-the-cell routing. Clock and Power Routing. (4L) Design for testability. Fault testing. Ad-hoc and structured DFT techniques. (8L)
Text Books, and/or reference material	**Text Books:** 1. Algorithms for VLSI Physical Design Automation. N.A.Sherwani. Kluwer Academic Publishers. 2. High-Level Synthesis: Introduction to Chip and System Design. Gajski et. al. . Kluwer Academic Publishers. 3. Digital Systems Testing and Testable Design. Abramovici et.al. Jaico Publications. **Reference Books** 1. VLSI Physical Design Automation. Sadiq M. Sait and Habib Youssef. Kluwer Academic Publishers. 2. Algorithms for VLSI Design Automation. Sabih H. Gerez. Wiley India. 3. Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits. Bushnell and Agrawal. Kluwer Academic Publishers.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	2	1	-	-	-	2	-

CO2	3	3	3	3	3	-	-	-	-	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	-
CO4	3	3	3	3	2	-	2	-	-	-	1	-

Mapping of CO (Course Outcome) and PO (Programme Outcome)
Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 713 Natural Language Processing 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 713	Natural Language Processing	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))
1. Basics of probability and statistics 2. CSC303: Data Structures and Algorithms 3. CSC 01: Introduction to Computing	CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**

Course Outcomes	● CO1: Describe the fundamental concepts underlying natural language processing (NLP). ● CO2: Demonstrate the approaches to syntactic and semantic analysis in NLP. ● CO3: Apply the concepts of NLP to solve real-life problems. ● CO4: Analyze various solutions to an NLP problem and choose the best one.
Topics Covered	Introduction to natural language processing. (1L) Basic Text Processing: Tokenization, Stemming. (2L) Minimum Edit Distance. (2L) Language Modeling: Introduction to N-grams, Estimating N-grams probabilities. Application of language modeling to real-life examples (such as text -classification). (4L) Generative Vs. Discriminative Models. (4L) POS Tagging. (4L) Parsing: Introduction of Probabilistic Parsing, Lexicalized Parsing, Dependency Parsing. (6L) Information Retrieval. (3L) Semantics: Word meaning and Senses. (3L) Machine Translation (rule based techniques, Statistical Machine Translation

	(SMT), parameter learning in SMT (IBM models)). (4L) Two applications: Question Answering and Text Summarization. (4L) Recent trends. (3L) Standards for Indian Languages: Key layout - IS 16350 : 2016, inscript information IS 13194:1991 (2L).
Text Books, and/or reference material	**Text Books:** Jurafsky, David, and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Prentice-Hall, 2000. ISBN: 0130950696. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008. **Reference Books:** Manning, Christopher D., and Hinrich Schütze. Foundations of Statistical Natural Language Processing. Cambridge, MA: MIT Press, 1999. ISBN: 0262133601. **Others:** 1. CS124: YouTube lecture videos by Dan Jurafsky. 2. 2012 NLP MOOC by Dan Jurafsky with Chris Manning:Youtube channel lecture videos

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	1	-	-	-	-	-	1
CO2	3	3	3	3	2	1	-	-	-	-	-	1
CO3	3	3	3	3	3	2	-	1	1	1	2	2
CO4	3	3	3	3	3	2	1	2	2	2	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 714 Data Warehousing and Data Mining 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 714	Data Warehousing and Data Mining	PEL	3	0	0	3	3
Pre-requisites Artificial Intelligence, DBMS, Object Oriented Programming		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					

	CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]
Course Outcomes	• CO1: Understanding the Concept of Data Warehousing and Data Mining. • CO2: Association Rules: Item set, Support, Confidence. • CO3: Classification – Pattern: Labelled Pattern, Decision Trees. • CO4: To understand the SVM, Generalization Error. • CO5: To understand the different types of Clustering Methods. • CO6: To understand the detection of different types of outliers and outlier detection.
Topics Covered	Data Warehousing: Multidimensional Data Model, Dimension Modelling, OLAP Operations, Slicing and Dicing, Warehouse Schema, Star Schema, Snowflake Schema, Advantages and Disadvantages of Snowflake Schema, Data Warehousing Architecture, Virtual Data Warehouse, Advantages and Disadvantages of Virtual Data Warehouse, Metadata, Types of Metadata, OLAP Engine, Different Options for OLAP Engine, Data Extraction, Data Cleaning, Loading, Refreshing. [4L] Data Mining: Different Definitions of Data Mining, KDD vs. Data Mining, Stages of KDD , DBMS vs. DM, AI vs. DM, Classifications of Data Mining, Stages of KDD, DM Techniques , Discovery Driven Tasks, Classification, Frequent Episodes, Discovery of Association Rules , Clustering, Deviation Detection, Mining Problems, Applications of DM, Other Mining Problems. [4L] Association Rules: Item set, Support, Confidence, Problem Decomposition, Frequent Item Set, Maximal Frequent Set, Border Set, Applications of Data Mining, Spotting Fraudulent Behaviour, Astronomy etc., Association Rules, Informal a priori Algorithm for Learning Association Rules, Finding Frequent Sets and Association Rules, Formal a priori Algorithm for Association Rule. [5L] Classification – Pattern: Labelled Pattern, Approaches of Classification, Evaluation of Classifiers, Normalized Confusion Matrix, Accuracy, Precision, Recall and F – score, Cross Validation Technique, Classification Techniques. [4L] Decision Trees: Inductive Learning, ID3 Program, Algorithm for Building Decision Trees , Advantages of Decision Trees for Classification Purpose, Development of Decision Trees for Different Training Data Sets, Rule Extraction from Pattern Set, Covering the instances, Extraction of rules, Instance Space, Covering Algorithm. [4L] Bayesian Belief Nets (DAG): K nearest Neighbour, ANN, Learning in ANN, Perceptron as a model of neuron, Single and multiplayer Perceptron for classification and knowledge representation, Back propagation Network, Supervised, Reinforcement and Unsupervised Learning. [4L] Classification (Complex): Support Vector Machine (SVM), Generalization Error, SVM to find out the best classification, Margin. [3L] Clustering: Partitioned and Hierarchical Clustering, k means Clustering, Fast k Means Clustering, Fuzzy K means Clustering, Hierarchical Clustering,

	Agglomerative and Divisive Hierarchical Clustering, Single Linkage, Complete Linkage and Average Linkage Clustering. [4L] Clustering (Complex): Outlier Detection, Outlier vs. Cluster, Types of Outliers, Outlier Detection Methodologies, Supervised, Unsupervised and Semi supervised detection , Statistical Approaches, Parametric and Non Parametric Methods, Proximity Based Methods, Clustering Based Methods. [4L] Temporal and Spatial Data Mining: Temporal Data Mining, Tasks involved, Temporal Association Rules, Sequence Mining, Episode Discovery, Spatial Mining, Tasks involved , Spatial Clustering. [3] Web Mining: Web Mining Techniques, Web Content Mining, Web Structure Mining, Web Usage Mining, Text Mining. [3L]
Text Books, and/or reference material	**Text Books:** 1. Data Mining Techniques – Arun K Pujari – Universities Press. 2. Data Mining – Vikram Pudi, P. Radha Krishna – Oxford University Press. **Reference Books:** 1. Data Mining – J. Han, M. Kamber, J. Pei -- Elesvier. 2. Data Mining – Hand, Mannila and Smith – PHI.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	2	2	-	-	-	-	-	-	3
CO2	2	1	1	2	2	-	-	-	-	-	-	3
CO3	3	3	2	3	3	-	-	-	-	-	-	3
CO4	3	3	2	3	3	-	-	-	-	-	-	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3
CO6	3	3	3	3	3	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 715 Digital Image Processing 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 715	Digital Image Processing	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
NIL		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course	● CO1: Understand image acquisition and camera basics.						

