HERITAGE INSTITUTE OF TECHNOLOGY

(An Autonomous Institute Under MAKAUT)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

B.Tech Course Structure

June 2020

PART I: COURSE STRUCTURE

FIRST YEAR
FIRST SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	CHEM1001	Chemistry-I	3	1	0	4	4
2	MATH1101	Mathematics-I	3	1	0	4	4
3	ELEC1001	Basic Electrical Engineering	3	1	0	4	4
Total Theory			**9**	**3**	**0**	**12**	**12**
B. Practical							
1	CHEM1051	Chemistry I Lab	0	0	3	3	1.5
2	ELEC1051	Basic Electrical Engineering Lab	0	0	2	2	1
3	MECH1052	Engineering Graphics & Design	1	0	4	5	3
Total Practical			**1**	**0**	**9**	**10**	**5.5**
Total of Semester without Honors			**10**	**3**	**9**	**22**	**17.5**
C. Honors							
1	HMTS1011	Communication for Professionals	3	0	0	3	3
2.	HMTS1061	Professional Communication Lab	0	0	2	2	1
Total Honors			**3**	**0**	**2**	**5**	**4**
Total of Semester with Honors			**13**	**3**	**11**	**27**	**21.5**

FIRST YEAR
SECOND SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	PHYS1001	Physics I	3	1	0	4	4
2	MATH1201	Mathematics II	3	1	0	4	4
3	CSEN1001	Programming for Problem Solving	3	0	0	3	3
4	HMTS1202	Business English	2	0	0	2	2
Total Theory			**11**	**2**	**0**	**13**	**13**
B. Practical							
1	PHYS1051	Physics I Lab	0	0	3	3	1.5
2	CSEN1051	Programming for Problem Solving Lab	0	0	4	4	2
3	MECH1051	Workshop / Manufacturing Practice	1	0	4	5	3
4	HMTS1252	Language Lab	0	0	2	2	1
Total Practical			**1**	**0**	**13**	**14**	**7.5**
Total of Semester without Honors			**12**	**2**	**13**	**27**	**20.5**
C. Honors							
1	ECEN1011	Basic Electronics	3	0	0	3	3
2	ECEN1061	Basic Electronics Lab	0	0	2	2	1
Total Honors			**3**	**0**	**2**	**5**	**4**
Total of Semester with Honors			**15**	**2**	**15**	**32**	**24.5**

SECOND YEAR
THIRD SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	CSEN2101	Data Structures and Algorithms	4	0	0	4	4
2	CSEN2102	Discrete Mathematics	4	0	0	4	4
3	ECEN2101	Analog Circuits	3	0	0	3	3
4	ECEN2104	Digital Logic	3	0	0	3	3
5	HMTS2001	Human Values and Professional Ethics	3	0	0	3	3
Total Theory			**17**	**0**	**0**	**17**	**17**
B. Practical							
1	CSEN2151	Data Structures and Algorithms Lab	0	0	3	3	1.5
2	CSEN2152	Software Tools Lab	0	0	3	3	1.5
3	ECEN2154	Digital Logic Lab	0	0	2	2	1
Total Practical			**0**	**0**	**8**	**8**	**4**
Total of Semester without Honors			**17**	**0**	**8**	**25**	**21**
C. Honors							
1	MATH2111	Probability and Statistical Methods	4	0	0	4	4
Total Honors			**4**	**0**	**0**	**4**	**4**
Total of Semester with Honors			**21**	**0**	**8**	**29**	**25**

SECOND YEAR
FOURTH SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	CSEN2201	Design & Analysis of Algorithms	4	0	0	4	4
2	CSEN2202	Computer Organization and Architecture	4	0	0	4	4
3	CSEN2203	Operating Systems	3	0	0	3	3
4	MATH2201	Mathematics-III Algebraic Structures	4	0	0	4	4
5	AEIE2205	Microprocessors and Microcontroller	2	0	0	2	2
6	EVSC2016	Environmental Sciences (Mandatory)	2	0	0	2	0
Total Theory			**19**	**0**	**0**	**19**	**17**
B. Practical							
1	CSEN2251	Design & Analysis of Algorithms Lab	0	0	3	3	1.5
2	CSEN2252	Computer Architecture Lab	0	0	2	2	1
3	CSEN2253	Operating Systems Lab	0	0	3	3	1.5
4	AEIE2255	Microprocessors & Microcontroller Lab	0	0	2	2	1
Total Practical			**0**	**0**	**10**	**10**	**5**
Total of Semester			**19**	**0**	**10**	**29**	**22**

THIRD YEAR
FIFTH SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	CSEN3101	Database Management Systems	4	0	0	4	4
2	CSEN3102	Formal Language & Automata Theory	4	0	0	4	4
3	CSEN3103	Object Oriented Programming	4	0	0	4	4
4	ECEN3106	Electronic Design Automation	2	0	0	2	2
5	CSEN3131- CSEN3140	Professional Elective-I	3	0	0	3	3
	CSEN3131 CSEN3132 CSEN3133 CSEN3134 CSEN3135	Computer Graphics & Multimedia Data Mining & Knowledge Discovery Web Technologies Graph Algorithms Introduction to Data Analysis with Python and R					
Total Theory			**17**	**0**	**0**	**17**	**17**
B. Practical							
1	CSEN3151	Database Management Systems Lab	0	0	3	3	1.5
2	CSEN3153	Object Oriented Programming Lab	0	0	3	3	1.5
3	ECEN3156	Electronic Design Automation Lab	0	0	2	2	1
Total Practical			**0**	**0**	**8**	**8**	**4**
Total of Semester without Honors			**17**	**0**	**8**	**25**	**21**
C. Honors							
1	CSEN3111	Artificial Intelligence	3	0	0	3	3
2	CSEN3161	Artificial Intelligence Lab	0	0	2	2	1
Total Honors			**3**	**0**	**2**	**5**	**4**
Total of Semester with Honors			**20**	**0**	**10**	**30**	**25**

THIRD YEAR
SIXTH SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	CSEN3201	Software Engineering	4	0	0	4	4
2	CSEN3202	Computer Networks	4	0	0	4	4
3	HMTS3201	Economics for Engineers	3	0	0	3	3
4	CSEN3231 - CSEN3240	Professional Elective-II	3	0	0	3	3
	CSEN3231 CSEN3232 CSEN3233 CSEN3234 CSEN3235 CSEN3236	Advanced Operating System Enterprise Application in Java EE Machine Learning Computational Geometry Cloud Computing Big Data					
5		Open Elective-I	3	0	0	3	3
	AEIE3221 ECEN3222 ECEN3223 MATH3221 MATH3223	Fundamentals of Sensors and Transducers Designing with Processors and Controllers Analog and Digital Communication Computational Mathematics Scientific Computing					
6	INCO3016	Indian Constitution and Civil Society (Mandatory)	2	0	0	2	0
Total Theory			**19**	**0**	**0**	**19**	**17**
B. Practical							
1	CSEN3251	Software Engineering Lab	0	0	3	3	1.5
2	CSEN3252	Computer Networks Lab	0	0	3	3	1.5
Total Practical			**0**	**0**	**6**	**6**	**3**
C. Sessional							
1	CSEN3293	Term Paper and Seminar	0	0	4	4	2
Total Sessional			**0**	**0**	**4**	**4**	**2**
Total of Semester			**19**	**0**	**10**	**29**	**22**

FOURTH YEAR
SEVENTH SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	HMTS4101	Principles of Management	3	0	0	3	3
2	CSEN4131-CSEN4140	Professional Elective-III	3	0	0	3	3
	CSEN4131 CSEN4132 CSEN4133 CSEN4134 CSEN4135	Soft Computing Cryptography & Network Security Image Processing Approximation Algorithms Information Retrieval					
3		Open Elective-II	3	0	0	3	3
	AEIE4121 AEIE4122 CHEN4121 CHEN4122 ECEN4121 ECEN4122 BIOT4026 MATH4121	Instrumentation and Telemetry Linear Control Systems and Applications Industrial Total Quality Management Industrial Pollution Control Software Defined Radio Error Control Coding Biology for Engineers Methods in Optimization					
4		Open Elective-III	3	0	0	3	3
	AEIE4127 MATH4122 BIOT4123 CHEN4123 ECEN4126 ECEN4127	Introduction to Embedded System Advanced Linear Algebra Biosensor Statistical Methods in Design of Experiments Ad Hoc Networks and Security Challenges Introduction to VLSI Design					
Total Theory			**12**	**0**	**0**	**12**	**12**
B. Sessional							
1	CSEN4191	Industrial Training / Internship	-	-	-	-	2
2	CSEN4195	Project-I	0	0	8	8	4
Total Sessional			**0**	**0**	**8**	**8**	**6**
Total of Semester without Honors			**12**	**0**	**8**	**20**	**18**
C. Honors							
1	CSEN4111	Compiler Design	3	0	0	3	3
2	CSEN4161	Compiler Design Lab	0	0	2	2	1
Total Honors			**3**	**0**	**2**	**5**	**4**
Total of Semester with Honors			**15**	**0**	**10**	**25**	**22**

FOURTH YEAR
EIGHTH SEMESTER

Sl.	Code	Subject	Contacts Periods/ Week				Credit Points
			L	T	P	Total	
A. Theory							
1	CSEN4231-CSEN4240	Professional Elective-IV	3	0	0	3	3
	CSEN4231 CSEN4232 CSEN4233 CSEN4234 CSEN4235 CSEN4236	Distributed Algorithms Mobile Computing Pattern Recognition Computational Complexity Social Network Analysis Computer Vision					
2	CSEN4241-CSEN4250	Professional Elective-V	3	0	0	3	3
	CSEN4241 CSEN4242 CSEN4243 CSEN4244 CSEN4245 CSEN4246	Distributed Databases Natural Language Processing Parallel Algorithms Real Time & Embedded System Quantum Computing Robotics					
3		Open Elective-IV	3	0	0	3	3
	AEIE4221 AEIE4222 BIOT4221 BIOT4222 CHEN4221 CHEN4222 ECEN4222 PHYS4121	Process Instrumentation Medical Instrumentation Computational Biology Non-conventional Energy Nanotechnology Introduction to Solar and Wind Technology Optical Fiber Communication Quantum Physics					
Total Theory			**9**	**0**	**0**	**9**	**9**
B. Sessional							
1	CSEN4295	Project-II	0	0	16	16	8
2	CSEN4297	Comprehensive Viva-voce	-	-	-	-	1
Total Sessional			**0**	**0**	**16**	**16**	**9**
Total of Semester			**9**	**0**	**16**	**25**	**18**

Open Electives to be offered by Computer Science and Engineering department for Non-departmental students

Sl.	Semester	Paper Code	Course Title	Contact Hours / Week				Credit Points
				L	T	P	Total	
1	6th	CSEN3221	Fundamentals of RDBMS	3	0	0	3	3
2	7th	CSEN4121	Fundamentals of Operating Systems	3	0	0	3	3
3	7th	CSEN4126	Intelligent Web and Big Data	3	0	0	3	3
4	8th	CSEN4221	Basics of Mobile Computing	3	0	0	3	3

Credit Summary for B Tech Programme with effect from 2018-2019

Sl.	Course Type	Credit Points
1	Humanities and Social Sciences including Management Courses	12
2	Basic Science Courses	23
3	Engineering Science Courses including Workshop, Drawing, Basics of Electrical / Mechanical / Computer, etc.	29
4	Professional Core Courses	52
5	Professional Elective Courses relevant to chosen Specialization / Branch	15
6	Open Subjects – Electives from other Technical and/or Emerging Subjects	12
7	Project Work, Seminar and Internship in industry or elsewhere	17
8	Mandatory Courses (Non-credit) [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	0
Total		**160**
9	Honors Courses	20
Grand Total		**180**

Honors Course for B. Tech Computer Science & Engineering Students

Sl.	Semester	Paper Code	Course Title	Contact Hours / Week			Credit Points
				L	T	P	
1	1st	HMTS1011	Communication for Professionals	3	0	0	3
2		HMTS1061	Professional Communication Lab	0	0	2	1
3	2nd	ECEN1011	Basic Electronics	3	0	0	3
4		ECEN1061	Basic Electronics Lab	0	0	2	1
5	3rd	MATH2111	Probability and Statistical Methods	4	0	0	4
6	5th	CSEN3111	Artificial Intelligence	3	0	0	3
7		CSEN3161	Artificial Intelligence Lab	0	0	2	1
8	7th	CSEN4111	Compiler Design	3	0	0	3
9		CSEN4161	Compiler Design Lab	0	0	2	1
Total							**20**

Definition of Credit (as per AICTE):

- 1 Hour Lecture (L) per Week = 1 Credit
- 1 Hour Tutorial (T) per Week = 1 Credit
- 1 Hour Practical (P) per Week = 0.5 Credits
- 2 Hours Practical (Lab) per Week = 1 Credit

Range of Credits (as per AICTE):

- A total of 160 credits will be necessary for a student to be eligible to get B Tech degree.
- A student will be eligible to get B Tech degree with Honors if he/she completes an additional 20 credits. These could be acquired through various Honors Courses offered by the respective departments.
- A part or all of the above additional credits may also be acquired through MOOCs. Any student completing any course through MOOC will have to submit an appropriate certificate to earn the corresponding credit.
- For any additional information, the student may contact the concerned HODs.

Swayam/MOOCs Courses recommended to the students of CSE department

Sl.	Code	Name	Credit Points	Corresponding Online Course	Offered by	Platform
1	ECEN1011	Basic Electronics	3	Fundamentals of Semiconductor Devices	IISc Bangalore	NPTEL
2	ECEN1061	Basic Electronics Lab	1			
3	HMTS1011	Communication for Professionals	3	Effective Business Communication **AND** Developing Soft Skills and Personality	IIM Bangalore	Swayam
4	HMTS1061	Professional Communication Lab	1		IIT Kanpur	Swayam
5	MATH2111	Probability and Statistical Methods	4	Stochastic Processes	IIT Delhi	Swayam
6	CSEN3111	Artificial Intelligence	4	Artificial Intelligence Search Methods for Problem Solving	IIT Madras	NPTEL

PART II: DETAILED SYLLABUS

Syllabus of 1st Semester

A. THEORY COURSES

Course Name: Chemistry-I					
Course Code: CHEM1001					
Contact Hours per week:	L	T	P	Total	Credit points
	3	1	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

CHEM1001.1. Knowledge of understanding the operating principles and reaction involved in batteries and fuel cells and their application in automobiles as well as other sectors to reduce environmental pollution.

CHEM1001.2. An ability to analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces for engineering applications.

CHEM1001.3. Have knowledge of synthesizing nano materials and their applications in industry, carbon nano tube technology is used in every industry now-a-days.

CHEM1001.4. Understanding of bulk properties and processes using thermodynamic considerations.

CHEM1001.5. 5 Elementary knowledge of IR, UV, NMR and X-ray spectroscopy is usable in structure elucidation and characterisation of various molecules.

CHEM1001.6. Knowledge of electronic effect and stereochemistry for understanding mechanism of the major chemical reactions involved in synthesis of various drug molecules.

2. Detailed Syllabus

Module 1 [10L]

Atomic structure and Wave Mechanics: Brief outline of the atomic structure, Duel character of electron, De Broglies's equation, the Heisenberg uncertainty principle, brief introduction of quantum mechanics, the Schrodinger wave equation, Hermitian operator, solution of the Schrodinger equation for particle in a one dimensional box, interpretation of the wave function Ψ, concept of atomic orbital.

Thermodynamics: Carnot cycle, 2nd law of thermodynamics, entropy, Clausius inequality, free energy and work function, Clausius Clapeyron Equation, Chemical Potential, Activity and Activity coefficient. Gibbs Duhem Relation.

Spectroscopic Techniques & Application: Electromagnetic spectrum: EMR interaction with matter - absorption and emission of radiation. Principle and application of UV- visible and IR spectroscopy, Principles of NMR Spectroscopy and X-ray diffraction technique.

Module 2 [10L]

Chemical Bonding: Covalent bond, VSEPR Theory, hybridization, molecular geometries, Dipole moment, Intermolecular forces, V.B. and M.O. Theory and its application in Homo and Heteronuclear diatomic molecules, Band theory of solids, Pi-molecular orbitals of ethylene and butadiene.

Periodicity: Effective nuclear charge, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, inert pair effect.

Ionic Equilibria: Acid Base Equilibria, Salt Hydrolysis and Henderson Equation, Buffer solutions, pH indicator, Common ion Effect, Solubility product, Fractional Precipitation.

Module 3 [10L]

Conductance: Conductance of electrolytic solutions, Strong and Weak electrolytes, effect of temperature and concentration. Kohlrausch's law of independent migration of ions, transport numbers and hydration of ions. Application of conductance Acid-base and precipitation titration.

Electrochemical Cell: Thermodynamic derivation of Nernst equation, Electrode potential and its application to predict redox reaction; Standard Hydrogen Electrode, Reference electrode, cell configuration, half-cell reactions, evaluation of thermodynamic functions; Reversible and Irreversible cells; Electrochemical corrosion. Electrochemical Energy Conversion: Primary & Secondary batteries, Fuel Cells.

Reaction dynamics: Rate Laws, Order & Molecularity; zero, first and second order kinetics. Pseudo unimolecular reaction, Arrhenius equation. Mechanism and theories of reaction rates (Transition state theory, Collison theory). Catalysis: Homogeneous catalysis (Definition, example, mechanism, kinetics).

Module 4 [10L]

Stereochemistry: Representations of 3- dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

Structure and reactivity of Organic molecule: Inductive effect, resonance, hyperconjugation, electrometric effect, carbocation, carbanion, free radicals, aromaticity.

Organic reactions and synthesis of drug molecule: Introduction to reaction mechanisms involving substitution, addition, elimination and oxidation- reduction reactions. Synthesis of commonly used drug molecules.

3. Textbooks

1. Atkins' Physical Chemistry, P.W. Atkins (10th Edition).
2. Organic Chemistry, I. L. Finar, Vol-1 (6th Edition).
3. Engineering Chemistry, Jain & Jain, (16th Edition).
4. Fundamental Concepts of Inorganic Chemistry, A. K. Das, (2nd Edition).
5. Engineering Chemistry -I, Gourkrishna Dasmohapatra, (3rd Edition).

4. Reference Books

1. General & Inorganic Chemistry, R. P. Sarkar.
2. Physical Chemistry, P. C. Rakshit, (7th Edition).
3. Organic Chemistry, Morrison & Boyd, (7th Edition).
4. Fundamentals of Molecular Spectroscopy, C.N. Banwell, (4th Edition).
5. Physical Chemistry, G. W. Castellan, (3rd Edition).
6. Basic Stereo chemistry of Organic Molecules, Subrata Sen Gupta, (1st Edition).

Course Name: Mathematics-I					
Course Code: MATH1101					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

MATH1101.1. Apply the concept of rank of matrices to find the solution of a system of linear simultaneous equations.
MATH1101.2. Develop the concept of eigen values and eigen vectors.
MATH1101.3. Combine the concepts of gradient, curl, divergence, directional derivatives, line integrals, surface integrals and volume integrals.
MATH1101.4. Analyze the nature of sequence and infinite series
MATH1101.5. Choose proper method for finding solution of a specific differential equation.
MATH1101.6. Describe the concept of differentiation and integration for functions of several variables with their applications in vector calculus.

2. Detailed Syllabus

Module 1 [10L]

Matrix: Inverse and rank of a matrix; Elementary row and column operations over a matrix; System of linear equations and its consistency; Symmetric, skew symmetric and orthogonal matrices; Determinants; Eigen values and eigen vectors; Diagonalization of matrices; Cayley Hamilton theorem; Orthogonal transformation.

Module 2 [10L]

Vector Calculus: Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative, Related problems on these topics.
Infinite Series: Convergence of sequence and series; Tests for conver gence: Comparison test, Cauchy's Root test, D' Alembert's Ratio test (statements and related problems on these tests), Raabe's test; Alternating series; Leibnitz's Test (statement, definition); Absolute convergence and Conditional convergence.

Module 3 [10L]

First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.
Ordinary differential equations of higher orders: General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods, Method of variation of parameters, Cauchy-Euler equations.

Module 4 [10L]

Calculus of functions of several variables: Introduction to functions of several variables with examples, Knowledge of limit and continuity, Determination of partial derivatives of higher orders with examples, Homogeneous functions and Euler's theorem and related problems up to three variables.
Multiple Integration: Concept of line integrals, Double and triple integrals. Green's Theorem, Stoke's Theorem and Gauss Divergence Theorem.

3. Textbooks

1. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, 2000.
2. Advanced Engineering Mathematics, E. Kreyszig, John Wiley & Sons, 2006.

4. Reference Books

1. Engineering Mathematics for first year, Veerarajan T., Tata McGraw-Hill, New Delhi, 2008.
2. Higher Engineering Mathematics, Ramana B.V., Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson, S. J. Bence., Cambridge University Press, 23-Mar-2006.
4. Differential Equations, S. L. Ross, Wiley India, 1984.
5. Differential Equations, G.F. Simmons and S.G. Krantz, McGraw Hill, 2007.
6. Vector Analysis (Schaum's outline series): M. R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education).
7. Engineering Mathematics: S. S. Sastry (PHI).
8. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Indian Edition.
9. Linear Algebra (Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education).