Outcomes	• CO2: Apply image enhancement and filtering techniques to the spatial and frequency domain of images • CO3: Design edge detection and segmentation algorithms for object detection and recognition purpose • CO4: Understand color image processing • CO5: Develop image compression models. • CO6: Develop image processing algorithms using ImageJ and Python.
Topics Covered	Introduction, Image acquisition process, image sensors, camera basics. (4L) Transform functions, Histogram, spatial and frequency filtering. (10L) Redundancy, compression models, coding methods. (8L) Point, Line, edge detection, thresholding, region based segmentation. (6L) Color models, color image processing, segmentation and compression using colors. (8L) Introduction to Image Processing using ImageJ and Python, Image databases. (6L)
Text Books, and/or reference material	**Text Books:** 1.Digital Image Processing by Rafael C Gonzalez & Richard E Woods. 2.Fundamentals of Digital Image Processing by Anil K Jain. **Reference Books:** Digital Image Processing by William K Pratt. **Others:** NPTEL online course.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	2	-	1	-	-	-	-	-	2
CO2	3	3	3	3	-	-	-	-	-	-	-	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3
CO4	2	2	2	2	-	-	-	-	-	-	-	3
CO5	3	3	3	3	-	-	-	-	-	-	-	3
CO6	2	2	3	3	3	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 716 Data Analytics 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 716	Data Analytics	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))
	CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**
Course Outcomes	● CO1: Classify the labelled dataset into different classes and group the unlabelled dataset into different clusters by uncovering hidden patterns and correlations among them.. ● CO2: Model a problem into a graph database after absorbing and connecting a large volume of data and performing the analytical task over the graph. ● CO3: Develop a recommendation system by predicting users' preferences based on similarity measures and evaluating its performance using the metrics such as Precision, recall, and F1-score. ● CO4: Understand and set up the Hadoop framework, which will allow them to efficiently manage and process big data in a distributed computing environment.
Topics Covered	Introduction to Data Analytics, Types of Data Analytics: Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, and Prescriptive Analytics. Use Cases, Issues and Challenges in Big Data Analytics. (4L) Fundamentals of Statistics: Population, Sample, Parameter, Statistic, Variable. Descriptive Statistics, Inferential Statistics. Basic Probability Theory: Random Experiment, Sample Space, Random Variables, Probability, Conditional Probability, Independence, Conditional Independence, Expectation, Variance, Probability Distribution, Joint Probability Distribution, Conditional Probability Distribution. (8L) Similarity Measures: Jaccard Similarity, Cosine Similarity, Adjusted Cosine Similarity. Missing Value Prediction Techniques: Mean Centering, Weighted Average, Z-Score. (6L) Basics of Complex Network: Scale-Free Networks, Small-World Phenomenon, Degree Distributions, Transitivity or Clustering. Centrality Measures: Degree Centrality, Betweenness Centrality, Closeness Centrality, Eigenvector Centrality, PageRank Centrality. Community Structure, Community Detection Algorithms: Girvan-Newman, Fast Greedy, Label Propagation, Clique Percolation Method. Community Quality Metrics: Modularity, NMI, Conductance. (10L) Introduction to Data Mining, Machine Learning Techniques: Least Square Regression, Decision-trees, SVM. Clustering Techniques: K-Means. (8L)

	Introduction to Hadoop Ecosystem – HDFS, Map-Reduce, PIG, HIVE, HBase, Mahout, Zookeeper, Flume, Sqoop, etc. (6L)
Text Books, and/or reference material	**Text Books:** 1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data – EMC Education Services – Wiley. 2. Machine Learning: Hands-On for Developers and Technical Professionals – Jason Bell – Wiley. **Reference Books:** 1. Networks: An Introduction – M. E. J. Newman – Oxford University Press. 2. Hadoop: The Definitive Guide – Tom White – O'Reilly.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	1	-	-	-	2	-	1	-	-
CO2	3	3	3	3	-	1	2	-	2	2	3	-
CO3	3	3	3	3	1	1	3	-	2	2	3	1
CO4	2	2	1	1	3	3	1	2	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 717 Biometrics 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 717	Biometrics	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Basic Mathematics – Knowledge and ability to use calculus, probability, and statistics are essential.		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding biometrics systems and its different characteristics. ● CO2: Implementation of different biometrics systems including face, fingerprint, iris, palm, signature, EEG, etc. ● CO3: Apply the concept of unimodal and multimodal paradigms in biometrics systems. ● CO4: Analyze different feature extraction and learning techniques for biometrics systems. ● CO5: Design and develop real life biometrics systems.					

Topics Covered	Biometrics Overview: Introduction, characteristics of biometric systems, biometric systems, biometric functionalities, biometrics system errors, design cycles of biometric systems, applications of biometric systems, security and privacy issues. [4L] Image Processing Techniques: What is image processing?, origin of image processing, fundamental steps in digital image processing, components of image processing system, image sensing and acquisition, image sampling and quantization, basic relationships between pixels. [6L] Filtering: Background, basic intensity transformation functions, histogram processing, fundamentals of spatial and frequency domain filtering, smoothing filters, sharpening filters, Discrete Fourier Transform, Fast Fourier Transform. [4L] Pattern Classification Techniques: Introduction, Bayesian decision theory, maximum likelihood and Bayesian parameter estimation, non-parametric techniques, linear discriminant functions, multilayer neural networks, non-metric methods. [6L] Fingerprint Recognition: Introduction, ridge pattern, fingerprint acquisition, feature extraction, matching, and fingerprint synthesis. [6L] Face Recognition: Introduction, image acquisition, face detection, feature extraction, matching and advanced topics. [6L] Iris Recognition: Introduction, iris recognition systems, image acquisition, iris segmentation, iris normalization, iris encoding and matching, iris quality and performance evaluation. [4L] Multi-modal Biometric Systems: Introduction, sources of multiple evidence, acquisition and processing architecture, fusion levels. [2L] Other Biometrics: Signature, hand shape, ear, palmprint, etc. [4L]
Text Books, and/or reference material	**Text Books:** ● Anil K. Jain, Arun Ross, and Karthik Nandakumar, Introduction to Biometrics, Springer, 2011. ● J. L. Wayman, Anil K. Jain, D. Maltoni, D. Maio, Biometric Systems: Technology, Design and Performance Evaluation, Springer, 2005. ● R. M. Bolle, J. Connell, S. Pankanti, N. K. Ratha, A. W. Senior, Guide to Biometrics, Springer, 2004. ● Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, 2nd

	Edition, Wiley, 2000. ● R.C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson, 2009. **Reference Books:** ● D. R. Kisku, P. Gupta and M. Tistarelli, Multibiometrics Systems: Modern Perspectives to Identity Verification, LAMBERT Publishing, 2012. ● D. R. Kisku, P. Gupta and J. K. Sing, Advances in Biometrics for Secure Human Authentication and Recognition, CRC Press, Taylor & Francis, 2013. ● D. R. Kisku, P. Gupta and J. K. Sing, Design and Implementation of Healthcare Biometric Systems, IGI Global, 2019. ● M. Dawson, D. R. Kisku, P. Gupta, J. K. Sing and W. Li, Developing Next-Generation Countermeasures for Homeland Security Threat Prevention, IGI Global, 2016. **Others:** Online Biometrics Courses 1. https://nptel.ac.in/courses/106104119/ 2. https://www.mooc-list.com/tags/biometric

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	1	1	-	-	1	2
CO2	2	3	3	2	3	1	2	1	-	-	1	2
CO3	2	3	3	2	3	1	2	1	-	-	2	2
CO4	2	3	2	3	2	1	1	1	-	-	2	1
CO5	3	3	3	3	2	1	2	1	-	-	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 718 Cryptography and Network Security 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 718	Cryptography and Network Security	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
CSE 602 Basic knowledge of linear algebra, probability theory. Programming skills are desirable.		CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]					