Course Name: Basic Electrical Engineering					
Course Code: ELEC1001					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

ELEC1001.1. Analyze DC electrical circuits using KCL, KVL and network theorems like Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.
ELEC1001.2. Analyze DC Machines; Starters and speed control of DC motors.
ELEC1001.3. Analyze magnetic circuits.
ELEC1001.4. Analyze single and three phase AC circuits.
ELEC1001.5. Analyze the operation of single-phase transformers.
ELEC1001.6. Analyze the operation of three phase induction motors.

2. Detailed Syllabus

Module 1 [11L]

DC Network Theorem: Kirchhoff's laws, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Star-Delta conversion.
Electromagnetism: Review of magnetic flux, Force on current carrying conductors, Magnetic circuit analysis, Self and Mutual inductance, B-H loop, Hysteresis and Eddy current loss, Lifting power of magnet.

Module 2 [10L]

AC single phase system: Generation of alternating emf, Average value, RMS value, Form factor, Peak factor, representation of an alternating quantity by a phasor, phasor diagram, AC series, parallel and series-parallel circuits, Active power, Reactive power, Apparent power, power factor, Resonance in RLC series and parallel circuit.

Module 3 [11L]

Three phase system: Generation of three-phase AC power, Balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams, power measurement by two wattmeter method.
DC Machines: Construction, EMF equation, Principle of operation of DC generator, Open circuit characteristics, External characteristics, Principle of operation of DC motor, speed-torque characteristics of shunt and series machine, starting of DC motor, speed control of DC motor.

Module 4 [10L]

Transformer: Construction, EMF equation, no load and on load operation and their phasor diagrams, Equivalent circuit, Regulation, losses of a transformer, Open and Short circuit tests, Efficiency, Introduction to three phase transformers.
Three-phase induction motor: Concept of rotating magnetic field, Principle of operation, Construction, Equivalent circuit and phasor diagram, torque-speed/slip characteristics.

3. Textbooks

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition.
2. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition.
3. Basic Electrical Engineering, Hughes.
4. Electrical Technology, Vol-I,Vol-II,Surinder Pal Bali, Pearson Publication.
5. A Textbook of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S. Chand & Company.

4. Reference Books

1. Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall.
2. Advance Electrical Technology, H.Cotton, Reem Publication.
3. Basic Electrical Engineering, R.A. Natarajan, P.R. Babu, Sictech Publishers.
4. Basic Electrical Engineering, N.K. Mondal, Dhanpat Rai.
5. Basic Electrical Engineering, Nath & Chakraborti.
6. Fundamental of Electrical Engineering, Rajendra Prasad, PHI, Edition 2005.

B. LABORATORY COURSES

Course Name: Chemistry–I Lab					
Course Code: CHEM1051					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes

After completion of the course, students will be able to:

CHEM1051.1. Knowledge to estimate the hardness of water which is required to determine the usability of water used in industries.

CHEM1051.2. Estimation of ions like Fe^{2+}, Cu^{2+} and Cl^{-} present in water sample to know the composition of industrial water.

CHEM1051.3. Study of reaction dynamics to control the speed and yield of various manufactured goods produced in polymer, metallurgical and pharmaceutical industries.

CHEM1051.4. Handling physico-chemical instruments like viscometer, stalagmometer, pH-meter, potentiometer and conductometer.

CHEM1051.5. Understanding the miscibility of solutes in various solvents required in paint, emulsion, biochemical and material industries.

CHEM1051.6. Knowledge of sampling water can be employed for water treatment to prepare pollution free water.

2. Detailed Syllabus

1. Estimation of iron using $KMnO_4$ self-indicator.
2. Iodometric estimation of Cu^{2+}.
3. Determination of Viscosity.
4. Determination of surface tension.
5. Adsorption of acetic acid by charcoal.
6. Potentiometric determination of redox potentials.
7. Determination of total hardness and amount of calcium and magnesium separately in a given water sample.
8. Determination of the rate constant for acid catalyzed hydrolysis of ethyl acetate.
9. Heterogeneous equilibrium (determination of partition coefficient of acetic acid in n-butanol and water mixture).
10. Conductometric titration for the determination of strength of a given HCl solution against a standard NaOH solution.
11. pH-metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
12. Determination of chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

3. Textbooks

1. Vogel's Textbook of Quantitative Chemical Analysis-G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.

4. Reference Books

1. Advanced Practical Chemistry- S. C. Das.
2. Practicals in Physical Chemistry- P. S. Sindhu.

Course Name: Basic Electrical Engineering Lab					
Course Code: ELEC1051					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	2	2	1

1. Course Outcomes

After completion of the course, students will be able to:

ELEC1051.1. Get an exposure to common electrical apparatus and their ratings.
ELEC1051.2. Make electrical connections by wires of appropriate ratings.
ELEC1051.3. Understand the application of common electrical measuring instruments.
ELEC1051.4. Understand the basic characteristics of different electrical machines.

2. Detailed Syllabus

1. Characteristics of Fluorescent lamps.
2. Characteristics of Tungsten and Carbon filament lamps.
3. Verification of Thevenin's & Norton's theorem.
4. Verification of Superposition theorem.
5. Verification of Maximum Power Transfer theorem.
6. Calibration of ammeter and voltmeter.
7. Open circuit and Short circuit test of a single-phase Transformer.
8. Study of R-L-C Series / Parallel circuit.
9. Starting and reversing of speed of a D.C. shunt Motor.
10. Speed control of DC shunt motor.
11. No load characteristics of D.C shunt Generators
12. Measurement of power in a three-phase circuit by two wattmeter method.

3. Textbooks and References

Lab Manual to be provided.

Course Name: Engineering Graphics & Design					
Course Code: MECH1052					
Contact Hours per week:	L	T	P	Total	Credit points
	1	0	4	5	3

1. Course Outcomes

After completion of the course, students will be able to:

MECH1052.1. To understand the meaning of engineering drawing.
MECH1052.2. To have acquaintance with the various standards (like lines, dimensions, scale etc.) and symbols followed in engineering drawing.
MECH1052.3. To represent a 3-D object into 2-D drawing with the help of orthographic and isometric projections.
MECH1052.4. To read and understand projection drawings.
MECH1052.5. To draw the section view and true shape of a surface when a regular object is cut by a section plane.
MECH1052.6. To use engineering drawing software (CAD).

2. Detailed Syllabus

Lecture Plan [13L]

1. Importance and principles of engineering drawing (1 L)
2. Concepts of Conic sections and Scale (1 L)
3. Introduction to concept of projection (Projections of points, lines and surfaces) (4 L)
4. Definitions of different solids and their projections (1 L)
5. Section of solids and sectional view (1 L)
6. Isometric projection (2 L)
7. Introduction to CAD (2 L)
8. Viva Voce (1 L)

Lab Hours [52 Hours]

Module 1 [8H]

Introduction to Engineering Drawing covering Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering & dimensioning, Conic section like Ellipse (General method only); Involute; Scales – Plain, Diagonal.

Module 2 [12H]

Orthographic Projections covering Principles of Orthographic Projections - Conventions - Projections of Points and lines inclined to both planes; Projections on Auxiliary Planes. Projection of lamina.

Module 3 [8H]

Projections of Regular Solids covering those inclined to both the Planes- Auxiliary Views.

Module 4 [4H]

Sections and Sectional Views of Right Angular Solids covering Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids.

Module 5 [8H]

Isometric Projections covering Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.

Module 6 [4H]

Overview of Computer Graphics covering listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids.

Module 7 [4H]

Customization & CAD Drawing consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles.

Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation.

Module 8 [4H]

Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame.

3. Reference Books

1. Elementary Engineering Drawing, Bhatt, N.D., Panchal V.M. & Ingle P.R., (2014), Charotan Publishing House.
2. Engineering Graphics, Narayana, K.L. and Kannaaiah P, TMH.
3. Engineering Graphics, Lakshminarayanan, V. and Vaish Wanar, R.S, Jain Brothers.
4. Engineering Drawing and Computer Graphics, Shah, M.B. & Rana B.C. (2008), Pearson Edication.
5. Engineering Graphics, Agarwal B. & Agarwal C. M. (2012), TMH Publications.

C. HONORS COURSES

Course Name: Communication for Professionals					
Course Code: HMTS1011					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

HMTS1011.1. Write business letters and reports

HMTS1011.2. Communicate in an official and formal environment.

HMTS1011.3. Effectively use the various channels of communication at workplace.

HMTS1011.4. Use language as a tool to build bridges and develop interpersonal relations in multi-cultural environment.

HMTS1011.5. Learn to articulate opinions and views with clarity.

HMTS1011.6. Use various techniques of communication for multiple requirements of globalized workplaces.

2. Detailed Syllabus

Module 1 [9L]

Introduction to Linguistics: Phonetics- Vowel and Consonant Sounds (Identification & Articulation); Word- stress, stress in connected speech; Intonation (Falling and Rising Tone); Voice Modulation; Accent Training; Vocabulary Building; The concept of Word Formation; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, Antonyms and standard abbreviations.

Module 2 [10L]

Communication Skills: Definition, nature & attributes of Communication; Process of Communication; Models or Theories of Communication; Types of Communication; Levels or Channels of Communication; Barriers to Communication.

Module 3 [10L]

Professional Writing Skills: Letter Writing: Importance, Types, Process, Form and Structure, Style and Tone; Proposal Writing: Purpose, Types of Proposals, Structure of Formal Proposals; Report Writing: Importance and Purpose, Types of Reports, Report Formats, Structure of Formal Reports, Writing Strategies.

Module 4 [10L]

Communication Skills at Work: Communication and its role in the workplace; Benefits of effective communication in the workplace; Common obstacles to effective communication; Approaches and Communication techniques for multiple needs at workplace: persuading, convincing, responding, resolving conflict, delivering bad news, making positive connections; Identify common audiences and design techniques for communicating with each audience.

3. Reference Books

1. Communication Skills, Kumar, S. &Lata, P., OUP, New Delhi2011.
2. Effective Technical Communication, Rizvi, Ashraf, M., Mc Graw Hill Education (India) Pvt. Ltd..Chennai,2018.
3. Technical Communication: Principles and Practice, Raman, M. and Sharma, S., 2nd Ed., 2011.

Course Name: Professional Communication Lab					
Course Code: HMTS1061					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	2	2	1

1. Course Outcomes

After completion of the course, students will be able to:

HMTS1061.1. Communicate in an official and formal environment.
HMTS1061.2. Effectively communicate in a group and engage in relevant discussion.
HMTS1061.3. Engage in research and prepare presentations on selected topics.
HMTS1061.4. Understand the dynamics of multicultural circumstances at workplace and act accordingly.
HMTS1061.5. Organize content in an attempt to prepare official documents.
HMTS1061.6. Appreciate the use of language to create beautiful expressions.

2. Detailed Syllabus

Module 1 [4L]

Techniques for Effective Speaking, Voice Modulation: Developing correct tone, Using correct stress patterns: word stress, primary stress, secondary stress, Rhythm in connected speech.

Module 2 [6L]

Effective Speaking and Social awareness; The Art of Speaking: Encoding Meaning Using Nonverbal Symbols, How to Improve Body Language, Eye Communication, Facial Expression, Dress and Appearance, Posture and Movement, Gesture, Paralanguage, Encoding meaning using Verbal symbols: How words work and how to use words, Volume, Pace, Pitch and Pause, Cross-Cultural Communication: Multiple aspects/dimensions of culture, Challenges of cross-cultural communication, Improving cross-cultural communication skills at workplace.

Module 3 [6L]

Group Discussion: Nature and purpose; Characteristics of a successful Group Discussion; Group discussion Strategies: Getting the GD started, contributing systematically, moving the discussion along, promoting optimal participation, Handling conflict, Effecting closure

Module 4 [10L]

Professional Presentation Skills: Nature and Importance of Presentation skills; Planning the Presentation: Define the purpose, analyze the Audience, Analyze the occasion and choose a suitable title; Preparing the Presentation: The central idea, main ideas, collecting support material, plan visual aids, design the slides; Organizing the Presentation: Introduction-Getting audience attention, introduce the subject, establish credibility, preview the main ideas, Body-develop the main idea, present information sequentially and logically, Conclusion-summaries, re-emphasize, focus on the purpose, provide closure; Improving Delivery: Choosing Delivery methods, handling stage fright; Post-Presentation discussion: Handling Questions-opportunities and challenges**.**

3. Reference Books

1. The Cambridge guide to Teaching English to Speakers of Other Languages, Carter, R. And Nunan, D. (Eds), CUP, 2001.
2. Writing and Speaking at Work: A Practical Guide for Business Communication, Edward P. Bailey, Prentice Hall, 3rd Ed., 2004.
3. Guide to Managerial Communication: Effective Business Writing and Speaking, Munter, M., Prentice Hall, 5th Ed., 1999.
4. Job Readiness for IT & ITES- A Placement and Career Companion, R. Anand, McGraw Hill Education.2015.
5. Campus Placements, Malhotra, A., McGraw Hill Education.2015.

Syllabus of 2nd Semester

A. THEORY COURSES

Course Name: Physics-I					
Course Code: PHYS1001					
Contact Hours per week:	L	T	P	Total	Credit points
	3	1	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

PHYS1001.1. To develop basic understanding of the modern science to the technology related domain.

PHYS1001.2. Analytical & logical skill development through solving problems.

PHYS1001.3. To impart idea of concise notation for presenting equations arising from mathematical formulation of physical as well as geometrical problems percolating ability of forming mental pictures of them.

PHYS1001.4. Imparting the essence and developing the knowledge of controlling distant object like satellite, data transfer through optical fibre, implication of laser technology, handling materials in terms of their electrical and magnetic properties etc.

PHYS1001.5. To understand how the systems under force field work giving their trajectories which is the basic of classical Field theory.

PHYS1001.6. To impart basic knowledge of the electric and magnetic behaviour of materials to increase the understanding of how and why electronic devices work.

2. Detailed Syllabus

Module 1 [12L]

Mechanics: Elementary concepts of grad, divergence and curl. Potential energy function; F=-grad V, Equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, Curl of a force field; Central forces; conservation of angular momentum; Energy equation and energy diagrams; elliptical, parabolic and hyperbolic orbit; Kepler Problem; Application: Satellite maneuvers.

Non-inertial frames of reference; rotating coordinate system; five term acceleration formula- centripetal and Coriolis accelerations; applications: Weather system, Foucault pendulum.

Module 2 [12L]

Oscillatory Motion: Damped harmonic motion – Over damped, critically damped and lightly damped oscillators; Forced oscillation and resonance. Electrical equivalent of mechanical oscillator, Wave equation, plane wave solution.

Optics: Elementary features of polarization of light waves. Double refraction, Production and analysis of linearly, elliptic and Circularly polarized light, Polaroid and application of polarizations**,** Polarimeter.

Laser & Fiber Optics: Characteristics of Lasers, Spontaneous and Stimulated Emission of Radiation, Meta-stable State, Population Inversion, Lasing Action, Einstein's Coefficients and Relation between them, Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser, Applications of Lasers.

Fiber optics - principle of operation, numerical aperture, acceptance angle, Single mode, graded indexed fiber.

Module 3 [12L]

Electrostatics in free space: Calculation of electric field and electrostatic potential for a charge distribution, Divergence and curl of electrostatic field, Laplace's and Poisson's equation for electrostatic potential. Boundary conditions of electric field and electrostatic potential. Method of images, energy of a charge distribution and its expression in terms of electric field.

Electrostatics in a linear dielectric medium: Electrostatic field and potential of a dipole, Bound charges due to electric polarization, Electric displacement, Boundary conditions on displacement, Solving simple electrostatic problem in presence of dielectric – point charge at the center of a dielectric sphere, charge in front of dielectric slab, Dielectric slab and dielectric sphere in uniform electric field.

Module 4 [12L]

Magnetostatics: Biot-Savart law, divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; equation for vector potential and its solutions for given current densities.

Magnetostatics in a linear magnetic medium: Magnetization and associated bound currents; Auxiliary magnetic field $\vec{H}$; boundary conditions on $\vec{B}$ and $\vec{H}$. Solving for magnetic field due to simple magnet like a bar magnet; Magnetic susceptibility; ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Faraday's Law: Differential form of Faraday's law expressing curl of electric field in terms of time derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi static approximation. Energy stored in a magnetic field.

3. Reference Books

1. Optics –Eugene Hecht Pearson Education India Private Limited.
2. Introduction to Electrodynamics, David J. Griffiths, Pearson Education IndiaLearning Private Limited.
3. Waves and Oscillations by N.K. Bajaj.
4. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker, Wiley.
5. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press.
6. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education.
7. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education.
8. Optics, Ghatak, McGraw Hill Education India Private Limited.
9. Refresher Course in B.Sc. Physics –Vol1 and Vol 2 –C.L.Arora.

Course Name: Mathematics-II					
Course Code: MATH1201					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**1**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

MATH1201.1. Demonstrate the knowledge of probabilistic approaches to solve wide range of engineering problem.

MATH1201.2. Recognize probability distribution for discrete and continuous variables to quantify physical and engineering phenomenon.

MATH1201.3. Develop numerical techniques to obtain approximate solutions to mathematical problems where analytical solutions are not possible to evaluate.

MATH1201.4. Analyse certain physical problems that can be transformed in terms of graphs and trees and solving problems involving searching, sorting and such other algorithms.

MATH1201.5. Apply techniques of Laplace Transform and its inverse in various advanced engineering problems.

MATH1201.6. Interpret differential equations and reduce them to mere algebraic equations using Laplace Transform to solve easily.

2. Detailed Syllabus

Module 1 [10L]

Basic Probability: Random experiment, Sample space and events, Classical and Axiomatic definition of probability, Addition and Multiplication law of probability, Conditional probability, Bayes' Theorem, Random variables, General discussion on discrete and continuous distributions, Expectation and Variance, Examples of special distribution: Binomial and Normal Distribution.

Module 2 [10L]

Basic Numerical Methods: Solution of non-linear algebraic and transcendental equations: Bisection Method, Newton-Raphson Method, Regula-Falsi Method. Solution of linear system of equations: Gauss Elimination Method, Gauss-Seidel Method, LU Factorization Method, Matrix Inversion Method. Solution of Ordinary differential equations: Euler's Method, Modified Euler's Method, Runge-Kutta Method of 4th order.

Module 3 [10L]

Basic Graph Theory: Graph, Digraph, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Sub-graph, Walk, Path, Circuit, Euler Graph, Cut sets and cut vertices, Matrix representation of a graph, Adjacency and incidence matrices of a graph, Graph isomorphism, Bipartite graph, Dijkstra's Algorithm for shortest path problem. Definition and properties of a Tree, Binary tree and its properties, Spanning tree of a graph, Minimal spanning tree, Determination of spanning trees using BFS and DFS algorithms, Determination of minimal spanning tree using Kruskal's and Prim's algorithms**.**

Module 4 [12L]

Laplace Transformation: Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations. Introduction to integral transformation, Functions of exponential order, Definition and existence of Laplace Transform(LT) (statement of initial and final value theorem only), LT of elementary functions, Properties of Laplace Transformations , Evaluation of sine , cosine and exponential integrals using LT, LT of periodic and step functions, Definition and properties of inverse LT, Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODEs with constant coefficients (initial value problem) using LT.

3. Textbooks

1. Advanced Engineering Mathematics, E. Kreyszig, Wiley Publications.
2. Engineering Mathematics, B.S. Grewal, S. Chand & Co.

4. Reference Books

1. Introduction to Probability and Statistics for Engineers and Scientists, S. Ross, Elsevier.
2. Introductory methods of Numerical Analysis, S.S. Sastry, PHI learning.
3. Introduction to Graph Theory, D. B. West, Prentice-Hall of India.

Course Name: Programming for Problem Solving					
Course Code: CSEN1001					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN1001.1. Understand and remember functions of the different parts of a computer.

CSEN1001.2. Understand and remember how a high-level language (C programming language, in this course) works, different stages a program goes through.

CSEN1001.3. Understand and remember syntax and semantics of a high-level language (C programming language, in this course).

CSEN1001.4. Understand how code can be optimized in high-level languages.

CSEN1001.5. Apply high-level language to automate the solution to a problem.

CSEN1001.6. Apply high-level language to implement different solutions for the same problem and analyze why one solution is better than the other.

2. Detailed Syllabus

Module 1 [10L]

Fundamentals of Computer: History of Computers, Generations of Computers, Classification of Computers.

Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Basic Concepts of Assembly language, High level language, Compiler and Assembler.

Binary & Allied number systems (decimal, octal and hexadecimal) with signed and unsigned numbers (using 1's and 2's complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit).

Basic concepts of operating systems like MS WINDOWS, LINUX.

How to write algorithms & draw flow charts.

Module 2 [10L]

Basic Concepts of C: C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements.

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. Standard input and output, formatted output -- printf, formatted input scanf.

Flow of Control: Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

Module 3 [10L]

Program Structures in C: Basic of functions, function prototypes, functions returning values, functions not returning values. Storage classes - auto, external, static and register variables – comparison between them. Scope, longevity and visibility of variables; C preprocessor (macro, header files), command line arguments; Arrays and Pointers: One dimensional arrays, pointers and functions – call by value and call by reference, array of arrays. Dynamic memory usage– using malloc(), calloc(), free(), realloc(). Array pointer duality; String and character arrays; C library string functions and their use.