Course Outcomes	● CO1: Introduce the basic mechanisms of Cryptography. ● CO2: Notion of computationally hard problems and their applications. ● CO3: Notion of trap-door and one-way functions and their applications. ● CO4: The attack and crypto-analysis. ● CO5: Ability to design secure protocols and their vulnerability analysis.
Topics Covered	1. Introduction, X.800 : Security architecture for Open Systems Interconnection, Attack, Adversarial Behavior. (2L) 2. Basic Number Theory, Field, Extension Field and applications. (5L) 3. Confidentiality, Symmetric and Asymmetric Encryption, Public key encryption mechanisms - RSA, ElGamal, Rabin's, Asymmetric Key Encryption - DES, AES. (10L) 4. Attacks- Passive attacks, Side channel Attacks, Factorizations and Index calculation methods, Countermeasures. (7L) 5. Implementational Issues - Fast Hardware for symmetric and Asymmetric key. (5L) 6. Pseudo-random number generation, Stream ciphers. (3L) 7. Message Integrity, Cryptographic hashing, Message Authenticity, Message Authentication code. (3L) 8. Entity Authentication, Digital signature, Nonrepudiation. (5L) 9. Secure protocol designing - SSL, PGP and TLS. (2L)
Text Books, and/or reference material	**Text Books:** 1. Handbook of Applied Cryptography, CRC Press (free ebook). 2. Douglas Robert Stinson, Maura Paterson, Cryptography: Theory and Practice. 3. O. Goldrich, Fundamentals of Cryptography: Basic Tools, Cambridge University Press. 4. N. Koblitz, A Course in Number Theory and Cryptography. 5. Abhijit Das, Key Cryptography: Theory and -C. E. Veni Madhavan, Public .Practice **Reference Books:** 1. M. Bellare and S. Goldwasser, Lecture Notes on Cryptography, 2001. **2.** Abhijit Das, Computational Number Theory, CRC Press. **Others:** 1. Janathan Knudsen, Java Cryptography, O'Relly Press.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	3	2
CO4	-	3	3	2	-	-	-	2	-	-	3	-
CO5	-	-	3	2	3	2	-	2	-	-	3	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 719 Multimedia Information Systems 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSE 719</td><td>Multimedia Information Systems</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="2">Knowledge of data structures databases and compression techniques</td><td colspan="6">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">•CO1: In depth understanding of media characteristics and resource requirement.
•CO2: Organizing multimedia content, physical storage and retrieval of multimedia data, Content-based Search and retrieval, creating and delivering networked and multimedia presentations, securing multimedia content and current research directions in this area.
•CO3: Understanding networking of multimedia data and how technology can help us access, deliver, browse, search, enrich and share multimedia content.
•CO4: Understanding of multimedia database storage and retrieval.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Overview of multimedia system: Textual information codes (Morse, ASCII, EBCDIC), audio, video and graphics, RTF, TIFF, RIFF. (3L)
Video and Animation: Capturing Graphics and Images Computer Assisted Graphics and Image Processing; Reconstructing Images; Graphics and Image Output Options. Basics; Television Systems; Digitalization of Video Signals; Digital Television; Basic Concepts; Virtual Reality, Video signal representation, Computer Video Format, Computer- Based animation, Animation Languages, Methods of controlling Animation, Display of Animation, Transmission of Animation. (10L)
Information representation, media synchronisation, SAS factors, relative and absolute temporal specifications, networking delays, Skew, Jitter, end to end delay factors, latency time for stored and captured objects. (6L)
Data Compression: Storage Space requirement, Coding Requirements Source, Entropy Coding Lossy Sequential DCT- based Mode, Expanded Lossy DCT-based Mode, JPEG and MPEG. (8L)
Data transmission techniques like simplex, duplex, baseband vs. broadband, synchronous transmission vs. asynchronous transmission, synchronization parameters. (5L)
Content-based Search and retrieval, creating and delivering networked and multimedia presentations, storage, manipulation, and retrieval of multimedia data residing across global computer networks, multimedia databases, indexing, retrieval by similarity. (10L)</td></tr>
<tr><td>Text Books, and/or reference</td><td colspan="7">Text Books:
Multimedia Information Networking, Nalin K.Sharda, Prentice Hall India.
Multimedia: Computing, Communications and Applications, Ralf Steinmetz and</td></tr>
</table>

material	Klara Nahrstedt, Pearson Education Asia. Multimedia Communications, Applications, Networks, Protocols and Standards, Fred Halsall, Pearson Education Asia. Multimedia Systems, John F. Koegel Buford, Pearson Education Asia. **Reference Books:** Subrahmanian and Jajodia, Multimedia Database Systems, Springer. V.S. Subrahmanian, Principles of Multimedia Database Systems, Morgan Kaufmann Publishers, 1998.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	3	3	1	1	3	2	3
CO2	3	3	3	2	3	3	3	1	2	3	2	3
CO3	3	3	3	2	2	3	3	1	2	3	2	3
CO4	3	3	3	2	3	3	3	1	2	3	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 720 Cellular Automata and its Application 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE720	Cellular Automata and its Application	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Digital Electronics		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes	● CO1: Understanding the basic and advanced concepts of Cellular Automata (CA). ● CO2: Understanding the different phases of evolution of CA machine. ● CO3: Understanding the method of characterization of CA machine/tool. ● CO4: Modeling of physical/real-time systems with a mathematical tool such as CA. ● CO5: Applying suitable class of CA for building CA based model to study.						
Topics Covered	**Introduction:** Basic definitions of cellular automata and symbolic dynamics, Injectivity, surjectivity, reversibility, Garden-of-Eden theorem, Hedlund's theorem, Conservation laws, universal computing reversible/irreversible CA, neighbourhood, dimensions, states, follow-up and review. [6L] **Characterization of CA behaviour and its applications:** Initial Phase of						

	Development, CA-Based Models - Language Recognizer, Biological Applications, CA as Parallel and Image Processing Systems, CA based model of physical systems. [6L] **New Phase of Development**–Wolfram's model of CA, 3-neighborhood 2-state CA, CA rules, Classification of rules, CA technology, CA as an FSM, Linear/non-linear/additive CA, Polynomial Algebraic Characterization of CA Behavior, Matrix Algebraic Characterization. [6L] **Irreversible/Group CA characterization in linear domain:** Null/Periodic boundary Characterization of the State-Transition Behavior, Cycle Set Characterization, Isomorphism between a CA and an LFSR. CA based Pseudorandom Pattern Generation, Pseudo noise sequence, CABIST, Pattern Classification. [6L] **Characterization of nongroup CA/non-invertible CA in linear domain**: General Characterization of Cyclic States (attractors), Characterization of Single Length Cycle Single Attractor CA (SACA), D1*CA, Multiple-Attractor Cellular Automata (MACA)[6L] **Non-linear CA:** Characterization of non-linear rules, invertible and non-invertible CA, CA with point states; applications in VLSI domain. [6L] **Advanced Concepts:** Extension of dimension, d-state CA, introduction to Asynchronous CA, follow-up and review**.** [6L]
Text Books, and/or reference material	**Text Books:** 1. Additive Cellular Automata: Theory and Applications, by Parimal Pal Chaudhuri, Dipanwita Roy Chowdhury, Sukumar Nandi, Santanu Chattopadhyay, Wiley. 2. Tommaso Toffoli, Norman Margolus. Cellular Automata Machines: A New Environment for Modelling. MIT Press. 3. *Cellular Automata and Complexity: Collected Papers* by Stephen Wolfram; Westview Press. **Reference Books:** 1. Game of Life Cellular Automata, by Andrew Adamatzky, Springer; 2010 edition. 2. A New Kind of Science, by Stephen Wolfram, Wolfram Media. 3. A New Kind of Computational Biology, by Chaudhuri, P.P., Ghosh, S., Dutta, A., Choudhury, S.P; Springer. 4. Joel L. Schife. Cellular Automata: A Discrete View of the World. Wiley - Interscience.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	-	1	-	-	-	-	1

CO2	1	1	1	1	1	-	1	-	-	-	-	1
CO3	1	2	1	1	2	-	1	-	-	-	-	1
CO4	3	3	3	3	3	-	2	-	-	-	-	3
CO5	3	3	3	3	3	-	2	-	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 721 Computational Geometry 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 721	Computational Geometry	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
A course on Design and analysis of algorithm		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: To demonstrate familiarity with some of the basic algorithmic techniques of the area. ● CO2: To design and analyze "new" geometric algorithms and to derive the lower bound for some geometric problems. ● CO3: To map practical problems to computational geometric problems and finding a solution to these geometric problems help to solve a wide range of practical problems in a variety of fields such as graphics, robotics, databases, sensor network ● CO4: To develop skills to work on geometrical manipulating software and to demonstrate acquaintance with modern research in the field.					
Topics Covered		**Computational Geometry Introduction:** Historical perspectives, Geometric preliminaries, Convex Hull, Algorithms to find the Convex Hull of a point set in 2D plane: Graham's Scan Algorithm, Divide and Conquer algorithm, Output sensitive algorithm: Jarvis's March Algorithm, Timothy Chan's Algorithm; Lower bound analysis for Convex Hull Algorithm [6L] **Line Segment Intersection**: Line Segment Intersection, The Doubly-Connected Edge List, Computing the Overlay of Two Subdivisions, Boolean Operations. [4L] **Polygon Triangulation:** Guarding and Triangulations, Area of a simple polygon, Counting the number of triangulations in a convex polygon, Art Gallery Theorem, Monotone Polygon, Partitioning a Polygon into Monotone Pieces, Triangulating a Monotone Polygon.					

	[6L] **Orthogonal Range Searching:** 1-Dimensional Range Searching, Kd Trees, Range Trees, Higher-Dimensional Range Trees, Fractional Cascading. [6L] **Point Location:** Point Location and Trapezoidal Maps, A Randomized Incremental Algorithm to compute a Trapezoidal Map and a Search structure, Kirkpatrick's planar point location problem. [6L] **Voronoi Diagram and Delaunay Triangulation:** Definition and Basic Properties of Voronoi Diagram, Computing the Voronoi Diagram: Fortune Sweep Algorithm, Divide and Conquer Algorithm. Closest pair Problems. Application of voronoi diagrams, Triangulations of Planar Point Sets, The Delaunay Triangulation, Computing the Delaunay Triangulation. [7L] **Arrangements and Duality:** Arrangement of lines, Zone theorem, Duality, Application of arrangements and duality, Ham Sandwich Cut. [4L] **Geometric Data Structure:** Interval Trees, Priority Search Trees. [3L]
Text Books, and/or reference material	**Text Books:** 1. Franco P. Preparata and Michael Ian Shamos, Computational Geometry- An Introduction, Springer Verlag. 2. Mark de Berg, Marc van Kreveld, Mark Overmars, Otfried Cheong, Computational Geometry: Algorithms and Applications, Third Edition, Springer Verlag. 3. Joseph O' Rourke, Computational Geometry in C, Cambridge University Press. **Reference Books:** **Others:** Lecture notes on Computational geometry by David Mount.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	3	2	-	-	-	-	-	-	2
CO2	1	2	3	3	2	-	-	-	-	-	-	2
CO3	1	2	3	3	3	-	-	-	-	-	-	2
CO4	1	2	3	3	3	-	-	-	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 722 Complex Network Theory 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hour	

						s	
CSE 722	Complex Network Theory	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Probability, Calculus, Linear Algebra, Graph Theory		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Illustrate the modern theory and applications of network science. ● CO2: Analyze structure of communities in different networks ● CO3: Define random walk and design real-world applications ● CO4: Apply of linear algebra and probability to real-world complex network problems ● CO5: Cultivate reading of research papers and articles					
Topics Covered		**Introduction to Network Science** (1L) **Graph Theory:** revision of basic concepts. (2L) **Properties of Complex networks**: Degree distribution, associativity, clustering coefficient.(4L) **Random Networks**: Poisson's distribution, giant component and its emergence, generating function, component size distribution. (6L) **Bipartite networks**: unipartite projection, giant component condition. (6L) **Centrality measures**: degree centrality, closeness centrality, betweenness centrality, eigen vector centrality, Peron Frobenius theorem.(4L) **Spectral Graph Theory**: eigen values and eigen vectors, spectrum of a graph, spectrum of a clique, eigen values and eigen vectors of special matrices like triangular and diagonal matrices, Markov matrix, trace of a matrix, physical interpretation of principal eigen vector, spectral coverage, significance of 2nd eigen vector, Motifs, Frobenius norms, dimension reduction. (4L) **Network Models:** Erdos Renii graph, power law distribution in small world network, scale free networks. (4L) **Random walks on graphs and its applications:** random walks and Markov chain, transitional probability, stationery state, hitting time, commute time, cover time, mixing rate, stochastic matrix, page rank algorithm, page rank ++, HITS (Hypertext induced topic selection) algorithm by Klienberg, HITS on citation networks, bibliographic coupling, SALSA (The stochastic approach to Link Structure analysis and TKC effects). (7L) **Community detection algorithms:** what is a community, core community, Wu-Huberman Algorithm, Radicchi's Algorithm, community detection algorithms based on shortest path betweenness and random walk betweenness.(4L)					
Text Books, and/or reference material		**Text Books:** ● " The structure and dynamics of networks" by Newman, Barabasi, Watts, Princeton University Press. ● "Networks: An Introduction" by Mark Newmann, Oxford University Press ● "Network Science" by Barabasi, Cambridge University Press. **Reference Books:** ● "Network Science" Theory and Applications by Ted G Lewis, Wiley. **Others:** ● http://www.infocobuild.com/education/audio-video-courses/computer-					

	science/complex-network-theory-iit-kharagpur.html (Video Lecture) by Dr. Animesh Mukherjee

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	3	1	2	1	-	-	-	-	2
CO2	1	3	3	2	1	1	-	-	-	-	-	1
CO3	3	2	3	1	2	1	-	-	-	-	-	1
CO4	3	3	3	2	2	1	-	-	-	-	-	1
CO5	1	1	1	1	2	1	-	2	2	3	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 723 Pattern Recognition 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 723	Pattern Recognition	PEL	3	0	0	3	3
Pre-requisites Artificial Intelligence, Data Mining, DBMS, Object Oriented Programming		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Idea about Pattern and Pattern Class, Design of a Pattern Recognition System. ● CO2: Idea of Instar, Outstar, Groups of Instar and Outstar, Different types of Memories. ● CO3: Concept of Feedforward, Feedback and Competitive Learning Network. ● CO4: Concept of Complex PR Tasks: RBF, RBF Network for Pattern Classification. ● CO5 : Idea of Temporal Pattern Recognition: Concepts.					
Topics Covered		Pattern and Pattern Class: Design of a Pattern Recognition System, Syntactic and Decision Theoretic Approach, Bayesian Decision Theory, Continuous Features, Error, Risk and Loss. [4L] Parametric and Non Parametric Methods: Histogram Method – Kernel Based Methods – K - Nearest Neighbor Method -- Probabilistic Neural Network base on Parzon Window – PNN Learning. [3L] Basics of ANN: Instar , Outstar, Groups of Instar and Outstar, Different types of Memories. [3L]					

	PR Tasks: PR Problems, Different PR Tasks by FF, FB and Competitive Learning Network, Pattern Clustering, Feature Mapping Problem, Different Feature Mapping Network, Self Organizing Network. [4L] FF ANN: Pattern Association Network, Hebb's Law, Pattern Classification Network. [3L] FB ANN: Pattern Association, Pattern Storage, Pattern Environment Storage, Auto association , Hopfield Network, Capacity and Energy of a Hopfield Network, State Transition Diagram, Stochastic Network and Boltzmann Machine. [5L] Competitive Learning Network: Pattern Storage, Pattern Clustering Network, Minimal Learning, Malsburg Learning and Leaky Learning. [4L] Complex PR Tasks: RBF, RBF Network for Pattern Classification, Advantages of RBF over MLFF ANN, CPN Network. [3L] Single and Multilayer Network: Gradient Descent Procedure, Newton's Algorithm, Fixed Increment Learning, Variable Increment Learning, Support Vector Machine(SVM), Multilayer Neural Networks, Unsupervised Learning. [5L] Temporal Pattern Recognition: Concepts, Problems in temporal sequence, Architecture for temporal PR Tasks, Avalanche Structure, Jordon Network, Fully Connected Recurrent Network, Difference between Avalanche Network and Jordon Network. [4L] Similarity Measures: Mahalanabis Distance, Properties of Metrics, Minkowski Metric, Manhattan / City Block / L1 norm, Euclidean Distance L2 Norm, Maximum Value Distance L∞ Norm, Hamming Distance L1 norm. [4L]
Text Books, and/or reference material	**Text Books:** 1. Pattern Classification – Duda, Hart & Stork – J. Wiley & Sons. 2. Artificial Neural Networks – B. Yegnanarayana – PHI. **Reference Books:** 1. Neural Networks for Pattern Recognition – C.M. Bishop – Oxford.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	3	-	-	-	-	-	-	3
CO2	3	3	2	2	3	-	-	-	-	-	-	3
CO3	3	2	3	2	3	-	-	-	-	-	-	3
CO4	3	3	2	2	3	-	-	-	-	-	-	3
CO5	3	3	2	2	3	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 724 Semantic Web Technology 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSE-724</td><td>Semantic Web</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="2">Data structure, DBMS, Web Technology, Basic Computer Logic</td><td colspan="6">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Understating the philosophy of Semantic Web and Linked Data
● CO2: Understanding the writing of own semantic web page by using publicly available vocabulary.
● CO3: Design and publish own data in Open Data format, such that other people can discover it easily.
● CO4: Able to develop different semantic web applications.
● CO5: Getting exposure in this topic for further higher studies and research.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Principles of Linked Data, Introduction, A Layered Approach. (3L)
Naming Things with URIs, Making URIs Dereferenceable. (3L)
The Semantic Web (SW) vision: What is SW? The difference between Current web and SW, SW technologies, the Layered approach. (5L)
The XML Language, Structuring, Namespaces, Addressing and Querying XML Documents. (5L)
Resource Description Framework, RDF syntax, RDF Schema (RDFS). (7L)
Construction RDF and RDFS: Different syntax implementation, How to Store into server, Construction of RDFS. (5L)
SPARQL: Query Language: Syntax and Query processing. (2L)
Web Ontology Language OWL: OWL Syntax and Intuitive Semantics, OWL Species. (4L)
Description Logics, Model-Theoretic Semantics of OWL. (4L)
Ontology Engineering: Introduction, Constructing Ontologies, Reusing existing Ontologies. (2L)
Protégé tools. (2L)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1.Semantic Web Primer: second edition by Grigoris Antoniou and Frank van Harmelen.
2.Foundations of Semantic Web Technologies by Hitzler Pascal.
Reference Books:
1. Ontological Engineering by Asunción Gómez-Pérez, Mariano Fernández-López, and Oscar Corcho.
2. Linked Data: Evolving the Web into a Global Data Space by Tom Heath and Christian Bizer.
Others:
Harald Sack semantic web videos.</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	-	2	2	1	-	1	2	3
CO2	2	3	1	2	3	1	-	-	-	1	-	-
CO3	-	3	3	-	3	-	-	-	-	1	1	1
CO4	1	3	2	3	3	1	-	-	-	1	3	2
CO5	1	2	2	3	3	1	-	-	-	1	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 725 Human Computer Interaction 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 725	Human Computer Interaction	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
NIL		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes	● CO1: Acquire knowledge about Components of HCI. ● CO2: To learn the basic Psychology of Usable Things. ● CO3: To learn about Usability Engineering, Usability Benchmarking. ● CO4: To learn Inspection methods, testing methods, design.						
Topics Covered	Introduction, Psychology of Usable Things. (7L) Usability Engineering, Know the User, Usability Benchmarking. (7L) Goal-Oriented Interaction Design, Prototyping. (7L) Usability Inspection Methods, Usability Testing Methods. (7L) Usability in Practice, Visual Design and Typography. (7L) Icon Design, Case Studies. (7L)						
Text Books, and/or reference material	**Text Books:** 1.Dix A., Finlay J., Abowd G. D. and Beale R. Human Computer Interaction, Pearson Education, 2005. 2.Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human. ComputerInteraction, Addison-Wesley, 1994. **Reference Books:** B. Shneiderman, Designing the User Interface, Addison Wesley 2000. **Others:** NPTEL online course.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	1	1	1	1	1	1	1	1
CO2	2	2	3	2	1	2	1	1	1	1	1	3
CO3	3	2	3	2	2	2	1	1	2	2	2	3
CO4	3	2	2	1	2	1	1	1	2	1	1	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 726 Incentive Mechanisms in Computer Science 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 726	**Incentive Mechanisms in Computer Science**	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), Mid-Term (MT) end assessment (EA))					
1. Introduction to computing		CT: 15%, MT: 25%, EA: 60%					
Course Outcomes	After completion of this course, the students ● CO1: Can have the efficiency to think about incentive issues in computation. ● CO2: Can learn the tools to tackle the incentive issues. ● CO3: Can understand the modern state of the art of incentive based computation. ● CO4: Can analyze the scenarios of incentive based computation. ● CO5: Can apply the knowledge in solving real life problems.						
Topics Covered	**Introduction:** Motivation to the course with canonical ideas of game theory (3L) **Incentives in labour market: School Choice, Medical Residency matching, Kidney exchange, House allocationetc.** (5L) **Auctions and Incentive issues.** (5L) **Incentives in Voting, Knapsack Voting , Participatory Democracy** (4L) **Incentives in P2P networks, Incentives for social participation (such as Stack Exchange etc.)**. (5L)						