Module 4 [10L]

User defined data types and files: Basic of structures; structures and functions; arrays of structures.

Files – text files only, modes of operation. File related functions – fopen(), fclose(), fscanf(), fprintf(), fgets(), fputs(), fseek(), ftell().

3. Textbooks
1. Schaum's outline of Programming with C – Byron Gottfried.
2. Teach Yourself C- Herbert Schildt.
3. Programming in ANSI C – E Balagurusamy.

4. Reference Books
1. C: The Complete Reference – Herbert Schildt.
2. The C Programming Language- D.M.Ritchie, B.W. Kernighan.

Course Name: Business English					
Course Code: HMTS1202					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**2**

1. Course Outcomes
After completion of the course, students will be able to:
HMTS1202.1. Acquire competence in using English language to communicate.
HMTS1202.2. Be aware of the four essential skills of language usage-listening, speaking, reading and writing.
HMTS1202.3. Be adept at using various modes of written communication at work.
HMTS1202.4. Attain the skills to face formal interview sessions.

2. Detailed Syllabus
Module 1 [6L]
Grammar (Identifying Common Errors in Writing): Subject-verb agreement, Noun-pronoun agreement, Misplaced Modifiers, Articles, Prepositions, Redundancies.

Module 2 [6L]
Basic Writing Strategies: Sentence Structures, Use of phrases and clauses in sentences, Creating coherence, Organizing principles –accuracy, clarity, brevity, Techniques for writing precisely, Different styles of writing: descriptive, narrative, expository, Importance of proper punctuation.

Module 3 [8L]
Business Communication- Scope & Importance: Writing Formal Business Letters: Form and Structure-Parts of a Business letter, Business Letter Formats, Style and Tone, Writing strategies.
Organizational Communication: Agenda & minutes of a meeting, Notice, Memo, Circular.
Organizing e-mail messages, E-mail etiquette.
Job Application Letter: Responding to Advertisements and Forced Applications, Qualities of well-written Application Letters: The You-Attitude, Length, Knowledge of Job Requirement, Reader-Benefit Information, Organization, Style, Mechanics – Letter Plan: Opening Section, Middle Section, Closing Section.
Resume and CV: Difference, Content of the Resume – Formulating Career Plans: Self Analysis, Career Analysis, Job Analysis, Matching Personal Needs with Job Profile – Planning your Resume – Structuring the Resume: Chronological Resume, The Functional Resume, Combination of Chronological and Functional Resume, Content of the Resume: Heading, Career Goal or Objectives, Education, Work Experience, Summary of Job Skills/Key Qualifications, Activities, Honors and Achievements, Personal Profile, Special Interests, References.

Module 4 [6L]
Writing skills: Comprehension: Identifying the central idea, inferring the lexical and contextual meaning, comprehension passage – practice. Paragraph Writing: Structure of a paragraph, Construction of a paragraph, Features of a paragraph, Writing techniques/developing a paragraph.
Précis: The Art of Condensation-some working principles and strategies. Practice sessions of writing précis of given passages.
Essay Writing: Characteristic features of an Essay, Stages in Essay writing, Components comprising an Essay, Types of Essays-Argumentative Essay, Analytical Essay, Descriptive Essays, Expository Essays, Reflective Essays.

3. Reference Books
1. Theories of Communication: A Short Introduction, Armand Matterlart and Michele Matterlart, Sage Publications Ltd.
2. Professional Writing Skills, Chan, Janis Fisher and Diane Lutovich. San Anselmo, CA: Advanced Communication Designs.
3. Hauppauge, Geffner, Andrew P. Business English, New York: Barron's Educational Series.
4. Kalia, S. & Agarwal, S. Business Communication,Wiley India Pvt. Ltd., New Delhi, 2015.
5. Mukherjee, H.S., Business Communication- Connecting at work., Oxford University Press.2nd Edition.2015.
6. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011.

B. LABORATORY COURSES

Course Name: Physics-I Lab					
Course Code: PHYS1051					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

1. Course Outcomes

After completion of the course, students will be able to:

PHYS1051.1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
PHYS1051.2. To learn the usage of electrical and optical systems for various measurements.
PHYS1051.3. Apply the analytical techniques and graphical analysis to the experimental data.
PHYS1051.4. Understand measurement technology, usage of new instruments and real time applications in engineering studies.
PHYS1051.5. To develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.

2. Detailed Syllabus

Module 1 Experiments in General Properties of matter:

Determination of Young's modulus by Flexure Method.
Determination of bending moment and shear force of a rectangular beam of uniform cross- section.
Determination of modulus of rigidity of the material of a rod by static method.
Determination of rigidity modulus of the material of a wire by dynamic method.
Determination of coefficient of viscosity by Poiseulle's capillary flow method.

Module 2 Experiments in Optics:

Determination of dispersive power of the material of a prism.
Determination of wavelength of light by Newton's ring method.
Determination of wavelength of light by Fresnel's bi-prism method.
Determination of the wavelength of a given laser source by diffraction method.

Module 3 Electricity & Magnetism experiments:

Determination of dielectric constant of a given dielectric material.
Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
Determination of the thermo-electric power at a certain temperature of the given thermocouple.
Determination of specific charge (e/m) of electron.

Module 4 Quantum Physics Experiments:

Determination of Planck's constant.
Determination of Stefan's radiation constant.
Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
Determination of Rydberg constant by studying Hydrogen/ Helium spectrum.
Determination of Hall co-efficient of semiconductors.
Determination of band gap of semiconductors.
To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells.

Minimum of six experiments to be performed taking at least one from each module mentioned above.

3. Reference Books

1. Optics –Eugene Hecht Pearson Education India Private Limited.
2. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited.
3. Waves and Oscillations by N.K. Bajaj.
4. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker, Wiley.
5. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press.
6. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education.
7. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education.
8. Optics, Ghatak, McGraw Hill Education India Private Limited.
9. Refresher Course in B.Sc. Physics –Vol1 and Vol 2 –C.L.Arora.

Course Name: Programming for Problem Solving Lab					
Course Code: CSEN1051					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**4**	**4**	**2**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN1051.1. To write simple programs relating to arithmetic and logical problems.
CSEN1051.2. To be able to interpret, understand and debug syntax errors reported by the compiler.
CSEN1051.3. To implement conditional branching, iteration (loops) and recursion.
CSEN1051.4. To decompose a problem into modules (functions) and amalgamating the modules to generate a complete program.
CSEN1051.5. To use arrays, pointers and structures effectively in writing programs.
CSEN1051.6. To be able to create, read from and write into simple text files.

2. Detailed Syllabus

Topic 1: LINUX commands and LINUX based editors
Topic 2: Basic Problem Solving
Topic 3: Control Statements (if, if-else, if-elseif-else, switch-case)
Topic 4: Loops - Part I (for, while, do-while)
Topic 5: Loops - Part II
Topic 6: One Dimensional Array
Topic 7: Array of Arrays
Topic 8: Character Arrays/ Strings
Topic 9: Basics of C Functions
Topic 10: Recursive Functions
Topic 11: Pointers
Topic 12: Structures
Topic 13: File Handling

3. Textbooks

1. Schaum's outline of Programming with C – Byron Gottfried.
2. Teach Yourself C- Herbert Schildt.
3. Programming in ANSI C – E Balagurusamy.

4. Reference Books

1. C: The Complete Reference – Herbert Schildt.
2. The C Programming Language- D.M.Ritchie, B.W. Kernighan.

Course Name: Workshop /Manufacturing Practices					
Course Code: MECH1051					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	1	**0**	**4**	**5**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

MECH1051.1. The students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.
MECH1051.2. The students will be able to fabricate components with their own hands.
MECH1051.3. They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
MECH1051.4. By assembling different components, they will be able to produce small devices of their interest.
MECH1051.5. The students will be able to describe different components and processes of machine tools.
MECH1051.6. The students will be able to apply the knowledge of welding technology and they can perform arc and gas welding to join the material.

2. Detailed Syllabus

Lecture [13 Hours]

1. Introduction on Workshop and Safety Precautions. (1 L)
2. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 L)

3. CNC machining, Additive manufacturing (1 L)
4. Fitting operations & power tools (1 L)
5. Electrical & Electronics (1 L)
6. Carpentry (1 L)
7. Plastic moulding, glass cutting (1 L)
8. Metal casting (1 L)
9. Welding (arc welding & gas welding), brazing (2 L)
10. Viva-voce (1 L)

Workshop Practice [52 Hours]

1. Machine shop (12 H)
2. Fitting shop (8 H)
3. Carpentry (4 H)
4. Electrical & Electronics (4 H)
5. Welding shop (Arc welding + gas welding) (8 H)
6. Casting (4 H)
7. Smithy (4 H)
8. Plastic moulding & Glass Cutting (4 H)
9. Sheet metal Shop (4 H)

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

3. Reference Books

1. Elements of Workshop Technology, Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Manufacturing Engineering and Technology, Kalpakjian S. And Steven S. Schmid, 4th edition, Pearson Education India Edition, 2002.
3. Manufacturing Technology – I, Gowri P. Hariharan and A. Suresh Babu, Pearson Education, 2008.
4. Processes and Materials of Manufacture, Roy A. Lindberg, 4th edition, Prentice Hall India, 1998.
5. Manufacturing Technology, Rao P.N., Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Name: Language Lab					
Course Code: HMTS1252					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

1. Course Outcomes

After completion of the course, students will be able to:

HMTS1252.1. Acquire the techniques to become an effective listener.
HMTS1252.2. Acquire the skill to become an effortless speaker.
HMTS1252.3. Organize and present information for specific audience.
HMTS1252.4. Communicate to make a positive impact in professional and personal environment.
HMTS1252.5. Engage in research and prepare authentic, formal, official documents.
HMTS1252.6. Acquire reading skills for specific purpose.

2. Detailed Syllabus

Module 1 [4L]

Listening Skills: Principles of Listening: Characteristics, Stages; Types of Listening: Passive listening, Marginal or superficial listening, Projective Listening, Sensitive or Empathetic Listening, Active or Attentive listening; Guidelines for Effective Listening; Barriers to Effective Listening; Listening Comprehension.

Module 2 [8L]

Interviewing: Types of Interviews, Format for Job Interviews: One-to-one and Panel Interviews, Telephonic Interviews, Interview through video conferencing; Interview Preparation Techniques, Frequently Asked Questions, Answering Strategies, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

Module 3 [6L]

Public Speaking: The Speech Process: The Message, The Audience, The Speech Style, Encoding, Feedback; Characteristics of a good speech : content and delivery, structure of a speech; Modes of delivery in public speaking: Impromptu, Extemporaneous, Prepared or Memorized, Manuscript; Conversation: Types of conversation: formal and informal, Strategies for effective conversation, Improving fluency; Situational conversation practice: Greetings and making introductions, Asking for information and giving instructions, agreeing and disagreeing; Conversational skills in the business scenario: One-to-one

and Group communication, Gender and Culture Sensitivity, Etiquette, Sample Business Conversation, Telephonic Conversation.

Module 4 [8L]

Presentation skills: Speaking from a Manuscript, Speaking from Memory, Impromptu Delivery, Extemporaneous Delivery, Analyzing the Audience, Nonverbal Dimensions of Presentation; Organizing the Presentation: The Message Statement, Organizing the Presentation: Organizing the Speech to Inform, The Conclusion, Supporting Your Ideas – Visual Aids: Designing and Presenting Visual Aids, Selecting the Right Medium; Project Team/Group Presentations.

3. Reference Books

1. The Cambridge guide to Teaching English to Speakers of Other Languages, Carter, R. And Nunan, D. (Eds), CUP, 2001.
2. Writing and Speaking at Work: A Practical Guide for Business Communication, Edward P. Bailey, Prentice Hall, 3rd Ed.
3. Guide to Managerial Communication: Effective Business Writing and Speaking, Munter, M., Prentice Hall, 5th Ed., 1999.
4. Communication and Language Skills, Sen, S., Mahendra, A. & Patnaik, P., Cambridge University Press, 2015.
5. Business and Administrative Communication, Locker, Kitty O., McGraw-Hill/ Irwin.
6. Intercultural Business Communication, Chaney,L. and Martin, J., Prentice Hall.

C. HONORS COURSES

Course Name: Basic Electronics					
Course Code: ECEN1011					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN1011.1. Categorize different semiconductor materials based on their energy bands and analyse the characteristics of those materials for different doping concentrations based on previous knowledge on semiconductors acquired.

ECEN1011.2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode both from device and circuit perspectives.

ECEN1011.3. Design different application specific circuits associated with diodes operating both in forward and reverse bias.

ECEN1011.4. Analyse various biasing configurations of Bipolar Junction Transistor and categorize different biasing circuits based on stability.

ECEN1011.5. Categorize different field-effect transistors based on their constructions, physics and working principles and solve problems associated with analog circuits based on operational amplifiers.

ECEN1011.6. Design and implement various practical purpose electronic circuits and systems meant for both special purpose and general purpose and analyse their performance depending on the type of required output and subsequently the applied input.

2. Detailed Syllabus

Module 1 [10L]

Basic Semiconductor Physics: Crystalline materials, Energy band theory, Conductors, Semiconductors and Insulators, Concept of Fermi Energy level, intrinsic and extrinsic semiconductors, drift and diffusion currents in semiconductor.

Diodes and Diode Circuits: Formation of p-n junction, Energy Band diagram, forward & reverse biased configurations, V-I characteristics, load line, breakdown mechanisms, Zener Diode and its Application; Rectifier circuits: half wave & full wave rectifiers: ripple factor, rectification efficiency.

Module 2 [8L]

Bipolar Junction Transistors (BJT): PNP & NPN BJT structures, current components in BJT, CE, CB, CC configurations, V-I Characteristics of CB & CE modes, regions of operation, Base width modulation & Early effect, thermal runaway, Concept of Biasing: DC load line, Q-point, basics of BJT amplifier operation, current amplification factors, different biasing circuits: fixed bias, collector to base bias, voltage divider bias.

Module 3 [9L]

Field Effect Transistors (FET): n-channel Junction Field Effect Transistor (JFET) structure & V-I characteristics.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): enhancement & depletion type MOSFETs (for both n & p channel devices), drain & transfer characteristics; MOSFET as a digital switch, CMOS inverter, voltage transfer characteristic (VTC), NAND & NOR gate realization using CMOS logic; Moore's Law, evolution of process node, state of integration (SSI, MSI, LSI, VLSI, ULSI); Classification of Integrated circuits (IC) and their applications.

Module 4 [9L]

Feedback in amplifiers: Concept of feedback, advantages of negative feedback (qualitative), Barkhausen criteria.

Operational Amplifier: Ideal OPAMP characteristics, OPAMP circuits: inverting and non-inverting amplifiers, Adder, Subtractor, Integrator, Differentiator, Basic Comparator.

Special Semiconductor Devices: Light Emitting Diode (LED), Silicon Controlled Rectifier (SCR), Photodiode: Operations, characteristics & applications**.**

3. Reference Books

1. Electronic Devices & Circuit Theory, Boylestad & Nashelsky.
2. Op Amps and Linear IC's, R.A Gayakwad, PHI.
3. Electronics Fundamentals and Applications, D. Chattopadhyay, P. C. Rakshit.
4. Microelectronics Engineering, Adel S. Sedra, Kenneth Carless Smith.
5. Integrated Electronics, Millman & Halkias.
6. Electronics Devices & Circuits, Salivahanan.
7. Electronic Principle, Albert Paul Malvino.

Course Name: Basic Electronics Lab					
Course Code: ECEN1061					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN1061.1. The students will correlate theory with diode behaviour.

ECEN1061.2. They will design and check rectifier operation with regulation etc.

ECEN1061.3. Students will design different modes with BJT and FET and check the operations.

ECEN1061.4. They will design and study adder, integrator etc. with OP-AMPs.

2. Detailed Syllabus

List of Experiments

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multi-meters etc.
2. Familiarization with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs in CB mode
7. Study of I-V characteristics of BJTs in CE mode
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators**.**

3. Reference Books

1. Electronic Devices & Circuit Theory, Boylestad & Nashelsky.
2. Op Amps and Linear IC's, R.A Gayakwad, PHI.
3. Electronics Fundamentals and Applications, D. Chattopadhyay, P. C. Rakshit.
4. Microelectronics Engineering, Adel S. Sedra, Kenneth Carless Smith.
5. Integrated Electronics, Millman & Halkias.
6. Electronics Devices & Circuits, Salivahanan.
7. Electronic Principle, Albert Paul Malvino.

Syllabus of 3rd Semester

A. THEORY COURSES

Course Name: Data Structures & Algorithms					
Course Code: CSEN2101					
Contact Hours per week:	L	T	P	Total	Credit points
	4	0	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2101.1. Understand and remember the basics of data structures and how time complexity analysis is applicable to different types of algorithms.

CSEN2101.2. Understand the significance and utility of different data structures and the context of their application. (For example, the queue in front of ticket counters uses first-in-first-out paradigm in a linear data structure)

CSEN2101.3. Apply different types of data structures in algorithms and understand how the data structures can be useful in those algorithms.

CSEN2101.4. Analyse the behaviour of different data structures in algorithms. (For example, given an algorithm that uses a particular data structure, how to calculate its space and time complexity.)

CSEN2101.5. Evaluate solutions of a problem with different data structures and thereby understand how to select suitable data structures for a solution. (For example, what are the different ways to find the second largest number from a list of integers and which solution is the best.)

CSEN2101.6. Evaluate different types of solutions (e.g. sorting) to the same problem.

2. Detailed Syllabus

Module 1 [8L]

Introduction: Why do we need data structure? Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type; Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – Big O, Ω, Θ, notations.

Array: Different representations – row major, column major. Sparse matrix - its implementation and usage. Array representation of polynomials.

Linked List: Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.

Module 2 [8L]

Stack and Queue: Stack and its implementations (using array, using linked list), applications. Queue, circular queue, deque. Implementation of queue- both linear and circular (using array, using linked list), applications. Implementation of deque- with input and output restriction.

Recursion: Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi, Eight Queens Puzzle (Concept of Backtracking).

Module 3 [13L]

Trees: Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post- order), threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples only). B- Trees – operations (insertion, deletion with examples only).

Graphs: Graph definitions and Basic concepts (directed/undirected graph, weighted/un-weighted edges, sub-graph, degree, cut vertex/articulation point, complete graph, simple path, simple cycle). Graph representations/storage implementations – adjacency matrix, adjacency list, Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) – concepts of edges used in DFS and BFS (tree-edge, back-edge, cross-edge, forward-edge), applications.

Module 4 [11L]

Sorting Algorithms: Bubble sort and its optimizations, Cocktail Shaker Sort, Insertion sort, Selection sort, Quicksort (Average Case Analysis not required), Heap sort (concept of max heap, application – priority queue), Counting Sort, Radix sort.

Searching: Sequential search, Binary search, Interpolation search.

Hashing: Hashing functions, collision resolution techniques (Open and closed hashing).

3. Textbooks

1. Fundamentals of Data Structures of C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed.
2. Data Structures in C, Aaron M. Tenenbaum.
3. Data Structures, S. Lipschutz.

4. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.

4. Reference Books

1. Data Structures and Program Design In C, 2/E, Robert L. Kruse, Bruce P. Leung.

Course Name: Discrete Mathematics					
Course Code: CSEN2102					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	4	**0**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2102.1. Interpret the problems that can be formulated in terms of graphs and trees.

CSEN2102.2. Explain network phenomena by using the concepts of connectivity, independent sets, cliques, matching, graph coloring etc.

CSEN2102.3. Achieve the ability to think and reason abstract mathematical definitions and ideas relating to integers through concepts of well-ordering principle, division algorithm, greatest common divisors and congruence.

CSEN2102.4. Apply counting techniques and the crucial concept of recurrence to comprehend the combinatorial aspects of algorithms.

CSEN2102.5. Analyze the logical fundamentals of basic computational concepts.

CSEN2102.6. Compare the notions of converse, contrapositive, inverse etc. in order to consolidate the comprehension of the logical subtleties involved in computational mathematics.

2. Detailed Syllabus

Module 1 [10L]

Graph Theory: Tree, Binary Tree, Spanning Tree. Walk, Path, Cycle, Hamiltonian Graph, The Travelling Salesman Problem, Euler Graph, The Chinese Postman Problem. Planar Graph, Euler's Formula for Planar Graph and Related Problems. Examples of Non-Planar Graphs. Kuratowski's Theorem. Matching and Augmenting Paths, Hall's Marriage Theorem and Related Problems. Vertex Coloring, Chromatic Polynomials.

Module 2 [10L]

Number Theory: Well Ordering Principle, Principle of Mathematical Induction, Divisibility theory and properties of divisibility, Fundamental Theorem of Arithmetic, Euclidean Algorithm for finding greatest common divisor (GCD) and some basic properties of GCD with simple examples, Congruence, Residue classes of integer modulo n ($\mathbb{Z}_n$) and its examples.

Module 3 [10L]

Combinatorics: Counting Techniques: Permutations and Combinations, Distinguishable and Indistinguishable Objects, Binomial Coefficients, Generation of Permutations and Combinations, Pigeon-hole Principle, Generalized Pigeon-Hole Principle, Principle of Inclusion and Exclusion, Generating Functions and Recurrence Relations: Solving Recurrence Relations Using Generating Functions and other Methods, Divide-and-Conquer Methods, Formulation and Solution of Recurrence Relations in Computer Sorting, Searching and other Application Areas.

Module 4 [12L]

Propositional Calculus: Propositions, Logical Connectives, Truth Tables, Conjunction, Disjunction, Negation, Implication, Converse, Contra positive, Inverse, Biconditional Statements, Logical Equivalence, Tautology, Normal Forms, CNF and DNF, Predicates, Universal and Existential Quantifiers, Bound and Free Variables, Examples of Propositions with Quantifiers.

3. Textbooks

1. Discrete Mathematics and its Applications, Kenneth H. Rosen, Tata McGraw- Hill.
2. Discrete Mathematics, T Veerarajan, Tata McGraw- Hill.

4. Reference Books

1. Elements of Discrete Mathematics: A Computer Oriented Approach, C L Liu and D P Mohapatra, McGraw Hill.
2. Discrete Mathematical Structure and Its Application to Computer Science, J.P. Tremblay and R. Manohar, McGraw Hill.
3. Discrete Mathematics for Computer Scientists and Mathematicians, J.L.Mott, A. Kandel and T.P.Baker, Prentice Hall
4. Discrete Mathematics,Norman L. Biggs, Seymour Lipschutz, Marc Lipson, Oxford University Press, Schaum's Outlines Series.
5. Higher Algebra (Classical), S.K. Mapa, Sarat Book Distributors.
6. Introduction to Graph Theory (2nd Ed), D G West, Prentice-Hall of India, 2006.

Course Name: Analog Circuits					
Course Code: ECEN2101					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN2101.1. Apply the previous knowledge gathered from Basic Electrical and Basic Electronics papers.
ECEN2101.2. Understand the concepts of BJT, MOSFET and biasing techniques of BJT and MOSFET based amplifier circuits.
ECEN2101.3. Analyse frequency response of amplifier circuits.
ECEN2101.4. Design different types sinusoidal oscillators and multi-vibrator circuits.
ECEN2101.5. Construct algebraic equations-based amplifier and analog computers using OP-AMP
ECEN2101.6. Design stable high-gain amplifier circuits.

2. Detailed Syllabus

Module 1 [9L]

Basic concepts and device biasing: Analog, discrete and digital signals. Diode: piecewise-linear model, clipping and clamping operation. BJT biasing circuits, Q-point and stability.
Small Signal analysis of Amplifiers: Small signal (h-parameter and r_e model) analysis of BJT CE mode amplifier circuit (derive input impedance, output impedance, voltage gain, current gain for the amplifiers).

Module 2 [9L]

Frequency Responses of Amplifiers: Frequency response of CE mode RC-coupled amplifier; effect of external and parasitic capacitors on cut-off frequencies.
Feedback & Oscillator Circuits: Concept of feedback, Effects of negative feedback in amplifiers, Oscillators circuits: Phase-shift, Wien-Bridge, Hartley, Colpitts and crystal Oscillators.

Module 3 [7L]

Fundamentals of OPAMP: Basic building blocks of OPAMP: Differential Amplifiers, Current source and current mirror circuits. Types of differential amplifiers, AC and DC analysis of differential amplifiers; Characteristics of an ideal OPAMP.
Applications of OPAMP: Inverting and non-inverting OPAMP amplifiers, Log-antilog amplifiers, Instrumentation amplifier, Precision rectifiers, basic comparator, Schmitt Trigger.

Module 4 [7L]

Power Amplifiers: Concepts and operations of Class A, B and AB amplifiers; Calculation of DC power, AC power and efficiency of these amplifiers.
Applications Analog IC: Description of 555 Timer IC, astable and mono-stable operations using 555. Study of 78XX and 79XX voltage regulator ICs.

3. Textbooks

1. Microelectronic Circuits by Adel S. Sedra, Kenneth C. Smith.
2. Electronics Devices and Circuits by Robert L. Boylestad, Louis Nashelskey.
3. Fundamentals of Microelectronics by Behzad Razavi.
4. Integrated electronics by Jacob Millman, Christos C. Halkias.

Course Name: Digital Logic					
Course Code: ECEN2104					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN2104.1. Students will learn Binary Number system, and logic design using combinational gates.
ECEN2104.2. Students will design applications of Sequential Circuits.
ECEN2104.3. Students will design Finite State Machines.
ECEN2104.4. Students will learn Memory classifications.
ECEN2104.5. Students will learn basics of CMOS logic.
ECEN2104.6. Students will be prepared to learn various digital component design as used in VLSI applications.

2. Detailed Syllabus

Module 1 [10L]

Binary System, Boolean Algebra and Logic Gates: Data and number systems; Binary, Octal and Hexadecimal representation and their conversions, BCD, Gray codes, excess 3 codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic. Boolean algebra, De-Morgan's theorem, Various Logic gates- their truth tables and circuits, universal logic gates, Representation in SOP and POS forms; Minimization of logic expressions by algebraic method, Karnaugh-map method, Quine-McCluskey method.

Module 2 [10L]

Arithmetic Circuits: Adder circuit – Ripple Carry Adder, CLA Adder, CSA, and BCD adder, subtractor circuit.
Combinational Circuit: Encoder, Decoder, Comparator, Multiplexer, De-Multiplexer and parity Generator. Shannon's Expansion Theorem, Realization of logic functions using Mux, Parity Generators.

Module 3 [10L]

Sequential Logic: Basic memory elements, S-R, J-K, D and T Flip Flops, Sequential circuits design methodology: State table and state diagram, State Reduction Method, Circuit Excitation and Output tables, Derivation of Boolean functions; Finite State Machine Design using Sequential circuit design methodology, various types of Registers (with Parallel load, shift Registers) and Counters (asynchronous ripple counters, synchronous counters: binary, BCD, Johnson).

Module 4 [6L]

Memory Systems: Concepts and basic designs of RAM (SRAM & DRAM), ROM, EPROM, EEPROM, Programmable logic devices and gate arrays (PLAs and PLDs)
Logic families: NMOS and CMOS, their operation and specifications. Realization of basic gates using above logic families, Open collector & Tristate gates, wired-AND and bus operations.

3. Textbooks

1. Digital Logic and Computer Design, Morris M. Mano, PHI.
2. Digital Principles & Applications, 5th Edition, Leach & Malvino, Mc Graw Hill Company.
3. Modern Digital Electronics, 2nd Edition, R.P. Jain. Tata Mc Graw Hill Company Limited.
4. Digital Logic Design, Fourth Edition - Brian Holdsworth & Clive Woods.
5. Digital Integrated Electronics, H.Taub & D.Shilling, Mc Graw Hill Company Limited.

4. Reference Books

1. Digital Design: Principles and Practices: John F. Wakerly.
2. Fundamental of Digital Circuits, A. Anand Kumar, PHI.

Course Name: Human Values and Professional Ethics					
Course Code: HMTS2001					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:
HMTS2001.1. Be aware of the value system and the importance of following such values at workplace.
HMTS2001.2. Learn to apply ethical theories in the decision-making process.
HMTS2001.3. Follow the ethical code of conduct as formulated by institutions and organizations.
HMTS2001.4. Implement the principles governing work ethics.
HMTS2001.5. Develop strategies to implement the principles of sustainable model of development.
HMTS2001.6. Implement ecological ethics wherever relevant and also develop eco-friendly technology.

2. Detailed Syllabus

Module 1 [10L]

Human society and the Value System: Values: Definition, Importance and application, Formation of Values: The process of Socialization, Self and the integrated personality, Morality, courage, integrity.
Types of Values: Social Values: Justice, Rule of Law, Democracy, Indian Constitution, Secularism; Aesthetic Values: Perception and appreciation of beauty; Organizational Values: Employee: Employer--- rights, relationships, obligations; Psychological Values: Integrated personality and mental health; Spiritual Values and their role in our everyday life; Value Spectrum for a Good Life, meaning of Good Life.
Value Crisis in Contemporary Society: Value crisis at: Individual Level, Societal Level, Cultural Level; Value Crisis management: Strategies and Case Studies.

Module 2 [10L]

Ethics and Ethical Values, Principles and theories of ethics, Consequential and non-consequential ethics, Egotism, Utilitarianism, Kant's theory and other non-consequential perspectives, Ethics of care, justice and fairness, rights and duties.
Ethics: Standardization, Codification, Acceptance, Application.
Types of Ethics: Ethics of rights and Duties, Ethics of Responsibility, Ethics and Moral judgment, Ethics of care
Ethics of justice and fairness, Work ethics and quality of life at work.
Professional Ethics: Ethics in Engineering Profession; moral issues and dilemmas, moral autonomy (types of inquiry), Kohlberg's theory, Gilligan's theory (consensus and controversy), Code of Professional Ethics Sample Code of ethics like ASME, ASCE. IEEE, Institute of Engineers, Indian Institute of materials management, Institute of Electronics and telecommunication engineers, Violation of Code of Ethics---conflict, causes and consequences
Engineering as social experimentation, engineers as responsible experimenters (computer ethics, weapons development), Engineers as managers, consulting engineers, engineers as experts, witnesses and advisors, moral leadership, Conflict between business demands and professional ideals, social and ethical responsibilities of technologies.
Whistle Blowing: Facts, contexts, justifications and case studies
Ethics and Industrial Law: Institutionalizing Ethics: Relevance, Application, Digression and Consequences.

Module 3 [10L]

Science, Technology and Engineering: Science, Technology and Engineering as knowledge and profession: Definition, Nature, Social Function and Practical application of science; Rapid Industrial Growth and its Consequences; Renewable and Non- renewable Resources: Definition and varieties; Energy Crisis; Industry and Industrialization; Man and Machine interaction; Impact of assembly line and automation; Technology assessment and Impact analysis; Industrial hazards and safety; Safety regulations and safety engineering; Safety responsibilities and rights; Safety and risk, risk benefit analysis and reducing risk; Technology Transfer: Definition and Types; The Indian Context.

Module 4 [6L]

Environment and Eco- friendly Technology: Human Development and Environment, Ecological Ethics/Environment ethics Depletion of Natural Resources: Environmental degradation, Pollution and Pollution Control, Eco-friendly Technology: Implementation, impact and assessment, Sustainable Development: Definition and Concept, Strategies for sustainable development, Sustainable Development: The Modern Trends, Appropriate technology movement by Schumacher and later development, Reports of Club of Rome.

3. Reference Books

1. Human Values, Tripathi, A.N., New Age International, New Delhi, 2006.
2. Classical Sociological Theory, Ritzer, G., The McGraw Hill Companies, New York,1996.
3. Postmodern Perspectives on Indian Society, Doshi, S.L., Rawat Publications, New Delhi,2008.
4. Sustainable Development, Bhatnagar, D.K., Cyber Tech Publications, New Delhi, 2008.
5. The age of Spiritual Machines, Kurzwell, R., Penguin Books, New Delhi,1999.
6. Social Problems in Modern Urban Society, Weinberg, S.K., Prentice Hall,Inc.,USA, 1970.
7. Sociology, Giddens, Anthony 2009, London: Polity Press (reprint 13th Edition).

B. LABORATORY COURSES

Course Name: Data Structure & Algorithms Lab					
Course Code: CSEN2151					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes

After completion of the course, students will be able to:
CSEN2151.1. To understand linear and non-linear data structures.
CSEN2151.2. To understand different types of sorting and searching techniques.
CSEN2151.3. To know how to create an application specific data structure.
CSEN2151.4. To solve the faults / errors that may appear due to wrong choice of data structure.
CSEN2151.5. To analyse reliability of different data structures in solving different problems.
CSEN2151.6. To evaluate efficiency in terms of time and space complexity, when different data structures are used to solve same problem.

2. Detailed Syllabus

Day 1: Time and Space Complexity

Lab Assignment

Create three different 10; 000 10; 000 matrices matrixOne, matrixTwo and result-Matrix, using dynamic memory allocation. Initialize matrixOne and matrixTwo by using rand() or srand() function, limit the values from 0 to 9. Multiply matrixOne and matrixTwo into resultMatrix.

While execution, open another terminal and use top command to see the usage of memory by the process. Calculate the time taken for the execution of the program.

Repeat the same exercise for 100,000 x 100,000matrices.

Home Assignment

Write a program (WAP) to check whether a matrix is i) identity, ii) diagonal. WAP to reverse the elements of an array without using any other variable.

Day 2: Array

Lab Assignment

WAP to add two polynomials using array. Minimize the memory usage as much as you can.

WAP to convert a matrix into its sparse representation (triple format). Once represented in sparse format, do not revert back to the matrix format any-more. Manipulate the sparse representation to find the transpose of the matrix (which should also be in sparse representation).

Calculate and find out whether using triple format for your example is advantageous or not.

Home Assignment

WAP to multiply two polynomials. Minimize usage of memory.

WAP to add two matrices using sparse representation. Manipulation of data should be done in sparse format.

Day 3: Singly Linked List

Lab Assignment

Write a menu driven program to implement a singly linked list with the operations:

i) create the list ii) insert any element in any given position (front, end or intermediate)

iii) delete an element from any given position (front, end or intermediate) iv)display the list

Home Assignment

Write a menu driven program to implement a singly linked list with the operations:

i) count the number of nodes ii) reverse the list

Day 4: Circular and Doubly Linked List

Lab Assignment

Write a menu driven program to implement a circular linked list with the operations:

i) create the list ii) insert any element in any given position (front, end or intermediate)

iii) delete an element from any given position (front, end or intermediate) iv)display the list

Home Assignment

Write a menu driven program to implement a doubly linked list with the operations:

i) create the list ii) insert any element in any given position (front, end or intermediate)

iii) delete an element from any given position (front, end or intermediate) iv)display the list

Day 5: Stack, Queue - with array

Lab Assignment

Write a menu driven program to implement stack, using array, with

i) push, ii) pop, iii) display, iv) exit operations.

WAP to evaluate a postfix expression.

Write a menu driven program to implement a queue, using array, with

i) insert, ii) delete, iii) display, iv) exit operations

Home Assignment

WAP to convert an infix expression to its corresponding postfix operation.

Write a menu driven program to implement a double-ended queue, using array, with the following operations:

i) insert (from front, from rear) ii) delete (from front, from rear)

iii) display iv) exit operations

Day 6: Stack, Queue - with linked list

Lab Assignment

Write a menu driven program to implement a stack, using linked list, with

i) push, ii) pop, iii) exit operations

Home Assignment

Write a menu driven program to implement a queue, using linked list, with

i) insert, ii) delete, iii) exit operations

Day 7: Circular Queue, Deque - with linked list
Lab Assignment
Write a menu driven program to implement a circular queue using linked list with
i) insert, ii) delete, iii) exit operations
Home Assignment
Write a menu driven program to implement a double-ended queue, using linked list, with the following operations:
i) insert (from front, rear), ii) delete (from front, rear), iii) exit operations

Day 8: Binary Search Tree (BST)
Lab Assignment
Write a program, which creates a binary search tree (BST). Also write the functions to insert, delete (all possible cases) and search elements from a BST.
Home Assignment
Write three functions to traverse a given BST in the following orders:
i) in-order, ii) pre-order, iii) post-order.
Display the elements while traversing.

Day 9: Searching
Lab Assignment
WAP to implement,
i) Linear Search, ii) Binary Search (iterative)
NB: As a pre-processing step, use bubble-sort to sort the elements in the search space.
WAP to generate integers from 1 to n (input parameter) in random order and guarantees that no number appears twice in the list. While the number sequence is being generated, store it in a text file.
Home Assignment
WAP to implement binary search recursively.

Day 10: Sorting
Lab Assignment
Write different functions for implementing,
i) Bubble sort, ii) Cocktail shaker sort, iii) Quick Sort.
Plot a graph of n vs. time taken, for n= 100, 1000, 10,000 and 100,000 to com-pare the performances of the sorting methods mentioned above. Use the second assignment of Day 9 to generate the data, using the given n values.
Home Assignment
Write different functions for implementing,
i) Insertion sort, ii) Merge sort.

Day 11: Graph Algorithms
Lab Assignment
Read a graph (consider it to be undirected) from an edge-list and store it in an adjacency list.
Use the adjacency list to run DFS algorithm on the graph and print the node labels. Detect and count the back-edges.
Home Assignment
WAP to implement BFS algorithm of a given graph (similarly as described for DFS, instead of back-edges count cross-edges)**.**

3. Textbooks

1. Fundamentals of Data Structures of C, Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed.
2. Data Structures in C, Aaron M. Tenenbaum.
3. Data Structures, S. Lipschutz.
4. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.

4. Reference Books

1. Data Structures and Program Design In C, 2/E, Robert L. Kruse, Bruce P. Leung.

Course Name: Software Tools Lab					
Course Code: CSEN2152					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2152.1. Understand the importance of knowing various tools to make programs more effective.
CSEN2152.2. Learn the concept and use of integrated development environment.
CSEN2152.3. Analyse the errors in a code using debugging methods in both Windows and Linux environment.
CSEN2152.4. Understand the need for version control and learn effective methods to do the same.
CSEN2152.5. Analyse a code with code coverage testing and know how to speed up execution using profiling tools.
CSEN2152.6. Demonstrate the utility of effectively using software tools to minimize memory leaks and bad memory manipulations in programs.

2. Detailed Syllabus

1. **CodeLite IDE [CodeBlock]**
   Learn to use CodeLite IDE for wrtiing C/C++ programming languages.
2. **Compiling with gcc**
   Learn all the command line options for compiling C programs in the unix environment using gcc.
3. **Git for sharing files and version control**
   Learn to setup a repository so that it can sync your local with that on the server. Learn to use cvs for version controlling.
4. **Debugging with gdb**
   gdb is the standard C/C++ debugger to debug your code. Learn to interact with gdb directly via a shell, or use a graphical interface provided by CodeLite IDE.
5. **Makefiles**
   Learn how to use makefile on Unix to properly build an executable.
6. **Code coverage testing with gcov**
   Learn about good testing using gcov to make sure the tests are exercising all the branches in the code.
7. **Runtime profiling with gprof**
   Learn about using gprof which is a very useful profiling tool for speeding up execution speed of a program: it will show where your program is spending most of its time, so one can know about the most important code to optimize.
8. **Memory profiling with valgrind**
   Learn to use valgrind which is a critical tool for helping one to find memory leaks in the program: malloc without free, accessing an array outside its bounds, etc.

3. Textbooks

1. The Definitive Guide to GCC, William von Hagen, 2nd Edition, 2006, Apress.
2. Linux Debugging and Performance Tuning: Tips and Techniques, Steve Best, Pearson Education,1st Edition, 2006.

4. Reference Books

1. Version control with Git, Jon Loeliger,1st Edition,2009, O'Reilly.
2. The Art of Debugging with GDB, DDD, and Eclipse, Norman Matloff, Peter Jay Salzman,2008.

Course Name: Digital Logic Lab					
Course Code: ECEN2154					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN2154.1. Use the concept of Boolean algebra to minimize logic expressions by the algebraic method, K-map method etc.
ECEN2154.2. Construct different Combinational circuits like Adder, Subtractor, Multiplexer, De-Multiplexer, Decoder, Encoder, etc.
ECEN2154.3. Design various types of Registers and Counters Circuits using Flip-Flops (Synchronous, Asynchronous, Irregular, Cascaded, Ring, Johnson).
ECEN2154.4. Realize different logic circuits using ICs built with various logic families.

2. Detailed Syllabus

Choose any ten experiments out of the twelve suggested next:

1. Realization of basic gates using Universal logic gates.
2. Four-bit parity generator and comparator circuits.
3. Code conversion circuits BCD to Excess-3 & vice-versa.
4. Construction of simple 3-to-8 Decoder circuit by 2-to-4 Decoders using logic gates.
5. Design a 4-to-1 Multiplexer using logic gates and use it as a Universal logic module.
6. Realization of SR (Set Reset), JK, and D flip-flops using Universal logic gates.
7. Construction of simple arithmetic logic circuits-Adder, Subtractor.
8. Realization of Asynchronous Up/Down Counter (Count up to 7) using logic gates.
9. Realization of Synchronous Up/Down Counter (Count up to 7) using logic gates.
10. Realization of Shift Registers using logic gates (Serial in Serial out and Parallel in Serial out).
11. Construction of Serial adder circuit using a D Flip-Flop and a Full adder.
12. Design a combinational circuit for BCD to Decimal conversion to drive 7-Segment display using logic gates.

C. HONORS COURSES

Course Name: Probability and Statistical Methods					
Course Code: MATH2111					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	4	**0**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

MATH2111.1. Articulate the axioms (laws) of probability.
MATH2111.2. Compare and contrast different interpretations of probability theory and take a stance on which might be preferred.
MATH2111.3. Formulate predictive models to tackle situations where deterministic algorithms are intractable.
MATH2111.4. Summarize data visually and numerically.
MATH2111.5. Assess data-based models.
MATH2111.6. Apply tools of formal inference.