	Incentive study in selfish routing (3L) **Incentives in BGP routing** (2L) **Incentives in cryptocurrencies** (3L) **Reputation system and incentive issues** (2L) **Incentivizing Forecasts and Feedback** (2L) **Prediction Markets** (2L) **Time-Inconsistent Planning** (2L) **Fair Division** (4L)
Text Books, and/or reference material	**Text Books:** 1. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani. Algorithmic Game Theory. Cambridge University Press, New York, NY, USA, 2007, ISSN: 978-0521872829. 2. T. Roughgarden, Twenty Lectures on Algorithmic Game Theory, Cambridge University Press, 2016, ISSN: 978-1316624791. **Reference Books:** 1. T. Roughgarden, CS364A: Algorithmic Game Theory Course (Stanford University), 2013 (Lecture Notes). 2. T. Roughgarden, CS269I: Incentives in Computer Science Course (Stanford University), 2016 and later offerings (Lecture Notes).

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	-	-	-	-	-	1	2
CO2	1	2	2	2	3	1	-	1	1	1	1	2
CO3	3	3	3	3	2	1	-	1	-	-	1	3
CO4	2	3	3	3	1	1	-	-	1	1	1	2
CO5	3	2	3	2	2	1	1	1	-	-	1	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

EIGHTH SEMESTER

CSE 811 Distributed Systems 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE811	Distributed Systems	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Operating systems. Computer Networks		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: To explain the paradigm of distributed computing. ● CO2: To explore various existing and possible architectures of distributed systems. ● CO3: To properly appreciate the issues that arise in distributed systems and explore solutions for the problems. ● CO4: To fully appreciate the advantages to be obtained from a distributed environment wrt fault tolerance, load sharing etc.					
Topics Covered		Introduction to Distributed Systems. Motivations. Design Issues. (3L) Clocks in a Distributed System. Synchronization Issues. Logical Clocks. Causal relationships. Vector Clocks. (3L) Distributed State Detection. Global State. Consistent Cut. Global State recording algorithm. (2L) Termination Detection. Credit based algorithm. Diffusion Computation based algorithm. (2L) Distributed Mutual Exclusion. Token based and non-token based algorithms. (4L) Deadlocks in Distributed Systems. Resource allocation Models. Deadlock Prevention. Deadlock Avoidance – Safe states. Deadlock detection and Correction. Phantom Deadlocks. Centralized, Distributed and Hierarchical deadlock detection algorithms. (5L) Fault recovery. Classes of Faults. Backward and Forward recovery. Log based recovery. Checkpoints. Shadow paging. (5L) Fault Tolerance. Data Replication. Quorum Algorithms. Distributed Commit Protocols. 2-phase commit. 3-phase commit. Election Algorithms. Bully algorithm. Ring topology algorithm. (8L) Byzantine faults and Agreement Protocols. (2L)					

	Distributed File systems. Mechanisms. Stateful and Stateless servers. Scalability. Naming and Name Servers. (4L) Distributed Scheduling. Load Balancing. Load Estimation. Stability. Process Migration. Remote Procedure Calls. Transparency. Binding. (4L)
Text Books, and/or reference material	**Text Books:** 1. Advanced Concepts in Operating Systems. Singhal and Sivaratri. McGraw Hill. **Refenence Books:** 1. Operating Systems: A Concept Based Approach. Dhamdhere. McGraw Hill. 2. Distributed Operating Systems: Concepts and Design. P.K.Sinha. Prentice Hall. 3. Distributed Operating Systems. A.Tanenbaum. Pearson Education. 4. Distributed Systems: Concepts and Design. Coulouris et.al. Pearson Education.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	3	3	2	3	3	2	-
CO2	3	2	3	2	2	2	2	2	2	3	2	-
CO3	3	2	3	2	2	2	2	2	2	3	2	-
CO4	3	2	3	2	2	2	2	3	3	3	3	-

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 812 Computer Vision 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 812	Computer Vision	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Probability and Statistics, Algebra, Optimization, Computer Graphics		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding basic architecture and principles of computer vision systems. ● CO2: Implementation of computer vision algorithms including depth estimation, multi-camera view and motion analysis components. ● CO3: Apply basic image processing and feature extraction techniques in					

	order to design computer vision algorithms. ● CO4: Analysis of pattern analysis and image segmentation techniques used for computer vision systems. ● CO5: Design and development of real time computer vision systems.
Topics Covered	Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. [5L] Depth estimation and Multi-camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel. [6L] Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. [8L] Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection. [5L] Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. [8L] Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation. [4L] Shape from X: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges. [6L]
Text Books, and/or reference material	**Text Books:** ● Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011. ● D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003. **Reference Books:** ● Richard Hartley and Andrew Zisserman, Multiple View Geometry in

	Computer Vision, Second Edition, Cambridge University Press, March 2004. ● K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990. ● R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992. **Others:** Swayam Online Course 1. https://swayam.gov.in/nd1_noc19_cs58/preview 2. https://www.coursera.org/courses?query=computer%20vision 3. https://www.edx.org/course/computer-vision-and-image-analysis-3 4. https://www.mooc-list.com/tags/computer-vision