2. Detailed Syllabus

Module 1 [10L]

Probability-I (Single variable probability distributions): Review of basic probability: Axiomatic definition, Addition and Multiplication law, Conditional probability and Bayes' Theorem, Expectation and Variance of single variable discrete and continuous distributions, Normal approximation to Binomial and Poisson Distribution, Exponential and Multinomial distribution, Moment generating and characteristic functions, Limit theorems: Markov's inequality and Chebyshev's inequality with examples.

Module 2 [10L]

Probability-II (Joint Distribution and Markov Chains): Joint distribution using joint probability mass/density function, Finding marginal pmf/pdf from joint distribution, Multiplicative property of joint pmf/pdf in case of independent random variables, Markov Chains: Introduction, Chapman-Kolmogorov equations, Classification of states, Some applications: Gambler's Ruin Problem.

Module 3 [10L]

Statistics-I: Moments, Skewness and Kurtosis, Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Covariance, Correlation and Regression, Spearman's Rank Correlation coefficient, Curve fitting: Straight line and parabolas.

Module 4 [10L]

Statistics-II: Population and Samples, The sampling distribution of mean (standard deviation known), The sampling distribution of mean (standard deviation unknown), Point and Interval estimation, Tests of Hypotheses, Null Hypotheses and Tests of Hypotheses with examples.

3. Textbooks

1. Probability and Statistics for Engineers, Richard A Johnson, Pearson Education.
2. Groundwork of Mathematical Probability and Statistics, Amritava Gupta, Academic Publishers.

4. Reference Books

1. Introduction to Probability Models, S.M. Ross, Elsevier.
2. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand and Sons.
3. An Introduction to Probability theory and its applications Vol-I, W. Feller, John Wiley and Sons.

Syllabus of 4th Semester

A. THEORY COURSES

Course Name: Design & Analysis of Algorithms					
Course Code: CSEN2201					
Contact Hours per week:	L	T	P	Total	Credit points
	4	0	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2201.1. Remember time complexities of various existing algorithms in different situations.
CSEN2201.2. Understand the basic principles of different paradigms of designing algorithms.
CSEN2201.3. Apply mathematical principles to solve various problems.
CSEN2201.4. Analyze the complexities of various algorithms.
CSEN2201.5. Evaluate the performance of various algorithms in best case, worst case and average case.
CSEN2201.6. Create/ Design a good algorithm for a new problem given to him/ her.

2. Detailed Syllabus

Module 1 [10L]

Algorithm Analysis: Time and space complexity. Asymptotic Notations and their significance. Asymptotic Analysis. Finding time complexity of well-known algorithms like-insertion sort, heapsort, Asymptotic solution to recurrences, Substitution Method, Recursion Tree, Master Theorem.
Divide-and-Conquer Method: Basic Principle, Binary Search – Worst-case and Average Case Analysis, Merge Sort – Time Complexity Analysis, quicksort – Worst-case and Average Case Analysis, Concept of Randomized Quicksort.
Medians and Order Statistics
Lower Bound Theory: Bounds on sorting and searching techniques**.**

Module 2 [16L]

Greedy Method: Elements of the greedy strategy. Fractional Knapsack Problem, Huffman codes.
Dynamic Programming: Basic method, use, Examples: 0-1 Knapsack Problem, Matrix-chain multiplication, LCS Problem.
Graph Algorithms: Minimum cost spanning trees: Prim's and Kruskal's algorithms and their correctness proofs (Greedy Method). Shortest Path Algorithm: Dijkstra's with correctness proof. (Greedy method), Bellman Ford with correctness proof, All pair shortest path (Floyd-Warshall Algorithm) (Dynamic Programming).

Module 3 [10L]

Amortized Analysis: Aggregate, Accounting and Potential methods.
String matching algorithms: Different techniques – Naive algorithm, string matching using finite automata, and Knuth , Morris , Pratt (KMP) algorithm with their complexities
Randomized Algorithm: Skip List.

Module 4 [10L]

Disjoint Set Manipulation: UNION-FIND with union by rank, Path compression.
Network Flow: Ford Fulkerson algorithm, Max - Flow Min - Cut theorem (Statement and Illustration)
NP-completeness: P class, NP-hard class, NP-complete class. Relative hardness of problems and polynomial time reductions. Satisfiability problem, Vertex Cover Problem, Independent Sets, Clique Decision Problem.
Approximation algorithms: Necessity of approximation scheme, performance guarantee. Approximation algorithms for 0/1 knapsack, vertex cover, TSP. Polynomial time approximation schemes: 0/1 knapsack problem**.**

3. Textbooks

1. Introduction to Algorithms by Cormen, Leiserson, Rivest and Stein. Third Edition, 2009. Prentice Hall.
2. Algorithm Design by Jon Kleinberg and Eva Tardos. Addison Wesley, 2005.

4. Reference Books

1. Computer Algorithms: Introduction to Design and Analysis by Sarah Basee and Allen van Gelder. 3rd Edition, Addison Wesley.

Course Name: Computer Organization and Architecture					
Course Code: CSEN2202					
Contact Hours per week:	L	T	P	Total	Credit points
	4	0	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2202.1. Understand the basic organization of computer and different instruction formats and addressing modes.
CSEN2202.2. Analyze the concept of pipelining, segment registers and pin diagram of CPU.
CSEN2202.3. Understand and analyze various issues related to memory hierarchy.
CSEN2202.4. Understand various modes of data transfer between CPU and I/O devices.
CSEN2202.5. Examine various inter connection structures of multi-processor.
CSEN2202.6. Design architecture with all the required properties to solve state-of-the-art problems.

2. Detailed Syllabus

Module 1 [10L]

Basics of Computer Organization: Basic organization of the stored program computer and operation sequence for execution of a program, Von Neumann & Harvard Architecture. RISC vs. CISC based architecture.
Fetch, decode and execute cycle, Concept of registers and storage, Instruction format, Instruction sets and addressing modes. Basics of Control Unit Design - hardwired and micro programmed control, Horizontal and Vertical micro instruction.

Module 2 [11L]

Memory and I/O Organization: Memory system overview, Cache memory organizations, Techniques for reducing cache misses, Hierarchical memory technology: Inclusion, Coherence and locality properties, Virtual Memory, Memory mapped IO. Introduction to I/O interfaces. Interrupts, Interrupt hardware, Enabling and Disabling interrupts, Concept of handshaking, Polled I/O, Priorities, Daisy Chaining. Vectored interrupts; Direct memory access, DMA control.

Module 3 [10L]

Pipelined Architecture: Brief Introduction, Performance Measures - speed up, Efficiency, performance - cost ratio etc.
Static pipelines - reservation tables, scheduling of static pipelines, definitions - minimum average latency, minimum achievable latency, greedy strategy etc. Theoretical results on latency bounds without proof.
Vector Processing: Vector registers; Vector Functional Units; Vector Load / Store; Vectorization; Vector operations: gather / scatter; Masking; Vector chaining.

Module 4 [9L]

SIMD Architectures: Brief introduction, various concepts illustrated by studying detailed SIMD algorithms, viz., Matrix multiplication, Sorting on Linear array.
Interconnection Networks: Detailed study of Interconnection Network - Boolean cube, Mesh, Shuffle-exchange, Banyan, Omega, Butterfly, Generalized Hypercube, Delta etc.

3. Textbooks

1. Computer Organization, 5th Edition, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, MGH.
2. Computer System Architecture, 3rd Edition, Morris M. Mano, Pearson.
3. Computer Organization and Design: The Hardware/Software interface, David A. Patterson and John L. Hennessy, 3rd Edition, Elsevier, 2005.
4. Advanced Computer Architecture and Parallel processing, Hwang & Briggs, MH.
5. Advanced Computer Architecture: Parallelism, Scalability, Programmability, Kai Hwang, McGraw-Hill.

4. Reference Books

1. Onur Mutlu's lecture materials on Computer Architecture from CMU web site: https://users.ece.cmu.edu/~omutlu/.
2. NPTEL materials on Computer Organization.

Course Name: Operating Systems					
Course Code: CSEN2203					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2203.1. Develop knowledge about the importance of computer system resources and the role of operating system in their management policies and algorithms.

CSEN2203.2. Understand processes and its management policies and scheduling of processes by CPU.

CSEN2203.3. Acquire an understanding of the need of process synchronization, evaluate the requirement for process synchronization and coordination handled by operating system.

CSEN2203.4. Analyse the memory management and its allocation policies and compare different memory management approaches.

CSEN2203.5. Use system calls for managing processes, memory, file system etc.

CSEN2203.6. Be familiar with different storage management policies and storage technologies.

2. Detailed Syllabus

Module 1 [7L]

Introduction: Operating system functions, OS Architecture (Monolithic, Microkernel, Layered, Hybrid), Different types of O.S. (batch, multi-programmed, time-sharing, real-time, distributed, parallel).

System Structure: Computer system operation, Operating system structure (simple, layered, virtual machine), O/S services, System calls.

Protection & Security: Goals of protection, Domain of protection, Access matrix and its representation, Threats and system security.

Module 2 [13L]

Processes and Threads: 7 state process model, Process scheduling, Operations on processes, Inter-process communication, Threads overview, Benefits of threads, User and kernel threads.

CPU Scheduling: Scheduling criteria, Preemptive & non-preemptive scheduling, Scheduling algorithms (FCFS, SJF, RR, Priority, Multi-level queue, Multi-level feedback queue), Comparative study of the algorithms, Multi-processor scheduling.

Process Synchronization: Background, Critical section problem, Software solution – Peterson and Bakery algorithm, Synchronization hardware, Semaphores, Classical problems of synchronization.

Deadlocks: System model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock.

Module 3 [9L]

Primary Memory: Background, Physical address, Logical address, Virtual address, Contiguous memory allocation (Fixed and Variable partition), Non-contiguous memory allocation techniques (Paging, Segmentation, Segmentation with Paging), Virtual memory, Demand Paging, Performance, Page replacement algorithms (FCFS, LRU, optimal), Thrashing.

Secondary Storage: Disk structure, Disk performance, Disk scheduling (FCFS, SSTF, SCAN, C-SCAN), Boot block, Bad blocks.

Module 4 [7L]

File Systems: File concept, Access methods, Directory structure, File system structure, Allocation methods (Contiguous, Linked, Indexed), Free-space management (Bit vector, Linked list, Grouping), Directory Implementation (Linear list, Hash table), Efficiency and Performance.

I/O Management: PC Bus Structure, I/O connections, Data transfer techniques (Programmed, Interrupt driven , DMA), Bus arbitration (Daisy chain, Polling, Independent request), Blocking and non-blocking I/O, Kernel I/O subsystem (Scheduling, Buffering, Caching, Spooling and device reservation, Error handling).

3. Textbooks

1. Operating System Concepts, 10E, Silberschatz A., Galvin P. B., Gagne G., Wiley Publications.
2. Operating Systems Internals and Design Principles, 9E, Stalling W., Pearson Education.

4. Reference Books

1. Operating System: Concept & Design, Milenkovie M., McGraw Hill.
2. Operating System Design & Implementation, Tanenbaum A.S., Prentice Hall NJ.
3. Operating System Concepts, Silberschatz A., Peterson J. L., Wiley Publications.
4. Operating Systems A Concept Based Approach, Dhamdhere D.M., McGraw Hill.

Course Name: Mathematics-III Algebraic Structures					
Course Code: MATH2201					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	4	**0**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

MATH2201.1. Describe the basic foundation of computer related concepts like sets, Posets, lattice and Boolean Algebra.

MATH2201.2. Analyse sets with binary operations and identify their structures of algebraic nature such as groups, rings and fields.

MATH2201.3. Give examples of groups, rings, subgroups, cyclic groups, homomorphism and isomorphism, integral domains, skew-fields and fields.

MATH2201.4. Compare even permutations and odd permutations, abelian and non-abelian groups, normal and non-normal subgroups and units and zero divisors in rings.

MATH2201.5. Adapt algebraic thinking to design programming languages.

MATH2201.6. Identify the application of finite group theory in cryptography and coding theory.

2. Detailed Syllabus

Module 1 [10L]

Sets, Relations and Functions: Basic operations on sets, Venn diagrams. Binary relations defined on sets, equivalence relations and equivalence classes, order, relation and lattices, partially ordered sets, Hasse diagrams, maximal, minimal, greatest and least elements in a partially ordered set, lattices and their properties, principle of duality, distributive and complemented lattices.

Module 2 [10L]

Group Theory I: Cartesian product, Binary operation, Composition Table. Group, Elementary theorems on groups, Quasi-group and Klein's 4 group. Permutations, Product of permutations, Group property of permutations, Cyclic permutation, Transposition, Even and Odd permutations, Proposition regarding permutations, Alternating Groups.

Module 3 [10L]

Group Theory II: Order of an element of a group, Properties of the order of an element of a group , Subgroups, some basic theorems on subgroups, Cyclic group, Cosets, Lagrange's theorem, Fermat's Little Theorem(statement only). Normal subgroup, some basic theorems on Normal subgroup.

Module 4 [6L]

Morphisms, Rings and Fields: Homomorphism and Isomorphism of groups, some basic theorems. Rings, some elementary properties of a ring, Ring with unity, Characteristic of a ring, Ring with zero divisors, Sub-ring, Integral domain, Field, Division Ring or Skew Field. (Emphasis should be given on examples and elementary properties).

3. Textbooks

1. Higher Algebra, S.K.Mapa, Sarat Book Distributors.
2. Advanced Higher Algebra, J.G.Chakravorty and P.R.Ghosh, U.N. Dhur and Sons.

4. Reference Books

1. A First course in Abstract Algebra, J.B.Fraleigh, Narosa.
2. Algebra, M. Artin, Pearson.

Course Name: Microprocessors & Microcontrollers					
Course Code: AEIE2205					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**2**

1. Course Outcomes

After completion of the course, students will be able to:

AEIE2205.1. Understand the architecture of 8-bit microprocessor (8085A).

AEIE2205.2. Develop the skill in program writing of 8-bit microprocessor (8085A).

AEIE2205.3. Understand the architecture and develop the skill in program writing of 16-bit microprocessor (8086).

AEIE2205.4. Understand the architecture and develop the skill in program writing of microprocessor 8051 and PIC16F877.

AEIE2205.5. Understand the architecture and operation of programmable peripheral device 8255A.

2. Detailed Syllabus

Module 1 [6L]

Introduction to 8-bit microprocessor: 8085 microprocessor internal architecture, 8085 pin configuration, Software instruction set, timing diagram of the instructions.

Module 2 [7L]

Addressing modes and Assembly language programming: Interrupts of 8085 processor: classification of interrupts, Programming using interrupts. Counter and Time delay, Support IC chips 8255- Block diagram, pin configuration, mode of operation, control word(s) format and Interfacing with Microprocessors.

Module 3 [7L]

Introduction to 8086/8088 Architecture: Architecture, memory segmentation, pin configuration, clock generator, instruction set, addressing modes and assembly language programming of 8086/8088, interrupts.

Module 4 [6L]

Introduction to microcontrollers: Intel MCS-51 family features, 8051 architecture, pin configuration, I/O ports and memory organization; Instruction set and basic assembly language programming, interrupts and returns; Interrupts, timer/counter and serial communication.

Brief introduction to PIC microcontroller (16F877): Architecture, pin details, memory layout etc.

3. Textbooks

1. Microprocessor architecture, programming and applications with 8085/8085A, Ramesh S. Gaonkar, Wiley eastern Ltd.
2. Fundamental of Microprocessor and Microcontrollers, B. Ram, Dhanpat Rai Publications.
3. Microprocessors and Microcontrollers, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, Oxford Publications.
4. 8085 Microprocessor and its Applications, A. Nagoor Kani, Third Edition, TMH Education Pvt. Ltd.

4. Reference Books

1. The 8051 Microcontroller and Embedded. Systems. Using Assembly and C. Muhammad Ali Mazidi, Janice Gillispie Mazidi. Rolin D. McKinlay, Second Edition, Pearson Publication.
2. Advanced Microprocessors and Peripherals, A.K.Ray, K.Bhurchandi, TMH Education Pvt. Ltd.
3. PIC Microcontroller and Embedded. Systems. Using Assembly and C. Muhammad Ali Mazidi, Janice Gillispie Mazidi. Rolin D. McKinlay, Pearson Publication.
4. Design with PIC Microcontroller, John Peatman, Pearson Publication.

Course Name: Environmental Sciences (Mandatory)					
Course Code: EVSC2016					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**0**

1. Course Outcomes

After completion of the course, students will be able to:

EVSC2016.1. Understand the natural environment and its relationships with human activities.
EVSC2016.2. Characterize and analyze human impacts on the environment.
EVSC2016.3. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.
EVSC2016.4. Educate engineers who can work in a multi-disciplinary environment to anticipate and address evolving challenges of the 21st century.
EVSC2016.5. Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.
EVSC2016.6. Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

2. Detailed Syllabus

Module 1 [6L]

Socio Environmental Impact: Basic ideas of environment and its component
Population growth: exponential and logistic; resources; sustainable development.
Concept of green chemistry: green catalyst, green solvents
Environmental disaster and social issue: environmental impact assessment, environmental audit, environmental laws and protection act of India.

Module 2 [6L]

Air Pollution: Structures of the atmosphere, global temperature models, Greenhouse effect, global warming; acid rain: causes, effects and control. Lapse rate and atmospheric stability; pollutants and contaminants; smog; depletion of ozone layer; standards and control measures of air pollution.

Module 3 [6L]
Water Pollution: Hydrosphere; pollutants of water: origin and effects; oxygen demanding waste; thermal pollution; pesticides; salts. Biochemical effects of heavy metals; eutrophication: source, effect and control. Water quality parameters: DO, BOD, COD. Water treatment: surface water and wastewater.

Module 4 [6L]
Land Pollution: Land pollution: sources and control; solid waste: classification, recovery, recycling, treatment and disposal.
Noise Pollution: Noise: definition and classification; noise frequency, noise pressure, noise intensity, loudness of noise, noise threshold limit value; noise pollution effects and control.

3. Textbooks
1. Basic Environmental Engineering and Elementary Biology, GourKrishna Das Mahapatra, Vikas Publishing House P. Ltd.
2. Environmental Chemistry, A. K. De, New Age International.
3. Environmental Chemistry with Green Chemistry, A. K. Das, Books and Allied P. Ltd.

4. Reference Books
1. Environmental Science, S. C. Santra, New Central Book Agency P. Ltd.
2. Fundamentals of Environment & Ecology, D. De, D. De, S. Chand & Company Ltd.

B. LABORATORY COURSES

Course Name: Design & Analysis of Algorithms Lab					
Course Code: CSEN2251					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes
After completion of the course, students will be able to:
CSEN2251.1. Understand and Apply different types of algorithm designing paradigms like divide and conquer, greedy, dynamic programming etc.
CSEN2251.2. Realize and Apply underlying mathematical principles of algorithms in the corresponding implemented program.
CSEN2251.3. Analyse and Evaluate the performance of various algorithms by observing the actual running time and main memory consumption of the corresponding implemented programs for best case, worst case and average case input data.
CSEN2251.4. Create / Design a good algorithm for solving real life computing problems, by using various design techniques and data structures, learnt in this course.

2. Detailed Syllabus
A tentative list (non-exhaustive) of the practical topics are given below:

1. **Divide and Conquer:** Implement Quick Sort and **randomized version** of quick sort using Divide and Conquer approach. Check the running time for each of the n! combinations or input sequences of a particular set of integers to observe the best, worst and average cases.
2. **Divide and Conquer:** Implement Merge Sort using Divide and Conquer approach. Check the running time for each of the n! combinations or input sequences of a particular set of integers to observe the best, worst and average cases.
3. Implement Heapsort algorithm. Check the running time for each of the n! combination or input sequences of a particular set of integers to observe the best, worst and average cases.
4. **Dynamic Programming:** Find the minimum number of scalar multiplications needed for chain of Matrices.
5. **Dynamic Programming:** Implement Bellman Ford Algorithm to solve Single Source shortest Path problem of a graph.
6. **Dynamic Programming:** Implement Floyd- Warshall Algorithm to solve all pair Shortest path for a graph.
7. **Dynamic Programming:** Solve 0/1 Knapsack problem using dynamic problem.
8. **Dynamic Programming:** Solve Longest Common Subsequence problem using dynamic problem.
9. **Greedy method:** Implement Dijkstra's algorithm to find Minimum Spanning Tree of a graph by using minimum priority Queue or minimum heap data structure.
10. **Greedy method:** Implement Prim's algorithm to find Minimum Spanning Tree of a graph by using minimum priority Queue or minimum heap data structure.

11. **Greedy method:** Implement Kruskal's algorithm to find Minimum Spanning Tree of a graph by implementing and using various operations of Disjoint-set forest data structure.
12. **Greedy method:** Implement Huffman coding using greedy approach.
13. **Realization of Amortized Analysis:** Implement a Queue using Stacks.
14. Implement KMP algorithm for string matching
15. Implement Ford-Fulkerson algorithm to get maximum flow in a given flow network.
16. **Randomized Algorithm:** Implement Skip-List)**.**

3. Textbooks

1. Introduction to Algorithms, Cormen, Leiserson, Rivest and Stein. Third Edition, 2009. Prentice Hall.
2. Algorithm Design, Jon Kleinberg and Eva Tardos. Addison Wesley, 2005.

4. Reference Books

1. Computer Algorithms: Introduction to Design and Analysis, Sarah Basee and Allen van Gelder. 3rd Edition, Addison Wesley.

Course Name: Computer Architecture Lab					
Course Code: CSEN2252					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2252.1. Students would be able to have adequate knowledge of basics of computer architecture.
CSEN2252.2. Students would be able to understand detailed implementation of machine instructions, their classifications and their relevance to programming paradigms.
CSEN2252.3. Students would have sufficient knowledge of design implementations of various arithmetic operations such as adder, multiplier etc.
CSEN2252.4. Students would be able to design and simulate various combinatorial and sequential logic circuits using Vivado/Xilinx.
CSEN2252.5. Students would be able to understand various memory functions.
CSEN2252.6. Students would be able to design a formal testbench from informal system requirements.

2. Detailed Syllabus

Programming using VHDL

1. All Logic Gates (Data flow and Behavioral model)
2. Half adder and half subtractor (Data flow and Behavioral Model)
3. Combinatorial Designs (Data flow and Behavioral Model)
   a. 2:1 Multiplexer
   b. 4:1 Multiplexer
   c. 3:8 Decoder
   d. Comparator
4. Full adder and full subtractor (Data flow, Behavioral and Structural Model)
5. Sequential design of flip flops (SR, JK, D, T)
6. ALU design
7. Ripple carry adder (Structural Model)
8. Adder subtractor composite unit (Structural Model)
9. 4 bit synchronous and asynchronous counters.
10. Small projects like stepper motor.

3. Textbooks

1. VHDL: Programming by Example, Douglas L. Perry, Fourth Edition, McGraw Hill.

4. Reference Books

1. Introduction to Logic Circuits & Logic Design with VHDL, LaMeres, Brock J, Springer.

Course Name: Operating Systems Lab					
Course Code: CSEN2253					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN2253.1. Understand and implement basic services and functionalities of the operating system using system calls.
CSEN2253.2. Will be able to describe and create user defined processes.
CSEN2253.3. Understand the benefits of thread over process and implement them.
CSEN2253.4. Synchronization programs using multithreading concepts.
CSEN2253.5. Use modern operating system calls and synchronization libraries in software to implement process synchronization.
CSEN2253.6. Implementation of Inter-process communication using PIPE.

2. Detailed Syllabus

1. **Shell programming:** Creating a script, making a script executable, shell syntax (variables, Conditions, control structures, functions and commands).
2. **Process:** starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.
3. **Signal:** signal handling, sending signals, signal interface, signal sets.
4. **Semaphore:** programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).
5. **POSIX Threads:** programming with pthread functions (viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel)
6. **Inter-process communication:** pipes (use functions pipe, popen, pclose), named pipes (FIFOs, accessing FIFO).

3. Textbooks

1. Your Unix The Ultimate Guide, Sumitabha Das, MH

4. Reference Books

1. Beginning Linux Programming, Neil Matthew, Richard Stones, Wrox.

Course Name: Microprocessors & Microcontroller Lab					
Course Code: AEIE2255					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

1. Course Outcomes

After completion of the course, students will be able to:

AEIE2255.1. Understand and apply different instructions of 8085 microprocessor.
AEIE2255.2. Understand and apply different instructions of 8086 microprocessor.
AEIE2255.3. Understand and apply different instructions of 8051 microcontroller.
AEIE2255.4. Interface 8085A microprocessor with different input and output devices (e.g., LEDs, seven segments displays ADC, DAC, and stepper motor etc.).
AEIE2255.5. Interface 8086A microprocessor/ 8051 microcontroller with different input and output devices (e.g., LEDs, seven segments displays ADC, DAC, and stepper motor etc).

2. Detailed Syllabus

1. Familiarization with 8085A trainer kit components with the process of storing and viewing the contents of memory as well as registers. Repeat the above all using 8085A Simulator.
2. Study of programs using basic instruction set (data transfer, load/store, arithmetic, logical) of 8085A microprocessor.
3. Programming using 8085A trainer kit/simulator for:
   a) Copying and Shifting block of memory
   b) Packing and unpacking of BCD numbers
   c) Addition/Subtraction of two 8-bit Hex numbers
   d) Addition of 16-bit Hex numbers.
   e) BCD Addition
   f) Binary to ASCII conversion

g) String Matching and Sorting.

4. Familiarization of 8086 microprocessor trainer kit/simulator using data transfer, load/store, arithmetic and logical instructions.
5. Write assembly language programs (ALP) using 8086 microprocessor trainer kit /simulator on the following:
   a) Finding the largest/ smallest number from an array
   b) Arranging numbers in ascending/descending order
   c) Shifting a block of data from one memory location to another
   d) Addition of a series of BCD numbers
   e) String matching
6. Interfacing of 8085A through 8255A PPI/ 8051 Microcontroller with switches and LEDs to perform
   a) Display operation
   b) Blinking operation and
   c) Scrolling operation
7. Interfacing with seven segment displays through 8-bit latch (e.g., 74LS373) using- a) 8085A trainer kit, b) 8086A trainer kit through 8255A PPI.
8. Interfacing of ADC, DAC, and Stepper motor with 8085A/8086 microprocessor trainer kit.

3. Textbooks and References

Assignment Sets to be provided.

Syllabus of 5th Semester

A. THEORY COURSES

Course Name: Database Management Systems					
Course Code: CSEN3101					
Contact Hours per week:	L	T	P	Total	Credit points
	4	0	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3101.1. Identify the basic concepts and various data model used in database design. Be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.

CSEN3101.2. Formulate relational algebra expression for queries and evaluate it using the concept of query processing and optimization.

CSEN3101.3. Create RDBMS schema mapping various business validations and formulate queries based on that schema using SQL to satisfy business requirements.

CSEN3101.4. Apply normalization and various types of dependencies for evaluating a relational database design.

CSEN3101.5. Apply and relate the concept of transaction, concurrency control and recovery in database.

CSEN3101.6. Understand with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

2. Detailed Syllabus

Module 1 [10L]

Introduction: An overview of database management system, Database system Vs file system, ACID properties, Advantage of database, Data Independency, Integrity constraints, Evolution of DBMS, Different types of database, Database Languages, Three-schema architecture of a database, Different users of Database, Role of DBA.

Relational Database Design using ER Model: Data modeling concepts, Notations for ER diagram (entity, different types of attributes, relationship, cardinality and degree of relationship, weak entity), Concepts of Super Key candidate key and primary key, Mapping Constraints (Mapping Cardinality constraint, Participation Constraints, Key Constraints), Design Issues, Generalization, aggregation, Extended E-R features (Generalization & Specialization, Aggregation, Attribute Inheritance), Examples of Drawing ER diagram, Convert ER diagrams into tables.

Relational Data Model: Concept of relations, Relational Algebra Operators: Selection, Projection, Union, Intersection, Set difference, Cross product, Rename, Assignment, Various types of joins, Division.

Module 2 [10L]

Introduction to SQL: DDL ,DML, DCL, TCL, Data definition in SQL, Table, Primary key and foreign key definitions, DDL syntax and semantics – Create/Alter/Drop/Truncate, Implementing various constraints in DDL (Data Types, Null, Primary Key, Unique Key, Referential Integrity Constraints using foreign key, Complex business rules using trigger and assertions), Creating and using views, Creating Index.

Data manipulation in SQL: Insert, Edit, Delete and Basic select- from- where block and its semantics, Update behaviors, Complex Querying using inner and outer join, Nested queries - correlated and uncorrelated, Aggregate functions group by and having clauses, Unions, Intersection, Minus.

Cursors, Trigger, Procedures and Functions in SQL/PL SQL, Using JSON functions in Oracle.

Dependency theory: (functional dependencies, Armstrong's axioms for FDs, Closure of a set of FDs, Minimal covers: irreducible set of Functional Dependencies or Canonical Cover), Attribute Closure, Determine candidate Keys of a relation.

Module 3 [10L]

Data Base Design & Normalization: Different anomalies in designing a Database, Normalization and different Normal Forms, Definitions of 1NF, 2NF, 3NF and BCNF and using various normal form during design, Decompositions and desirable properties of them, Lossy and Loss-less join decompositions, Dependency preservation, Normalization using multi-valued dependencies and 4NF, Join dependency, Definition of 5NF.

Module 4 [13L]

Concurrency control and Recovery Management: Transaction Fundamentals: OLTP environments, Concurrency issues, Need for transactions, Necessary properties of transactions (ACID properties), and Transaction states.

Concurrency control schemes (Pessimistic scheme, Optimistic scheme, pros and cons), Scheduling Transactions for concurrent execution, Anomalies with Interleaved Execution, Various schedules (Serial, Conflict serializability, View serializability), Testing of conflict serializability.

Recoverability and recoverability of Schedule (Irrecoverable schedule, Recoverable with cascading rollback), Lock-Based Concurrency Control, Lock Based Protocols, Two Phase Locking and how it works, Deadlock in DBMS, Wait-for graph, Detecting deadlocks using wait-for graphs, Schemes of Deadlock prevention (explain with example Wait-Die Scheme, Wound wait scheme). Transaction Support in SQL.

File Organization & Index Structures: File Organization: Fixed-Length and Variable-Length Records Organization of Records in Files (Sequential File Organization, Clustering File Organization.

Index: Basic Concept, Various types (Ordered, Hash), Ordered Indexing Methods (Primary Index - Dense index, Sparse index), Multilevel and Secondary Indices, Using B-trees as dynamic multi-level indexes, Introduction to B+ tree index and various operation in B+ tree index. Creating Indexes using SQL - Function-Based Index, Bitmap Indexing.

Query Processing and Optimization: Different steps of processing a high-level query, Notation for Query Trees and Query Graphs, Translating SQL into relational algebra, Query Optimizer Concepts, Measures of Query Cost, Different Query Algorithms used (no details), Concepts of Materialization and Pipelining, Heuristic Optimization of Query Trees, Statistical Information for Cost Estimation, Steps used for Cost-Based Optimization.

3. Textbooks

1. Database System Concepts, Henry F. Korth and Silberschatz Abraham, Mc.Graw Hill.
2. Fundamentals of Database Systems, Elmasri Ramez and Navathe Shamkant, Benjamin Cummings Publishing Company.
3. Database Management System, Ramakrishnan, McGraw-Hill.
4. Transaction Processing: Concepts and Techniques, Gray Jim and Reuter Address, Moragan Kauffman Publishers.
5. Advanced Database Management System, Jain, CyberTech.
6. Introduction to Database Management, Vol. I, II, III, Date C. J., Addison Wesley.
7. Principles of Database Systems, Ullman JD., Galgottia Publication.

4. Reference Books

1. Principles of Database Management Systems, James Martin, 1985, Prentice Hall of India, New Delhi.
2. Database Management Systems, Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill.

Course Name: Formal Language & Automata Theory					
Course Code: CSEN3102					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	4	**0**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3102.1. Recall the basic characteristics of various types of machines, languages and grammars.
CSEN3102.2. Compare different computational models, languages and grammars based on their properties and behaviors.
CSEN3102.3. Apply formal mathematical methods to prove properties of languages, grammars, and automata.
CSEN3102.4. Apply the knowledge of theory of computation to an engineering application (e.g. designing the compilers).
CSEN3102.5. Classify formal languages and Evaluate whether a language/grammar belongs to a given type or not.
CSEN3102.6. Design automata for given languages/grammars. Generate languages/grammars for a given automaton and Construct grammars for languages and vice versa.

2. Detailed Syllabus

Module 1 [11L]

Fundamentals: Basic definition of sequential circuit, block diagram, mathematical representation, concept of transition table and transition diagram, Design of sequence detector (Application of concept of Automata to sequential circuit design), Introduction to finite state model.

Finite state machine: Definitions, capability & state equivalence, kth- equivalence concept. Minimization of FSM, Equivalence between two FSM's, Limitations of FSM; Moore & Mealy machine and their conversion.

Finite Automata: Deterministic finite automaton (DFA) and non-deterministic finite automaton (NFA). Transition diagrams and Language recognizers; Application of finite automata, NFA with ϵ transitions - Significance, acceptance of languages. Design of DFA/ NFA for given languages.

Conversions and Equivalence: Equivalence between NFA with and without ϵ transitions. NFA to DFA conversion.

Module 2 [12L]

Introduction to Formal Languages and Grammars: Chomsky Classification of grammar: unrestricted, context sensitive, context free and regular grammar. Grammar Formalism: Right linear and left linear grammars, Regular grammar, Regular Languages, Regular sets. Regular expressions, identity rules, Problems on Regular expressions. Arden's theorem statement, proof and applications. Constructing finite Automata for a given regular expressions, Regular string accepted by NFA/DFA.

Pumping lemma of regular sets. Closure properties of regular sets (proofs not required). Equivalence between regular grammar and FA.

Module 3 [13L]

Context free grammar: Introduction to Context free grammars, Derivation/ parse trees, Sentential forms, Right most and leftmost derivation of strings, ambiguity in context free grammars, various problems on CFG. Minimization of Context Free Grammars: Removal of useless, null and unit productions. Chomsky normal form and Greibach normal form. Pumping Lemma for Context Free Languages. Enumeration of properties of CFL (proofs omitted). Closure property of CFL, Ogden's lemma & its applications.

Push Down Automata: Push down automata, Definition and design of PDA. Acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence. Equivalence of CFL and PDA, conversion from one to another. (Proofs not required). Introduction to DCFL and DPDA.

Module 4 [12L]

Turing Machine: Introduction to Turing Machine, Definition, Model. Design of TM for different languages, TM as language accepter. TM as transducers. Computable functions. Languages accepted by a TM, recursively enumerable and recursive languages. Diagonalization method. Church's hypothesis, counter machine. Types of Turing machines (proofs not required). Universal Turing Machine. Decidability, Undecidability, Various Undecidable problems like Post's Correspondence Problem (PCP), Turing Machine Halting Problem, Ambiguity of Context Free Grammars etc.

3. Textbooks

1. Introduction to Automata Theory Language and Computation, Hopcroft H.E. and Ullman J. D., Pearson Education.
2. An Introduction to Formal Languages and Automata, Peter Linz, Jones and Bartlett Publishers.
3. Introduction to the Theory of Computation, Sipser Michael. Cengage Learning.
4. Theory of Computer Science, Automata Languages and computation", Mishra and Chandrashekaran, 2nd edition, PHI.

4. Reference Books

1. Switching & Finite Automata, ZVI Kohavi, 2nd Ed., Tata McGraw Hill.
2. Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
3. Introduction to languages and the Theory of Computation, John C Martin, TMH.
4. Elements of Theory of Computation, Lewis H.P. & Papadimitrou C.H. Pearson.

Course Name: Object Oriented Programming					
Course Code: CSEN3103					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	4	**0**	**0**	**4**	**4**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3103.1. Understand the principles of object-oriented programming.
CSEN3103.2. Compare the relative merits of C++ and Java as object-oriented programming languages.
CSEN3103.3. Understand the importance of error management and incorporate exception-handling in object-oriented programs.
CSEN3103.4. Apply multithreading techniques to improve performance.
CSEN3103.5. Apply the features of C++ and Java supporting object-oriented programming to develop modular applications.
CSEN3103.6. Analyse problems and estimate when object-oriented programming is an appropriate methodology to design and develop object-oriented software using C++ and Java.

2. Detailed Syllabus

Module 1 [10L]

Overview of Object-Oriented Programming Concepts: Difference between OOP and procedural programming – advantages & disadvantages. class, object, message passing, inheritance, encapsulation, polymorphism.

OOP with C++: Basic Programming Concepts: Data Types, Operators, Control Statements & Loops, Functions & Parameters Arrays, Pointers & References. Class & Object, Abstraction / Encapsulation, Access Specifier. Static Member, Friend Function. Constructor and Destructor.

Module 2 [10L]

OOP with C++: Function and Operator Overloading. Inheritance and Derived Class: Abstract Class, Runtime Polymorphism, Virtual Base Class, Overriding. Exception Handling. Namespaces, Class Template and Function Template.

Module 3 [10L]

OOP with Java: Features of Java, Byte Code & JVM, Concepts of Java Application and Applet. Basic Programming Concepts: Data Types, Operators, Control Statements & Loops, Functions & Parameters, Array. String Handling Concepts & related Functions, Command Line Arguments. User Input through Scanner. Class & Object, Access Specifier, Static Members, Constructor, Garbage Collector, Nested & Inner Class: Function Overloading, Inheritance, Runtime Polymorphism, Abstract Class.

Module 4 [11L]

Package and Interface. Exception Handling: Types of Exception Classes, Use of Try & Catch with Throw, User-defined Exceptions Classes. Threads, Communication and Synchronization of Threads: Multithreading, Thread Lifecycle, Thread Priorities, Inter-thread Communication. Applet Programming (using Swing): Applet Lifecycle, Application & Applet, Parameter Passing, Event Model & Listener, I/O.

3. Textbooks

1. The C++ Programming Language, Stroustrup, Adisson Wesley.
2. Object Oriented Programming in C++, R. Lafore, SAMS.
3. Java 2.0 Complete Reference, H. Schildt, McGrawHill.

4. Reference Books

1. JAVA How to Program, Deitel and Deitel, Prentice Hall.
2. Programming with Java: A Primer, E. Balagurusamy, 3rd Ed. – TMH.

Course Name: Electronic Design Automation					
Course Code: ECEN3106					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**2**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN3106.1. Getting exposure to VLSI Design Cycle, Process nodes and Design Challenges.
ECEN3106.2. Designing of Industry Standard CMOS Combinational Digital Gates.
ECEN3106.3. Designing of Industry Standard TG based Sequential Digital Gates.
ECEN3106.4. Learning High Level Synthesis in EDA flow.
ECEN3106.5. Learning Logic Synthesis in EDA flow and Verilog RTL.
ECEN3106.6. Learning Physical Place and Route in EDA flow.

2. Detailed Syllabus

Module 1 [8L]

VLSI Circuits & Physical Layout: MOS Transistor Characteristics, MOS as Digital Switch, NMOS Logic Family, CMOS Logic Family, CMOS Inverter Characteristics, Delay & Noise, CMOS NAND, NOR and Combinational Logic Circuits, Pass Transistor Logic & Transmission Gate, CMOS Sequential Circuits, CMOS D-Latch and D-Flip-Flop, Setup and Hold Time.
CMOS Cross Section, Layout and Mask layers, Inverter Layout, Lambda Rule vs Micron Rule, Std Cell Layout Topology, Stick Diagram, Euler Path Algorithm.

Module 2 [4L]

VLSI Design Methodology: Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), Technology growth and process Node.
VLSI Design Cycle, Full Custom Design, Std Cell based Semi Custom Design, Gate Array Design, PLD, FPGA: CLB, LUT.

Module 3 [6L]

EDA: High level Synthesis and Logic Synthesis: High level Synthesis EDA Flow, Control and Data Flow Graph, Scheduling, Allocation, Binding, Verilog RTL.
Combinational Logic Optimization: Binary Decision Diagram (BDD), OBDD, ROBDD, Technology Mapping: Pattern DAG, Subject DAG, Sequential Logic Optimization.

Module 4 [6L]

EDA: Physical Design Automation: Physical Layout Automation EDA Flow, Partitioning: KL Algorithm, Floor-planning cost function, Floor plans Placement, Global Routing: Steiner Tree, Maze Routing. Detailed Routing: Channel Routing, Horizontal Constraint Graph, Vertical Constraint Graph, Cyclic Constraint, Left-edge Algorithm.

3. Textbooks

1. Principles of CMOS VLSI Design, A Systems Perspective, Neil Weste, Kamran Eshraghian, Addison Wesley, 2nd Edition, 2000.
2. Algorithms for VLSI Physical Design Automation, N. Sherwani, Kluwer Academic Publishers (3rd edition).

4. Reference Books

1. CMOS Digital Integrated Circuits, Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition).
2. CMOS VLSI Design, A Circuits and Systems Perspective (3rd Edition), Neil Weste, David Harris, Ayan Banerjee. Pearson.
3. Digital Integrated Circuit, Design Perspective, M. Rabaey, Prentice-Hall.
4. VLSI Design and EDA TOOLS, Angsuman Sarkar, Swapnadip De, Chandan Kumar Sarkar, Scitech Publications (India) Pvt. Ltd., 2011.
5. Algorithms for VLSI Design Automation, Gerez, Wiley, 2011.

LIST OF COURSES FOR PROFESSIONAL ELECTIVE–I

Paper Code	Paper Name
CSEN3131	Computer Graphics and Multimedia
CSEN3132	Data Mining and Knowledge Discovery
CSEN3133	Web Technologies
CSEN3134	Graph Algorithms
CSEN3135	Introduction to Data Analysis with Python and R

Course Name: Computer Graphics & Multimedia					
Course Code: CSEN3131					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3131.1. Compare and study effectiveness of different line and circle drawing algorithms on Raster scan display.
CSEN3131.2. Design two-dimensional graphics and apply two dimensional transformations.
CSEN3131.3. Design three-dimensional graphics and apply three dimensional transformations.
CSEN3131.4. Apply Illumination and color models and apply clipping techniques to graphics.
CSEN3131.5. Demonstrate activities and applications of device dependent and independent color models, image representation techniques (raster and random graphics).
CSEN3131.6. Understood Different types of Multimedia File Format and demonstrate image, video, text analysis tools and techniques.