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	-	-	-	-	-	-	2
CO2	2	3	3	3	2	-	-	-	-	-	-	2
CO3	2	2	3	2	3	-	-	-	-	-	-	2
CO4	2	3	2	3	2	-	-	-	-	-	-	2
CO5	2	2	3	3	3	-	-	-	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 813 Optical Networks 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 813	Optical Networks	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Basic Concepts of Computer Networks, and Algorithms		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: Understanding the fundamental concepts and identifying different issues of optical networks. ● CO2: Comprehend the basic concepts and solution techniques for the different fundamental problems like routing and wavelength assignment (RWA), virtual topology design, wavelength rerouting, and traffic grooming in optical network design. ● CO3: Acquire knowledge of the wavelength convertible network. ● CO4: Comprehend the multicast routing in optical networks.					
Topics Covered		1. **Fundamentals and Different Problems**: Optical fiber principles, Optical transmission system, Wavelength Division Multiplexing(WDM), optical networking evolution, Optical Network Architectures, Different issues in					

	wavelength routed networks. (06L) 2. **Routing and Wavelength Assignment (RWA) algorithms**: ILP formulation of the RWA problem, Route Selection algorithms – Fixed Routing, Fixed Alternate Routing, Exhaust Routing, Least Congested Path Routing, Limited alternate Routing. Wavelength Selection algorithms. Joint wavelength-Route selection algorithm. (07L) 3. **Wavelength Convertible Networks**: Need for Wavelength Converters, Wavelength convertible Switch Architecture, Routing in Convertible Networks, Performance Evaluation of Convertible networks, Network with Sparse Wavelength Conversion, Converter Placement problem. (06L) 4. **Wavelength Rerouting Algorithm**: Benefits of wavelength rerouting, Issues in wavelength rerouting, Rerouting algorithm. (04L) 5. **Virtual Topology Design**: Physical and Virtual topology, Traffic routing over virtual topology, Limitations on virtual topology, Virtual topology problem formulation, Virtual topology design heuristics. (06L) 6. **Traffic Grooming:** Basic concepts, Grooming node architecture, ILP formulation of the traffic grooming problem, Different heuristics (MST, MRU, TGCP, etc) for the traffic grooming problem. (06L) 7. **Optical Multicast Routing**: Multicast routing problem, architecture of Light spliting node and MI node, Network with full splitting and sparse splitting, Multicast Tree generation algorithms – Source based, Steiner based and Virtual source based tree generation algorithms. (07L)
Text Books, and/or reference material	**Text Books:** **1.** WDM OPTICAL NETWORKS Concepts, Design and algorithms. by C. Siva Ram Murthy and Mohan Gurusamy (PHI). 2. OPTICAL NETWORKS by Biswanath Mukherjee (TMH). **Reference Books:** 1. Optical Networks: A Practical Perspective (3rd Edition) by R. Ramaswami, K. Sivarajan, G. Sasaki (Morgan Kaufmann Publishers).

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	1	1	-	-	-	-	-	-	2
CO2	2	3	3	3	2	-	-	-	-	-	-	3
CO3	2	3	3	2	2	-	-	-	-	-	-	3
CO4	2	3	3	2	2	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 814 Internet of Things 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSE 814</td><td>Internet of Things</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3"></td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Understand the basic concepts of Internet of Things.
● CO2: Preparing the right background to take up research works in emerging wireless technologies and Internet of Things.
● CO3: Service computing models for IoT - edge computing, Machine learning mechanisms in IoT scenarios.
● CO4: Able to understand the innovation opportunity in IoT application segments.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Module 1: Introduction to IoT and Sensing (3L)
Introduction to IoT, Sensing, Edge computing, Data processing, Learning. Introduction to layered architecture of IoT.
Module 2: Sensing and actuating (4L)
working principle of some sensors like Ultrasonic sensor, Thermal Sensors, Infrared Sensors, Pollutant Sensors, Temp, IMU Sensor etc.; basic actuation mechanisms and common actuators.
Module 3: Microcontroller/Microcomputer (4L)
Open source hardware, Play with Sensors using Arduino Programming, Local data processing using Raspberry Pi/Uddo Neo, using different Network Modules (Bluetooth, WiFi, GSM/GPRS).
Module 4:Wireless Networks Present and Future (10L)
Concept of TCP/IP protocol Stack, 802.11 Protocol (WiFi Network), LoRa Network, Acoustic Communication, Socket Programming, Wireshark Tool
Module 5: IoT Protocols (4L)
HTTP, QUIC, CoAP, MQTT.
Module 6:Performance and Security in IoT(6L)
Performance modeling of stochastic systems, QoS modeling, estimation of IoT service response times; fundamentals of lightweight security protocols. IS/ISO/IEC TR 22417: 2017 IoT general standards.
Module 7: Case Study of IoT Based Applications (11L)
Case Study 1: (activity Identification) Human Activity using Ultra sonic Sensors/Thermal Sensors.
Case Study 2: (Environment Monitoring) Pollution Monitoring and Forecasting in Indoor and Outdoor.
Case Study 3: (Road Transportation System) (a)Important PoIs using GPS trails,</td></tr>
</table>

	(b)Context Aware Speed Profiling from Mobile Phone Sensors, (c)My Smartphone Can Monitor My Street-lights. Case Study 4: **(Challenged Networks)** offline Crisis Mapper Design using ChatBot, IoT Protocol Stack Development using Acoustic Communication. Case Study 5: **(Agriculture Monitoring):** Smart Farming using MQTT Protocol through Cost-effective Heterogeneous Sensors. SmartCity IoT: Integration of multiple IoT application segments, dynamic directory management, service replication and server selection; putting it all together.
Text Books, and/or reference material	**Text Books** **1.** "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press). 2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press).

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	2	1	-	-	1	-	1
CO2	3	2	2	2	1	1	1	1	-	1	-	2
CO3	2	3	2	1	3	2	2	2	1	2	1	1
CO4	-	3	2	3	3	3	2	2	2	2	3	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 815 Cloud Computing 3-0-0 3 Credits 3 Hour

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 815	Cloud Computing	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes	After the completion of this course, student will be able to: ● CO1: Understand the core concepts of the cloud computing paradigm: paradigm shift, the characteristics, advantages and challenges of various models and services. ● CO2: Apply fundamental concepts in cloud infrastructures to understand the tradeoffs in power, efficiency and cost, and then study how to leverage and manage single and multiple datacenters to build and deploy cloud applications that are resilient, elastic and cost-efficient. ● CO3: Learn system, network and storage virtualization and outline their role in enabling the cloud computing system model. ● CO4: Analyze the performance, scalability, and availability of the underlying cloud technologies and software. ● CO5: Identify security and privacy issues in cloud computing.						

	• CO6: Explain recent research results in cloud computing and identify their pros and cons.
Topics Covered	**Introduction to Services Oriented Computing -** Service Oriented Software, Web Applications Paradigm.[2] **Services Oriented Architecture -** SOA and Web Services Fundamentals, SOA and Service-Orientation, SOA - Planning and Analysis, SOA - Technology and Design, SOA Reference model (OASIS), SOA standard S3, Business Process and SOA, Software as a Service (SaaS) [4] **Web Services -** Introduction to Web Services, Web Service Jargon – Publishing, Discovery and Binding, Web Service Technologies – WSDL, SOAP, UDDI, Issues and Challenges – MANET, CLOUD, DTN,Formal, Representation of Services[4] **Cloud Computing Basics-** Overview, Applications, Intranets and the Cloud. Organization and Cloud Computing- Benefits, Limitations, Security Concerns. [2] **Cloud Infrastructure -** Data center, Virtualization, Clients, Security, Network, Services and Delivery Models (SaaS, PaaS, IaaS). Case study like Amazon EC2, Microsoft Azure etc. Deployment types (Private, Public, Hybrid) [4] **Software as a Service (Saas)-** Understanding the Multitenant Nature of SaaS Solutions, Understanding SOA. [2] **Platform as a Service (PaaS)-** IT Evolution Leading to the Cloud, Benefits of Paas Solutions, Disadvantages of Paas Solutions. [2] **Infrastructure as a Service (Iaas)-**Understanding IaaS, Improving Performance through Load Balancing, System and Storage Redundancy, Utilizing Cloud-Based NAS Devices, Advantages, Server Types. [3] **Virtualization-**Understanding Virtualization, History, Server Virtualization, Data Storage Virtualization. [4] **Securing the Cloud**- General Security Advantages of Cloud-Based Solutions, Introducing Business Continuity and Disaster Recovery. Disaster Recovery-Understanding the Threats. [4] **Migrating to the Cloud-**Cloud Services for Individuals, Cloud Services Aimed at the Mid-Market, Enterprise-Class Cloud Offerings, and Migration. [4] **Designing Cloud Based Solutions-**System Requirements, Design Is a Give-and-Take Process. Coding Cloud Based Applications-Creating a Simple Yahoo Pipe, Using Google App Engine and creating a Windows Azure Application. Application Scalability-Load-Balancing Process, Designing for Scalability, Capacity Planning Versus Scalability, Scalability and Diminishing Returns and Performance Tuning. [7]
Text Books, and/or reference material	**Text Books:** Cloud Computing: A Practical Approach by Anthony T. Velte Toby J. Velte, Robert Elsenpeter, The McGraw-Hill Publisher. Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more. by Dr. Kris Jamsa, Jones & Bartlett Publisher. **Reference Books:** Cloud Computing Bible by Barrie Sosinsky, Published by Wiley Publishing. Cloud Computing for Dummies by Judith Hurwitz, Robin Bloor, Marcia Kaufman, and Dr. Fern Halper, Wiley Publishing. Cloud Computing Theory And Practice Danc.Marinercus, Elsevier.