2. Detailed Syllabus

Module 1 [10L]

Introduction to computer graphics & graphics systems: Overview of computer graphics, representing pictures, preparing, presenting & interacting with pictures for presentations; Visualization & image processing; RGB color model, direct coding, lookup table; storage tube graphics display, Raster scan display, 3D viewing devices, Plotters, printers, digitizers, Light pens etc.; Active & Passive graphics devices; Computer graphics software.

Scan Conversion: Points & lines, Line drawing algorithms; DDA algorithm, Bresenham's line algorithm, Circle generation algorithm; Ellipse generating algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm.

Module 2 [9L]

2D transformation & viewing: Basic transformations: translation, rotation, scaling; Matrix representations & homogeneous coordinates, transformations between coordinate systems; reflection shear; Transformation of points, lines, parallel lines, intersecting lines, Viewing pipeline, Window to view port co-ordinate transformation, clipping operations, point clipping, line clipping, clipping circles, polygons & ellipse. Cohen and Sutherland line clipping, Sutherland-Hodgeman Polygon clipping, Cyrus-beck clipping method.

Overview of 3D Transformation and Viewing: 3D transformations: translation, rotation, scaling & other transformations. rotation about an arbitrary axis in space, reflection through an arbitrary plane; general parallel projection transformation; clipping, viewport clipping, 3D viewing.

Module 3 [8L]

Curves: Curve representation, surfaces, designs, Bezier curves, B-spline curves, end conditions for periodic B-spline curves, rational B-spline curves.

Hidden surfaces: Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, the Painter's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods, fractal -geometry.
Color & shading models: Light & color model; interpolative shading model; Texture.

Module 4 [9L]
Text: Different types of text representation, Hypertext, text representation formats.
Audio: Basic Sound Concepts, Types of Sound, Digitizing Sound, Computer Representation of Sound (Sampling Rate, Sampling Size, Quantization), Audio Formats, Audio tools, MIDI.
Video: Analogue and Digital Video, Recording Formats and Standards (JPEG, MPEG, H.261) Transmission of Video Signals, Video Capture.
Animation: Techniques of 2D & 3D animation, formats of Animation
Image and Video Database: Image representation, segmentation, similarity-based retrieval, image retrieval by color, shape and texture; indexing- k-d trees, R-trees, quad trees.

3. Textbooks
1. Computer Graphics (C version 2nd Ed.), Hearn, Baker, Pearson education.

4. Reference Books
1. Schaum's outlines Computer Graphics (2nd Ed.), Z. Xiang, R. Plastock, TMH.
2. Computer Graphics: Principles and Practice, 2nd Edition, Foley, Vandam, Feiner and Hughes, Pearson Education, 2003.
3. Mathematical Elements for Computer Graphics (2nd Ed.), D. F. Rogers, J. A. Adams, TMH.
4. Multimedia: Computing, Communications & Applications, Ralf Steinmetz and Klara Nahrstedt, Pearson Ed.
5. Multimedia Communications, Fred Halsall, Pearson Ed.
6. Multimedia Fundamentals: Vol. 1- Media Coding and Content Processing, Ralf Steinmetz and Klara Nahrstedt, PHI.
7. Principles of Multimedia, Ranjan Parekh, TMH.
8. Introduction to Computer Graphics and Multimedia, A Mukhopadhyay, A Chattopadhyay, Vikas Publication.

Course Name: Data Mining & Knowledge Discovery					
Course Code: CSEN3132					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes
After completion of the course, students will be able to:
CSEN3132.1. Learn and understand basic knowledge of data mining and related models.
CSEN3132.2. Understand and describe data mining algorithms.
CSEN3132.3. Understand and apply Data mining algorithms.
CSEN3132.4. Suggest appropriate solutions to data mining problems.
CSEN3132.5. Analyse data mining algorithms and techniques.
CSEN3132.6. Perform experiments in Data mining and knowledge discovery using real-world data.

2. Detailed Syllabus
Module 1 [9L]
Introduction and Rule-based Classification: What is Data Mining? Why do we need data mining? Data Mining System - Architecture and Processes. Challenges in Data Mining.
Decision Tree: General approach for solving a classification problem, Decision Tree Induction, Overfitting Pruning.
Rule-based Classification: How a rule-based classifier works, rule-ordering schemes, how to build a rule-based classifier, direct and indirect methods for rule extraction.

Module 2 [9L]
Advanced Classification Techniques: Bayes' Classifier: Bayes' theorem, Naïve Bayes classifier.
Support Vector Machines (SVM): Maximum margin hyperplanes, Linear SVM: separable case, non-separable case, Non-linear SVM.

Module 3 [9L]
Ensemble Methods, Association Rule Mining: Ensemble Methods: Bagging, Boosting, Random Forests
Association Rule Mining: Introduction, Frequent itemset generation, (Apriori principle, candidate generation and pruning), Rule generation, Compact representation of frequent item sets, FP-growth algorithm, Sub-graph mining.

Module 4 [9L]
Cluster Analysis: Introduction: Motivations, objectives and applications of clustering. Different types of clustering.

Partitional Clustering: K-means, Bisecting K-means, PAM.
Hierarchical Clustering: Agglomerative, Divisive, MIN, MAX, dendrogram representation.
Density-based Clustering: DBSCAN. Cluster evaluation, further reading – OPTICS, DENCLUE, CHAMELEON, BIRCH, CURE, ROCK.

3. Textbooks
1. Data Mining Concepts and Techniques, 3rd, Edition, J. Han and M. Kamber, Morgan Kaufmann Publishers, July 2011.

4. Reference Books
1. Introduction to Data Mining, P. N. Tan, M. Steinbach and V. Kumar, Pearson Publishers.
2. Pattern Recognition and Machine Learning, First Edition, C. Bishop, Springer, 2006.
3. Neural Networks and Learning Machines, Third Edition, S. Haykin, PHI Learning, 2009.
4. Pattern Classification, Second Edition, R. Duda, P. Hart and D. Stock, Wiley-Interscience, 2000.

Course Name: Web Technologies					
Course Code: CSEN3133					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes
After completion of the course, students will be able to:
CSEN3133.1. Understand the basic tags of HTML, CSS, java script and DHTML.
CSEN3133.2. Connect a server-side program using servlet and JSP to a DBMS and perform insert, update and delete operations on DBMS table.
CSEN3133.3. Write a server-side program using servlet and JSP to store the data sent from client, process it and store it on database.
CSEN3133.4. Prepare a well formed / valid XML document, schema to store and transfer data.
CSEN3133.5. Understand various types of attacks and their characteristics.
CSEN3133.6. Get familiar with network security designs using available secure solutions (such as PGP, SSL, IPSec).

2. Detailed Syllabus
Module 1 [8L]
Introduction: Commonly used protocols: HTTP, HTTPs, TELNET, Electronic Mail-POP3, SMTP etc., WWW-Evolution and its characteristics.
Basics of Web Technology: Static web page, Dynamic web page, Active web page.
HTML and CSS: Introduction, Editors, Elements, Attributes, Heading, Paragraph. Formatting, Link, Head, Table, List, Block, Layout, CSS. Form, Iframe, Colors, Colorname, Colorvalue. Image Maps.

Module 2 [10L]
Web page scripting, server and client side: Java Script: Data types, variables, operators, conditional statements, array object, date object, string object.
Extensible Markup Language (XML): Introduction, Tree, Syntax, Elements, Attributes, Validation, Viewing. XHTML in brief.
Java Servlet: Servlet environment and role, HTML support, Servlet API, The servlet life cycle, Cookies and Sessions.

Module 3 [10L]
Advanced Java Server Side Programming: JSP: JSP architecture, JSP servers, JSP tags, understanding the layout in JSP, Declaring variables, methods in JSP, inserting java expression in JSP, processing request from user and generating dynamic response for the user, using include and forward action, Creating ODBC data source name, introduction to JDBC, prepared statement and callable statement. J2EE: An overview of J2EE web services.

Module 4 [8L]
Network Security: Threats: Malicious code-viruses, Trojan horses, worms; Active and Passive attacks: eavesdropping, spoofing, modification, denial of service attacks.
Network security techniques: Password and Authentication; VPN, IP Security, security in electronic transaction, Secure Socket Layer (SSL).
Firewall: Introduction, Packet filtering, Stateful, Application layer, Proxy.

3. Textbooks
1. Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, ASP.NET, XML and Ajax, Dreamtech Press; first edition.
2. Web Technologies, Godbole and Kahate, Tata McGraw-Hill Education.
3. Web Technologies: A Computer Science Perspective, Jeffrey C. Jackson, Pearson,2011.

4. Reference Books

1. Web Technology: A Developer's Perspective, N.P.Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013.
2. Internetworking Technologies, An Engineering Perspective, Rahul Banerjee, PHI Learning, Delhi, 2011.
3. Java Servlets and JSP, Murach's.
4. Java for the Web with Servlets, JSP, and EJB, Budi. Kurniawan.
5. Cryptography and Network security, William Stallings.

Course Name: Graph Algorithms					
Course Code: CSEN3134					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3134.1. Learn the advanced concepts and key features of Graph algorithms.
CSEN3134.2. Understand the algorithmic approach to Graph related problems.
CSEN3134.3. Explain and Analyse the major graph algorithms.
CSEN3134.4. Employ graphs to model engineering problems, when appropriate.
CSEN3134.5. Defend and argue the application of the specific algorithm to solve a given problem.
CSEN3134.6. Synthesize new algorithms that employ graph computations as key components, and Analyse them.

2. Detailed Syllabus

Module 1 [8L]

Connected components and transportation related graph problems: Representation of graphs, Sub graphs, Degree Sequences, Connectivity, Cut-Vertices and Bridges, Digraphs; Depth First Search. DFS for undirected graphs, non-separable components and directed graphs. Topological Sorting. Strongly connected components, Tarjan's algorithm for strongly connected components; Eulerian tours, Characterization. De Bruijn Sequences. Eulerian Digraphs ; Hamiltonian graphs and travelling salesman problem. Exponential-time dynamic programming for the TSP, approximation algorithms and the approximation ratio, MST-doubling heuristic, Christofides' heuristic.

Module 2 [10L]

Flow networks and Bipartite graphs: Max flow min cut theorem, max flow algorithms and their applications; Min cost max flow algorithm, their applications; Bipartite graphs, formulating bipartite maximum matching as a flow problem.
Matching and covering related graph problems: Matchings, stable marriage problem, Gale-Shapley algorithm for stable marriage problem; Hopcroft–Karp algorithm. Using matchings to find vertex covers and independent sets.

Module 3 [10L]

Graph Coloring, Planarity and longest path: Graph coloring, greedy coloring, Maximal clique; Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizing's theorem. Introduction to planarity of the graph, duality of the planar graph and max cut of the planar graph. Euler's formula, Kuratowski's theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces; Longest path Problem, hardness and heuristic for solution.

Module 4 [8L]

Random graphs and Selected topics: Random graphs and probabilistic methods; Dominating sets, the reconstruction problem, intersection graphs, interval graphs, perfect graphs, Chordal graphs; Maximum Clique-Minimum coloring problem in interval graph; Algorithms for independent set, clique and vertex coloring in Chordal graphs.

3. Textbooks

1. Graph Algorithms, Shimon Even and Guy Even, Cambridge University Press, 2nd Edition 2012.
2. Introduction to Graph Theory, Douglas B. west, Prentice Hall, 2001.
3. Graph Theory and Its Applications, Jonathan L. Gross and Jay Yellen.
4. Advanced graph algorithms, T. Kloks.

4. Reference Books

1. Graph Theory, R. Diestel, Springer-Verlag, 2nd edition, 2000.
2. Modern Graph Theory, Bela Bollobas, Springer, 1998.
3. Algorithm Design, Jon Kleinberg and Eva Tardos.

Course Name: Introduction to Data Analysis with Python and R					
Course Code: CSEN3135					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3135.1. Learn and understand the basics of the Python Programming Language.
CSEN3135.2. Learn about basic Python data structures.
CSEN3135.3. Learn about the NumPy and pandas libraries in Python.
CSEN3135.4. Learn and understand the basics of the R Programming Language.
CSEN3135.5. Learn about R data structures.
CSEN3135.6. Learn how to apply Python and R in building solutions to basic data analysis problems.

2. Detailed Syllabus

Module 1 [9L]

Data Science Introduction: Facets of data. The Big Data Ecosystem and Data Science. The Data Science Process. Retrieval, cleansing, integrating and transforming data. Exploratory Data Analysis. Data Visualization.
Introduction to Python: History of Python. Setting up the development environment. Variables, Expressions, Statements. Functions, Conditionals, Recursion, Iteration.
Data Organization: Files and Exceptions. Classes, objects, inheritances, Object Oriented Programming in Python.

Module 2 [9L]

Manipulating Strings: Regular Expressions in Python.
Python Data Structures: Lists, Tuples, Dictionaries, Sets.
Effective Python: Pythonic Thinking and Writing Better Pythonic Code.

Module 3 [9L]

Processing with NumPy: The Basics of NumPy Arrays. Array Indexing: Accessing Single Elements. Array Slicing: Accessing Subarrays. Reshaping of Arrays. Array Concatenation and Splitting. Computation on NumPy Arrays: Universal Functions. The Slowness of Loops. Aggregations: Min, Max, Summing the Values in an Array. Computation on Arrays: Broadcasting. Rules of Broadcasting.Comparisons, Masks, and Boolean Logic. Working with Boolean Arrays. Boolean Arrays as Masks. Fancy Indexing.
Data Manipulation with pandas: Introduction to pandas data structures. Series, Data frames, Index objects. Re-indexing, Selection, Filtering, Axis Indices, Summarizing, Handling missing data, Hierarchical Indexing.

Module 4 [9L]

R Programming Introduction: R UI, RStudio, Functions, Arguments, Scripts.
R Data Structures: Vectors, Attributes, Matrices, Arrays, Classes, Factors, Lists, Data Frames.
Computing with R: Using R Operations: Selection, Modification, Logical sub-setting.
Handling Missing Information, Conditionals, Scoping rules, Assignment, Evaluation, Loops: For, While, Repeat, Efficiency Issues. R Code: Debugging, Profiling, Simulations with R code.

3. Textbooks

1. Introduction to Programming Using Python, Y. Daniel Liang. Pearson, 2017.
2. Python for Data Analysis, Wes McKinney, O'Reilly, 2017.
3. Hands on Programming in R, Garrett Grolemund, O'Reilly.

4. Reference Books

1. Python for Everybody, Charles Severance, 2016.
2. Advanced R, Hadley Wickham. CRC Press, 2015.
3. R for Data Science, Hadley Wickham and Garrett Grolemund, 2017.
4. Introducing Data Science, D. Cielen, A. Meysman, M.Ali, Manning Publishers, 2018.
5. Effective Python, Brett Slatkin, Pearson, 2015.

B. PRACTICAL COURSES

Course Name: Database Management Systems Lab					
Course Code: CSEN3151					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3151.1. Learn to use Entity Relationship Diagram (ERD) model as a blueprint to develop the corresponding relational model in a RDBMS system like Oracle DBMS.

CSEN3151.2. Apply DDL component of Structured query language (SQL) to create a relational database from scratch through implementation of various constraints in Oracle RDBMS system.

CSEN3151.3. Apply DML component of Structured query language (SQL) for storing and modification of data in Oracle RDBMS system.

CSEN3151.4. Apply DQL component of Structured query language (SQL) to construct complex queries for efficient retrieval of data from existing database as per the user requirement specifications.

CSEN3151.5. Conceptualize and apply various P/L SQL concepts like cursor, trigger in creating database programs.

CSEN3151.6. Develop a fully-fledged database backend system using SQL and P/L SQL programming to establish overall integrity of the database system.

2. Detailed Syllabus

Creation of a database using a given ERD Model as blueprint:

SQL Data Definition Language - Create (and Alter) table structure, Apply (and Alter) constraints on columns/tables viz., primary key, foreign key, unique, not null, check. Verify/ Review the table structure (along with applied constraints) using appropriate data dictionary tables like user_constraints, user_cons_columns, etc. Create view, materialized view using one or more table.

SQL Data Manipulation Language - Insert into rows (once at a time/ and in bulk) from a table, Update existing rows of a table, Delete rows (a few or all rows) from a table.

Data Query Language (DQL):

Basic select-from-where structure - Usage of Top, Distinct, Null keywords in query, Using String and Arithmetic Expressions, Exploring Where Clause with various Operators and logical combination of various conditions, Sorting data using Order By clause. Usage of IN, LIKE, ALL keywords.

Introduction to Joins -Natural Joins, equi-join, non-equi-join, Self-Join, Inner Join, Outer (left, right) Join.

Set operations- Unions, Intersect, minus set operations on table data using SQL.

Using single row functions in Queries - NVL function (to handle ambiguity of null data), upper, lower, to_date, to_char functions, etc.

Using group/multiple row functions in Queries like Count, Sum, Min, Max, Avg, etc, using Group By and Having Clause, Using Group By with Rollup and Cube.

Sub-query - Working with various nested structure of Sub Queries - use in from or where clause with more than one level of nesting, correlated sub-query- Ranking table data using correlated sub-query.

P/L SQL:

Stored Procedures and Functions- Basic programming constructs of PL / SQL like if, else, else-if, loop, while, for structure Populate stored procedure variables with the data fetched from table using SQL command.

Working with Cursors - Creating Cursors, parameterized cursor, Locks on cursors, Exploring advantages of cursors.

Introduction to triggers - Constraints vs Triggers, Creating, Altering, Dropping triggers, use of for/ after/ instead of triggers, Using trigger to validate/ rollback a Transaction, Automatically populate integer data based primary key columns (e.g., Id.) using trigger**.**

3. Textbooks

1. Database System Concepts, Henry F. Korth and Silberschatz Abraham, Mc.Graw Hill.
2. Fundamentals of Database Systems, Elmasri Ramez and Novathe Shamkant, Benjamin Cummings Publishing Company.

4. Reference Books

1. SQL, PL/SQL: The Programming Language of Oracle (With CD-ROM) (English) 4th Revised Edition, Ivan Bayross, BPB Publications.

Course Name: Object Oriented Programming Lab					
Course Code: CSEN3153					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3153.1. Apply object-oriented principles or features in software design process to develop C++ and Java programs for real life applications.

CSEN3153.2. Reduce the complexity of procedural language by employing operator overloading, inheritance and exception handling techniques for developing robust and reusable software.

CSEN3153.3. Develop programs using stream classes for various I/O operations and design concurrent programs using threads to maximize the use of processing power.

CSEN3153.4. Design applications for text processing using String class and develop user interactive applications using event handling.

CSEN3153.5. Analyse the difference between two object-oriented programming languages C++ and Java.

2. Detailed Syllabus

Assignments on C++:

Day 1

1. Introduction to OOPs concepts, Difference between Structure and Class 2. Use of Constructor and Destructor

Day 2

1. Function overloading, Friend Function, Friend Class

Day 3

1. Operator Overloading without using friend function 2. Operator Overloading with using friend function

Day 4

1. Inheritance: Single, Multilevel, Multiple, Hybrid

Day 5

1. Virtual Base class, Virtual Function, Abstract Class

Day 6

1. Exception Handling 2. Templates and namespace

Assignments on Java:

Day 7

1. Understanding Java platform, compilation, and execution of a java program.
2. Implement class, object, constructor, methods, and other OOP features.

Day 8

1. Inheritance Basics, more uses of constructor, method overriding, use of final.

Day 9

1. Object class, practical use of abstract class.
2. Using Interface for achieving multiple inheritance, implementation of package.

Day 10

1. Exception handing fundamentals, java built-in exceptions, Use of Scanner class for console input, use of own Exception subclass.

Day 11

1. Java thread life cycle model and implementation approach, thread priority, implementation of synchronization.
2. I/O Basics, byte stream and character streams, reading and writing files.

Day 12

1. Applet life cycle implementation, text processing using Java predefined String, StringBuilder and StringBuffer classes.

Day 13

1. GUI basics and Window fundamentals, working with different Component, Container and Layout Managers.

Day 14

1. Event handling for interactive GUI application.

3. Textbooks

1. The C++ Programming Language, Stroustrup, Adisson Wesley.
2. Object Oriented Programming in C++, R. Lafore, SAMS.
3. Java 2.0 Complete Reference, H. Schildt, McGrawHill.

4. Reference Books

1. JAVA How to Program, Deitel and Deitel, Prentice Hall.
2. Programming with Java: A Primer, E. Balagurusamy – 3rd Ed. – TMH.

Course Name: Electronic Design Automation Lab					
Course Code: ECEN3156					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	2	2	1

1. Course Outcomes

After completion of the course, students will be able to:

ECEN3156.1. Learning Industry Standard Frontend and Synthesis CAD Tool (Xilinx Vivado).
ECEN3156.2. Learning Industry Standard Verilog RTL Behavioral and Structural Design.
ECEN3156.3. Learning Logic Synthesis and Place and Route using FPGA Flow.
ECEN3156.4. Learning Industry Standard Backend CAD Tool (Mentor Graphics).
ECEN3156.5. Designing CMOS Combinational Digital Gates
ECEN3156.6. Designing CMOS/TG Sequential Digital Gates.