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	-	2	-	1	2	-	-	-
CO2	1	2	3	-	2	1	1	1	1	-	-	-
CO3	1	1	-	-	2	2	1	-	2	-	-	-
CO4	3	2	2	3	2	2	-	-	1	-	-	1
CO5	-	1	2	3	1	3	-	3	-	-	-	2
CO6	3	3	1	3	2	-	-	-	-	-	-	3

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 816 Mobile Computing 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 816	Mobile Computing	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Computer Networks		CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]					
Course Outcomes		● CO1: Introduce the basics of Wireless Networks. ● CO2: Preparing the right background to take up research works in emerging wireless technologies and Internet of Things. ● CO3: To introduce the scopes of using sensing, edge computing, Machine learning mechanisms in pervasive cyber physical systems. ● CO4: Able to understand the innovation opportunity in IoT application segments. ● CO5: Hands-on experience on Wireless Networks & Mobile Computing.					
Topics Covered		**Module 1:** Physical Layer **(6 L)** Bit transmission over Wireless, Vary Much different from Wired Network. **Module 2:** Mac Layer **(8 L)** Access in Shared Medium, Difference between Wired MAC & Wireless MAC, Different Type of MACs (a) Random MAC (b) Scheduled MAC, Examples of MAC Implementation (WiFi Protocol --802.11, Bluetooth Protocol--805.15). **Module 3:** Network Layer **(8 L)**					

	Reactive Routing, Proactive Routing, DSR Principle, AODV Principle, Location Aware Routing. Adhoc Network, Delay Tolerant Network, Opportunistic Network Introduction, Architecture & Applications, Routing Algorithms – Epidemic, Prophet, Spray & Wait, Spray & Focus, Maxprop Simulation Tool - ONE Simulator. **Module 4:** Transport Layer **(8 L)** Wireless TCP and rationale, Difference between Wired TCP and Wireless TCP, QoS Measurement of Wireless Networks. **Module 5:** Modelling **(8 L)** Mathematical Modelling of Network Functionalities - Combining them to derived overall performance. **Module 6:** Case Study: Implementation of opportunistic Networks in Challenged Network scenarios **(4 L)** (a) Connection Mechanism (b) Sync - Transferring the information in Collaborative manner (c) Offline Dashboard (Information Summarization) (d)security
Text Books, and/or reference material	**Text Books:** 1. “Mobile Communication”, by Jochen Schiller (PEARSON EDUCATION LIMITED). 2. “Wireless Networking” A kumar, D. manjunath, J. Kuri, Elsevier, 2008. 3. “Wireless Communication”, T. S. Rappaport, Pearson, latest edition. **Reference Books:** **Research Papers:** 1. IEEE Infocom Tutorials slides by Prof. Nitin Vaidya. **Others:** Tools: ● Sniffer Tool (Wireshark) ● Simulation Tools: OMNET ONE NS3

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	-	1	-	-	-	-	-	-
CO2	2	2	3	2	-	2	-	-	-	2	-	-
CO3	2	2	2	2	3	3	3	1	-	-	-	3
CO4	2	1	3	3	-	3	-	-	-	-	3	-
CO5	2	3	3	3	3	3	3	-	3	3	2	3

Mapping of CO (Course Outcome) and PO (Programme Outcome)
Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 817 Expert Systems 3-0-0 3 Credits 3 Hours

<table>
<tr><td colspan="8">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSE 817</td><td>EXPERT SYSTEMS</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites
Artificial Intelligence, Data Mining, Pattern Recognition, OOP</td><td colspan="5">Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))</td></tr>
<tr><td colspan="3"></td><td colspan="5">CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Idea about Knowledge Base & Expert Systems.
● CO2: Idea of Inference Tool and Inference Engine and different methods of Inference Methodologies.
● CO3: Idea about Reasoning under Uncertainty and Uncertainty Management which is really crucial under present day scenario.
● CO4: Concept of the Design of Expert System Components and Experts Systems.
● CO5: Some Examples of Practical Experts System.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">1. Introduction to Expert Systems: Definition of an Expert System – Advantages of Expert Systems – Characteristics of Expert Systems - Applications and Domains – Procedural and Non procedural Systems. [6L]

2. The Different Techniques for Knowledge Representation: Meaning of Knowledge – Productions – Semantic Nets- Frames – Logics – Propositional and Predicate Logic – The universal and existential quantifiers. [7L]

3. The Different Methods of Inference : Trees, Lattice and Graph – State and Problem Space – Rules of Inference – Logic Systems – Resolution Systems and Deductions – Forward and Backward Reasoning – Meta knowledge. [7L]

4. The Reasoning Under Uncertainty and Inexact Reasoning – Uncertainty – Types of Errors – Classical Probability – Experimental and Subjective probabilities – Compound and Conditional Probabilities – Temporal Reasoning – Uncertainty in Inference Chains – Evidence Combination – Uncertainty and Rules – Certainty Factors – Dempster- Shafer Theory – Approximate Reasoning. [8L]</td></tr>
</table>

	5. The Design of Expert Systems Tool and Expert Systems : Selecting Appropriate Problem – Stages in the development – Errors in Development – Expert System Life Cycle – A Life Cycle Model. [7L] 6. Some Practical Examples of Expert System Design – Modular Design – Phases and Control Facts – Importing and Exporting facts – Modules and Execution Control – Certainty Factors – Decision Trees – Backward Chaining – A Monitoring Problem.[7L]
Text Books, and/or reference material	**Text Books:** 1. Expert Systems Principles and Programming – Bikash Publishing House. 2. Pattern Classification- – Duda, Hart & Stork – J. Wiley & Sons. **Reference Books:** 1. Artificial Neural Networks – B. Yegnanarayana – PHI. 2. Neural Networks for Pattern Recognition – C.M. Bishop – Oxford.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	-	-	-	-	-	-	3
CO2	3	2	2	3	3	-	-	-	-	-	-	3
CO3	3	2	1	2	3	-	-	-	-	-	-	3
CO4	3	2	1	2	3	-	-	-	-	-	-	3
CO5	3	2	1	2	3	-	-	-	-	-	-	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 818 Ethics, Society, and Computer Science 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE818	Ethics, Society, and Computer Science	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
Basic knowledge of programming and AI/ML		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes		● CO1: To understand professional and ethical responsibilities, including those defined in the ACM/IEEE Professional Code of Ethics. ● CO2: To ensure fairness, accountability, and transparency while working on machine learning, artificial intelligence and related fields. ● CO3: To appreciate the threats to privacy posed by modern data aggregation and data processing techniques. ● CO4: To design technologies incorporating ethical considerations from the					

	specification provided.
Topics Covered	**Introduction:** What is Ethics?, Ethics and Computer Science, Social consensus on unethical practices by computer professionals, Conventional issues, Emerging issues in the age of data driven (AI/ML based) decision making, History and Evolution of ethics with advances in computer science and engineering. (4L) **Ethics in Data collection and aggregation:** Basic mechanism of data driven (AI/ML based) decision making, Data aggregation and decision making, Data Ownership, Collection and collation of digital imprints of users, Data stealing and data broking, Informed consent, Data repurposing, Privacy, Anonymity, Data validity, Establishing data protection framework with legal backing, Concept of differential privacy, GPDR. (10L) **Algorithmic Fairness:** Discriminatory impact of imperfect decisions, Case study: Facial recognition software, Criminal justice using big data, recidivism models for sentencing guidelines, predictive policing, Trust in AI/ML based decision making, Algorithmic fairness, Notions of fairness, Parity based and preference based notions, Fairness and accuracy, Identifying and mitigating inherent bias in data and/or machine learning algorithms, Proper choice of representative sample, Making training data fair, Designing fairness aware classifiers, Algorithmic audit, Challenges, Audit based on user survey, Sock puppet audit, Audit based on scrapping/crawling. (12L) **Transparency and Explainability:** Black-box phenomenon and trust, Unpredictability, Explanation/Reasoning, Right to explanation, Explainability and accuracy trade off, Transparency and interpretability, DARPA XAI, ML model explainability, Linear model explainability, Nonlinear model explainability, Neural networks explainability, LIME package, SHAP values, What-if tool. (5L) **AI Ethics:** Moral issues in autonomous and intelligent systems, Narrow (or Weak) AI and General (or Strong) AI, Weaponization of AI, Moral issues in autonomous robots, Robot ethics, Moral issues in self-driving cars, Moral Machine Quiz. (5L) **Personalization:** Personalized recommendation, search and newsfeed, Intellectual isolation associated with personalization, Objective search results, Personalized advertisement, Cross-domain tracking. (3L) **Code of Ethics:** Ethical standards by international professional societies, IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, ACM Code of Ethics and Professional Conduct. (3L)
Text Books, and/or reference material	**Text Books:** 1. D J Patil, Hilary Mason, Mike Loukides, “Ethics and Data Science”, O'Reilly Media, Inc.; 1st edition (July, 2018). 2. P. Singer, “Practical Ethics”, Cambridge University Press, 3rd edition (February 2011)

	Reference Books: 1. Cathy O'Neil, "Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy", Crown; 1st edition (September 6, 2016). 2. John C. Havens, "Heartificial Intelligence: Embracing Our Humanity to Maximize Machines", TarcherPerigee; (February 2, 2016). 3. Wendell Wallach, Colin Allen, "Moral Machines: Teaching Robots Right from Wrong", Oxford University Press; 1st edition (June 3, 2010). 4. Garry Kasparov, "Deep Thinking: Where Machine Intelligence Ends and Human Creativity Begins", PublicAffairs; 1st edition (May 2, 2017).

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	1	-	-	-	2	-	1	-	-
CO2	3	3	3	3	-	1	2	-	2	2	3	-
CO3	3	3	3	3	1	1	3	-	2	2	3	1
CO4	2	2	1	1	3	3	1	2	-	-	-	2

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

CSE 819 Knowledge Management 3-0-0 3 Credits 3 Hour

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 819	Knowledge Management	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					
Course Outcomes	CO1: Understand Knowledge and its creation, acquisition, dissemination, use and re-use. CO2: Understand KM systems and its application in knowledge generation and knowledge transfer CO3: Understand knowledge codification and system development, testing and deployment of KM systems. CO4: To evaluate effectiveness of KM System, draw inference from data,						

	data mining for knowledge extraction, understand role of KM Systems and Applications in institutes and organizations.
Topics Covered	KM concepts: Use of KM, KM System Life Cycle, aligning KM and business strategy (6L) Knowledge Types, KM System Life Cycle models (5L) Knowledge codification and system development, testing and deployment, Knowledge transfer and knowledge sharing (7L) KM systems: Analysis, design and development of KM System (5L) KM tools: inferences from data, data mining and knowledge portals (6L) Evaluation of KM effectiveness: Tools and metrics, Case studies on KM Systems and Applications (7L) KM experiences from Indian companies, KM innovation and Learning organization, The future of KM (6L)
Text Books, and/or reference material	**Text Books:** 1. Elias.M. Awad & Hassan M. Ghaziri – "Knowledge Management" Pearson Education. 2. Knowledge Management in Theory and Practice - 2nd edition by Kimiz Dalkir. **Reference Books:** 1. Guus Schreiber, Hans Akkermans, Anjo Anjewierden, Robert de Hoog, Nigel Shadbolt, Walter Van de Velde and Bob Wielinga, "Knowledge Engineering and Management", Universities Press. 2. C.W. Holsapple, "Handbooks on Knowledge Management", International Handbooks on Information Systems, Vol 1 and 2. **Others:** This course follows the structure of NPTEL Course on Knowledge Management by Prof. KBL Srivastava, IIT Kharagpur, link: https://nptel.ac.in/courses/110105076

Mapping of CO (course outcome) and PO (Program Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	1	3	3	3	3
CO2	3	3	3	3	3	3	3	1	3	3	3	3
CO3	3	3	3	3	3	3	3	1	3	3	3	3
CO4	3	3	3	3	3	3	3	1	3	3	3	3

Correlation levels 1, 2 or 3 as defined below:

1. Slight (Low) 2. Moderate (Medium) 3. Substantial (High)

Annexure - II

Note: CSC504 Microcontroller based Systems is now converted to CSC504 Embedded Systems.

CSC 504 Microcontroller based Systems 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC 504	Microcontroller based Systems	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))					
		CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]					

Course Outcomes	● CO1: Remember the architecture and instruction sets of PIC and ARM. ● CO2: Understand PIC interrupts, interfacing of peripherals. ● CO3: Apply the knowledge in LCD keyboard interfacing, ADC, DAC and Sensor interfacing and ARM assembly language programming. ● CO4: Analyze ADC, DAC and Sensor interfacing using PIC; relate PIC and ARM architectures. ● CO5: Appraise the architecture of PIC and ARM in terms of RISC architecture. ● CO6: Create embedded ARM applications.
Topics Covered	**UNIT I INTRODUCTION TO PIC MICROCONTROLLER 9 14** Introduction to PIC Microcontroller–PIC 16C6x and PIC16C7x Architecture–PIC16cxx–- Pipelining - Program Memory considerations – Register File Structure - Instruction Set - Addressing modes –Simple Operations. (12L) **UNIT II INTERRUPTS AND TIMER 9 PIC** Microcontroller Interrupts- External Interrupts-Interrupt Programming–Loop time subroutine - TimersTimer Programming– Front panel I/O-Soft Keys– State machines and key switches–Display of Constant and Variable strings. (8L) **UNIT III PERIPHERALS AND INTERFACING 9 I 2 C** Bus for Peripherals Chip Access–Bus operation-Bus subroutines– Serial EEPROM—Analog to Digital Converter–UART-Baud rate selection–Data handling circuit–Initialization - LCD and keyboard Interfacing - ADC, DAC, and Sensor Interfacing. (8L)

	UNIT IV INTRODUCTION TO ARM PROCESSOR 9 ARM Architecture –ARM programmer's model –ARM Development tools- Memory Hierarchy–ARM Assembly Language Programming–Simple Examples–Architectural Support for Operating systems. (10L) **UNIT V ARM ORGANIZATION 9 3-Stage Pipeline ARM Organization**– 5-Stage Pipeline ARM Organization–ARM Instruction ExecutionARM Implementation–ARM Instruction Set– ARM coprocessor interface– Architectural support for High Level Languages – Embedded ARM Applications. (4L)
Text Books, and/or reference material	**Text Books:** 1. Peatman,J.B., "Design with PIC Micro Controllers"PearsonEducation,3rdEdition, 2004. 2. Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000. **Reference Books:** 1. Mazidi, M.A.,"PIC Microcontroller" Rollin Mckinlay, Danny causey Prentice Hall of India

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO2	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO3	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO4	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO5	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO6	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Annexure III
Modification of syllabus of some courses

CSE 719 Multimedia Information Systems 3-0-0 3 Credits 3 Hours

Department of Computer Science and Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSE 719	Multimedia Information Systems	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous Assessment (CA), Mid-Term (MT), End Term (ET))
Knowledge of Data Structures and DBMS	CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**
Course Outcomes	• CO1: In depth understanding of media and data stream, sound, audio, image, video and animation. • CO2: Understand multimedia compression techniques, multimedia operating systems fundamentals and multimedia network fundamentals. • CO3: Understanding multimedia synchronisation aspects, SAS factors, issues on dealing with multiple data formats, data encryption/decryption techniques. • CO4: Understanding of multimedia database storage and retrieval.
Topics Covered	Overview of multimedia system: Text, audio, video, graphics. Computer based animation-display of animation, animation languages, methods of controlling animation, transmission of animation. (6L) Media Synchronization and QOS (4L) Entropy, data compression, image compression, audio compression, video compression (10L) Multimedia Operating Systems issues like real time operation, resource management, process management, file systems, multimedia networking and communication fundamentals (9L) Data Encryption/Decryption techniques for media transmission (3L) Multimedia databases, query types, multimedia data storage and retrieval (10L)
Text Books, and/or reference material	**Text Books:** Multimedia Information Networking, Nalin K.Sharda, Prentice Hall India. Multimedia: Computing, Communications and Applications, Ralf Steinmetz and Klara Nahrstedt, Pearson Education Asia. Multimedia Communications, Applications, Networks, Protocols and Standards, Fred Halsall, Pearson Education Asia. Multimedia Systems, John F. Koegel Buford, Pearson Education Asia. **Reference Books:** Subrahmanian and Jajodia, Multimedia Database Systems, Springer. V.S. Subrahmanian, Principles of Multimedia Database Systems, Morgan Kaufmann Publishers, 1998.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	3	3	2	3	3	3	1	2	3	2	3
CO2	3	3	3	2	3	3	3	1	2	3	2	3
CO3	3	3	3	2	3	3	3	1	2	3	2	3
CO4	3	3	3	2	3	3	3	1	2	3	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)