2. Detailed Syllabus

List of Experiments:

1. Familiarities with Xilinx Vivado Front end and Synthesis CAD Tool
2. Verilog RTL Design and Testing of Digital Gates (INV, NAND, NOR, MUX, AOI, OAI …)
3. Verilog RTL Design and Testing of Functional Blocks (Adder, Decoder, ALU …)
4. Verilog RTL Design and Testing of Sequential Gates (Latch, Flop …)
5. Verilog RTL Structural Design and Testing of Functional Blocks
6. Verilog RTL Design and Testing for Finite State Machine (Mealy, Moore)
7. Logic Synthesis and P & R using Vivado for FPGA
8. Familiarity with Mentor Graphics Back end CAD Tool
9. CMOS Inverter, NAND, NOR Delay, VTC, Noise Analysis
10. CMOS/TG Sequential Design and Analysis

3. Textbooks

1. Principles of CMOS VLSI Design, A Systems Perspective, Neil Weste, Kamran Eshraghian, Addison Wesley, 2nd Edition.
2. Algorithms for VLSI Physical Design Automation, N. Sherwani, Kluwer Academic Publishers (3rd edition).

4. Reference Books

1. CMOS Digital Integrated Circuits, Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition).
2. CMOS VLSI Design, A Circuits and Systems Perspective (3rd Edition), Neil Weste, David Harris, Ayan Banerjee. Pearson.
3. Digital Integrated Circuit, Design Perspective, M. Rabaey, Prentice-Hall.
4. VLSI Design and EDA TOOLS, Angsuman Sarkar, Swapnadip De, Chandan Kumar Sarkar, Scitech Publications (India) Pvt. Ltd., 2011.
5. Algorithms for VLSI Design Automation, Gerez, Wiley, 2011.

C. HONORS COURSES

Course Name: Artificial Intelligence					
Course Code: CSEN3111					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3111.1. Remember and understand the basic principles of state-space representation of any given problem, various searching and learning algorithms, game playing techniques, logic theorem proving etc.
CSEN3111.2. Comprehend the importance of knowledge as far as intelligence is concerned and the fundamentals of knowledge representation and inference techniques.
CSEN3111.3. Apply this knowledge so that it can be used to infer new knowledge in both certain and uncertain environment
CSEN3111.4. Apply various AI searching algorithms, like state-space search algorithm, adversarial search algorithm, constraint satisfaction search algorithm as and when required.
CSEN3111.5. Understand the working knowledge of Prolog/ Lisp in order to write simple Prolog/ Lisp programs and explore more sophisticated Prolog/ Lisp code on their own.
CSEN3111.6. Design and evaluate the performance of a heuristic applied to a real-world situation.

2. Detailed Syllabus

Module 1 [9L]

Introduction: Definition of AI, Intelligent Behavior, Turing Test, Typical AI Problems, Various AI Approaches, Limits of AI.

Introduction to Intelligent Agents: Agents & environment, Agent Architecture, Agent Performance, Rational Agent, Nature of Environment, Simple Reflex Agent, Goal Based Agent, Utility Based Agent.

Knowledge Representation & Propositional Logic: Knowledge representation issues, Approaches to knowledge representation, Propositional Logic – its syntax & semantics, Inference rules, Resolution for propositions, Limitation of Propositional Logic.

Problem Solving using Single Agent Search: Introduction to State-space search, state-space search notation, search problem, Formulation of some classical AI problems as a state space search problem, Explicit Vs. Implicit State space.

Uninformed Search Techniques: Basic Principles, Evaluating parameters, BFS, DFS, Depth Limited Search, Iterative Deepening DFS, Uniform Cost Search & Bidirectional Search, Properties of various search methods & their comparative studies.

Module 2 [9L]

Informed Search Methods: Basic Principles, Heuristics, A* Search and its properties, Admissible & Consistent heuristic, Iterative deepening A* (IDA*) and AO* search, Local Search Techniques – Hill climbing & Simulated Annealing, Comparison with other methods

Problem Solving using Two Agent Search: Adversarial Search – Game Tree, MINIMAX Algorithm, Alpha-Beta Pruning, Performance Analysis.

Constraint Satisfaction Problem: Definition of CSP, Representation of CSP, Formulation of Various popular problems as CSP, Solution methods of CSP – Backtracking & Forward Checking.

Module 3 [9L]

Knowledge Representation & Predicate Logic: Syntax & Semantics of FOPL, Representation of facts using FOPL, Clauses, Resolution, Unification methods of inference, Default & Non-Monotonic reasoning.

Knowledge Representation using Rules: Rule based system, Horn clauses, Procedural vs. declarative knowledge, forward & backward reasoning, Introduction of logic programming using PROLOG/ LISP.

Probabilistic reasoning: Representing knowledge in an uncertain domain, probabilistic inference rules, Bayesian networks – representation & syntax, semantics of Bayesian net, Brief discussion on Fuzzy sets & fuzzy logic.

Other Representational Formalism: Inheritable knowledge, Semantic network, Inference in Semantic network, Extending Semantic Network, Frames, Slots as objects.

Module 4 [9L]

Planning: Introduction, Simple planning agent, Problem solving vs. planning, Logic based planning, Goal Stack planning, Planning as a search, Total-order vs. partial order planning.

Learning: Overview, Taxonomy of learning system, various learning models, learning rules, Naïve Bayes classifier and Decision tree based learning, Brief idea about learning using Neural Network & Genetic Algorithm.

Natural Language Processing: Introduction, Syntactic processing, semantic analysis, discourse & pragmatic processing.

Expert Systems: Representing and using domain knowledge, expert system shells, and knowledge acquisition.

3. Textbooks

1. Artificial Intelligence: A Modern Approach, Stuart Russell & Peter Norvig, Pearson Education.
2. Artificial Intelligence, Rich & Knight, TMH.

4. Reference Books

1. Artificial Intelligence & Intelligent Systems, N.P Padhy, Oxford University Press.
2. Introduction to Artificial Intelligence & Expert Systems, Dan W. Patterson, PHI.
3. Artificial Intelligence: A new Synthesis, Nils J. Nilsson, Morgan Kaufmann Publishers, Inc.
4. PROLOG Programming for Artificial Intelligence, Ivan Bratko, Pearson India.

Course Name: Artificial Intelligence Lab					
Course Code: CSEN3161					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**2**	**2**	**1**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3161.1. Remember and understand the working principles of PROLOG/ LISP
CSEN3161.2. Apply LIST structure of PROLOG as and when required
CSEN3161.3. Make use of CUT to the programs as and when required
CSEN3161.4. Solve the problems by using accumulator
CSEN3161.5. Apply the principles of reasoning and inference to real world problems
CSEN3161.6. Design programs to solve various puzzles.

2. Detailed Syllabus

In this laboratory students will be familiarized with PROLOG/ LISP language. A tentative outline is given below:

1. Introduction to PROLOG facts & rules with the help of a simple family tree; how the goals are given in PROLOG; some simple queries on the family tree
2. Formation of recursive definition; how PROLOG executes the goals; simple assignments
3. How PROLOG deals with problems with numbers – integers, real; with some examples
4. Introduction to LIST structure; how PROLOG implements LIST; some simple assignments on LIST.
5. Some more complex assignments on LIST; Introduction of Accumulators – simple assignments
6. Introduction to CUT with simple assignments; implementation of Sorting algorithms
7. PROLOG clauses for file operation – with simple assignments
8. Implementation of Graph Search algorithms like DFS, BFS; Some application of DFS & BFS
9. Implementation of some well-known puzzles, like 8-queens problem, Towers-of-Hanoi problem, Missionaries & Cannibals problem etc.
10. Introduction to LISP
11. Some simple assignments on LISP.

3. Textbooks

1. PROLOG Programming for Artificial Intelligence, Ivan Bratko, Pearson India.

4. Reference Books

1. Logic and Prolog Programming, Saroj Kaushik, New Age International Publishers.

Syllabus of 6th Semester

A. THEORY COURSES

Course Name: Software Engineering					
Course Code: CSEN3201					
Contact Hours per week:	L	T	P	Total	Credit points
	4	0	0	4	4

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3201.1. Prepare software requirement specifications as per IEEE guidelines.
CSEN3201.2. Model function-oriented and object-oriented software systems using industry standard techniques (e.g. DFD, ERD, UML).
CSEN3201.3. approach Testing of software systems in a methodical manner.
CSEN3201.4. Estimate software size using industry-standard methods (e.g. FPA).
CSEN3201.5. Work out software project schedule and staffing plan.
CSEN3201.6. Identify software project risks and their mitigation approach.

2. Detailed Syllabus

Module 1 [12L]

Introduction to Software Engineering: Software Engineering – objectives and definitions, Software Life Cycle – different phases, Lifecycle Models - Waterfall, Relaxed Waterfall, RAD, Prototyping, Incremental, Spiral.
Modern Software Engineering practices: Agile: Values and Principles, Philosophy, Agile vs. Waterfall, Methods and Practices of Agile, Pitfalls of Agile methodology, Scrum: Roles, Workflow: Sprint, Daily Scrum, Sprint review etc., Limitations of scrum, Extreme Programming: Principles, Guidelines, Activities, Values, Practices, Introduction to DevOps and SEMAT.
Requirements Analysis and Specification Phase: Requirements Collection and Analysis, Requirement Specifications – General Structure of Software Requirement Specifications (SRS), Functional and Non-functional Requirements, Representing Requirements as Use Cases with examples.
Structured Analysis Modeling Techniques: Process Model using Context Diagrams (CD) and Data Flow Diagram (DFD) with examples, Data Dictionary, Decision Tree, Decision Table with examples, Data Model using Entity Relationship Diagram (ERD) with examples.

Module 2 [12L]

Design Phase: Overview – Comparison between Requirement Analysis and Design, Attributes of Good Design, Design Approaches – Functional and Object Oriented Design approaches, Design Aspects – Top-Down and Bottom-Up, Structured Design – Module Design (or High Level Design), Detail Design (or Low Level Design), Functional Decomposition – Abstraction, Structure Chart, Structured English, Design Issues – Cohesion, Coupling.
Object Oriented Analysis and Design: OOAD Basic Concepts, Unified Modeling Language (UML) – different types of diagrams for different views of system, User View – Use Case Diagram with examples, Structural Views – Class Diagram with examples, Behavioral View – Sequence, Collaboration, Activity and State Chart Diagrams with examples.

Module 3 [12L]

Coding or Programming: Programming Principles and Guidelines – Structured Programming, Code Re-use, Coding Standards / Guidelines, Coding Process – Incremental Coding, Test Driven Development, Pair Programming / Extreme Programming Source Code Version Control, Build, Code Refactoring.
Review and Testing: Self Review / Peer Review, Testing Overview-- Objective, Definition, Static and Dynamic Testing, Functional vs. Non-functional Testing, Testing Artifacts – Test Cases and Test Suites, Traceability Matrix, Test Data, Stub and Driver, Testing Process – Test Case Design, Test Case Execution, Test Result, Defect Logging and Tracking, Testing Methods -- White Box Testing with Test Coverage using Control Flow Graph (CFG) and Cyclomatic Complexity, Black Box Testing with Equivalence Class Partitioning and Boundary Value Analysis, Testing Level – Unit Testing, Integration Testing, System Testing, (User) Acceptance Testing, Regression Testing, Performance Testing, Usability Testing, Non-functional Testing.

Module 4 [12L]

Software Maintenance: Types of Maintenance – Corrective, Preventive, Adaptive Change Management and Maintenance Process models, Estimation of maintenance cost.
Software Estimation: Overview of Software Estimation – Size, Effort, Duration and Cost
Size Estimation Methods – Lines of Code (LOC) and Function Points (FP) Estimation of Effort and Duration based on Size and Productivity, Constructive Cost Model (COCOMO) – Basic COCOMO, Intermediate COCOMO (COCOMO 81), Detailed COCOMO (COCOMO II).

Project Management: Project Management Overview - Planning, Staffing, Execution, Monitoring and Control Responsibilities of Project Manager, Project Scheduling – Work Breakdown Structure (WBS) and Activity network, Gantt Charts, PERT chart, Determining the Critical Path.
Configuration Management: Overview of Configuration Management, Software Configuration Management tasks: Identification, Change Control, Version Control, Auditing, Concept of Baseline, Versioning of Configurable Items (CI).

3. Textbooks
1. Software Engineering: A Practitioners Approach, 5th Ed, R. S. Pressman, McGraw-Hill, 2001.
2. Software Engineering, 7th Ed, Sommerville, Addison-Wesley, 2005.

4. Reference Books
1. Software Engineering: A Precise Approach, 3rd Edition, Pankaj Jalote, 2013.
2. Fundamentals of Software Engineering, 3rd Edition, Rajib Mall, 2013.
3. Fundamentals of Software Engineering, 2nd Ed, C. Ghezzi, M. Jazayeri and D. Mandrioli, Prentice Hall of India, 2003.

Course Name: Computer Networks					
Course Code: CSEN3202					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	4	**0**	**0**	**4**	**4**

1. Course Outcomes
After completion of the course, students will be able to:
- **CSEN3202.1.** Learn the terminology and concepts of the OSI reference model, TCP- IP reference model and the need for the layered architecture.
- **CSEN3202.2.** Understand the concepts of protocols, network interfaces, and design/performance issues in local area networks and wide area networks
- **CSEN3202.3.** Analyse the requirements for a given organizational structure and select the most appropriate networking architecture and technologies
- **CSEN3202.4.** Demonstrate various types of routing techniques
- **CSEN3202.5.** Defend and argue the various quality of service measures to improve network throughput.
- **CSEN3202.6.** Synthesize the strength and shortcomings of the underlying protocols, and then go on to hypothesize new and better application layer protocols.

2. Detailed Syllabus
Module 1 [10L]
Introduction: Direction of data flow (simplex, half duplex, full duplex), Network topology, categories of network (LAN, MAN, WAN).
Protocols and standards: Reference models: OSI reference model, TCP/IP reference model, their comparative study
Physical Layer: Digital signal coding, Modulation (Digital and Analog), Multiplexing, Switching, Telephone Networks, Transmission Media and its properties**.**

Module 2 [13L]
Data link layer: Framing / Stuffing, Error detection and correction.
Flow Control Protocols: Stop-and-Wait / Go-Back-N / Selective Repeat; HDLC, PPP.
MAC sub-layer: Ethernet (IEEE 802.3): ALOHA / CSMA-CD / Collision Resolution, Controlled Access and Channelization methods.
Devices: Transparent Bridges / Source-Route Bridges / Ethernet Switches; Backward Learning Algorithm; Construction of Spanning Trees; Routers.

Module 3 [10L]
IPv4: Packet format; Classfull addressing / sub-netting / subnet mask; CIDR / super-netting / masks.
IPv6: address format / packet format / differences with IP (v4).
Protocols: IP, ICMP, ARP.
Routing algorithm: concept of static and dynamic routing, Distance vector / Link state algorithm.
Protocols: OSPF, BGP.

Module 4 [10L]
Transport Layer: Process to process delivery / multiplexing and other services of transport layer.
Transport Layer protocols: TCP: Three-way handshaking, Window management, Flow and congestion control with slow start, additive increase, multiplicative decrease; UDP; Difference between UDP and TCP.
General Congestion control algorithm: open and closed loop; Techniques to improve: QoS Leaky bucket / Token bucket.
Modern Topics: Introduction to wireless LAN and Bluetooth, Mobile IP, Mobile TCP.

3. Textbooks

1. Computer Networks, Andrew S. Tanenbaum, Pearson Education, Fourth edition.
2. Data and Computer Communication, William Stallings, Prentice hall, Seventh edition.
3. High speed Networks and Internets, William Stallings, Pearson education, Second edition.

4. Reference Books

1. Cryptography and Network security, William Stallings, PHI, Third edition.
2. ISDN and Broadband ISDN with Frame Relay and ATM, William Stallings.
3. Computer Networking: A Top Down Approach, 5th Ed., Kurose & Ross.

Course Name: Economics for Engineers					
Course Code: HMTS3201					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

HMTS3201.1. Evaluate a project and estimate the total cost of the project

HMTS3201.2. Apply financial analytical methodologies to prepare a report regarding the financial performance of an organization

HMTS3201.3. Participate actively in an organization's capital budgeting process

HMTS3201.4. Provide vital inputs regarding the pricing of a product

HMTS3201.5. Apply the knowledge of the interplay of various economic variables and indicators in workplace

HMTS3201.6. Provide insight about different accounting concepts and apply broader concepts like costs, revenues, assets, liabilities, capital, profit, investment and interest.

2. Detailed Syllabus

Module 1 [8L]

Market: Meaning of Market, Types of Market, Perfect Competition, Monopoly, Monopolistic and Oligopoly market.
The basic concept of economics – needs, wants, utility.
National Income-GDP, GNP. Demand & Supply, Law of demand, Role of demand and supply in price determination, Price Elasticity.
Inflation: meaning, reasons, etc.

Module 2 [8L]

Business: Types of business, Proprietorship, Partnership, Joint-stock company, and cooperative society – their characteristics.
Banking: role of commercial banks; credit and its importance in industrial functioning.
Role of central bank: Reserve Bank of India.
International Business or Trade Environment.

Module 3 [12L]

Financial Accounting-Journals. Ledgers, Trial Balance, Profit & Loss Account, Balance Sheet.
Financial Statement Analysis (Ratio and Cash Flow analysis).
Cost Accounting- Terminology, Fixed, Variable and Semi-variable costs.
Break Even Analysis. Cost Sheet. Budgeting and Variance Analysis.
Marginal Cost based decisions.

Module 4 [8L]

Time Value of Money: Present and Future Value, Annuity, Perpetuity.
Equity and Debt, Cost of Capital.
Capital Budgeting: Methods of project appraisal - average rate of return - payback period - discounted cash flow method: net present value, benefit cost ratio, internal rate of return.
Depreciation and its types, Replacement Analysis, Sensitivity Analysis.

3. Reference Books

1. Financial Accounting- A Managerial Perspective, R. Narayanswami, Prentice-Hall of India Private Limited. New Delhi
2. Fundamentals of Financial Management, Horne, James C Van, Prentice-Hall of India Private Limited, New Delhi
3. Modern Economic Theory, H. L. Ahuja., S. Chand. New Delhi.
4. Engineering Economic Analysis, Newman, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P., New York: Oxford University Press. 2012.

LIST OF COURSES FOR PROFESSIONAL ELECTIVE-II

Paper Code	Paper Name
CSEN3231	Advanced Operating System
CSEN3232	Enterprise Application in Java EE
CSEN3233	Machine Learning
CSEN3234	Computational Geometry
CSEN3235	Cloud Computing

Course Name: Advanced Operating System					
Course Code: CSEN3231					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3231.1. Describe operating system structures and communication protocols.

CSEN3231.2. Understand key mechanisms and models for distributed systems including logical clocks, causality, vector timestamps, distributed hash tables, consistent global states, election algorithms, distributed mutual exclusion, consistency, replication, fault tolerance, distributed deadlocks, recovery, agreement protocols

CSEN3231.3. Learn how to design and implement distributed algorithms.

CSEN3231.4. Understand the high-level structure distributed file systems.

CSEN3231.5. Design various areas of research in distributed systems.

CSEN3231.6. Understand the basic concepts of real time operating system.

2. Detailed Syllabus

Module 1 [9L]

Introduction to Distributed System: Introduction, Examples of distributed system, Resource sharing, Challenges

Operating System Structures: Review of structures: monolithic kernel, layered systems, virtual machines. Process based models and client server architecture; The micro-kernel based client-server approach.

Communication: Inter-process communication, Remote Procedure Call, Remote Object Invocation, Tasks and Threads. Examples from LINUX, Solaris 2 and Windows NT.

Module 2 [9L]

Theoretical Foundations: Introduction. Inherent Limitations of distributed Systems. Lamport's Logical clock. Global State: Chandy, Lamport's Global State Recording Algorithm.

Distributed Mutual Exclusion: Classification of distributed mutual exclusion algorithm. Non-Token based Algorithm: Lamport's algorithm, Ricart-Agrawala algorithm. Token based Algorithm: Suzuki-Kasami's broadcast algorithm. A comparative performance analysis of different algorithms w.r.t Response time, Synchronoization delay, Message traffic, Universal performance bound.

Distributed Deadlock Detection: Deadlock handling strategies in distributed systems. Control organizations for distributed deadlock detection. Centralized and Distributed deadlock detection algorithms: Completely Centralized algorithms, path pushing, edge chasing, global state detection algorithm.

Module 3 [9L]

Distributed file systems: Issues in the design of distributed file systems: naming, writing policy, Cache consistency, Availability, Scalability and Semantics. Use of the Virtual File System layer. Case Studies: Sun NFS, The Sprite File System, CODA, The x-Kernel Logical File System.

Distributed Shared Memory: Architecture and motivations. Algorithms for implementing DSM: The Central-Server Algorithm, The Migration Algorithm, The Read-Replication Algorithm, The Full-Replication Algorithm. Memory Coherence. Case Studies: IVY, Clouds.

Distributed Scheduling: Issues in Load Distributing: Load, Classification of Load Distribution, Load Balancing vs Load Sharing, Preemptive vs Non-preemptive; Components of a load distribution; Stability.

Module 4 [9L]

Real Time operating Systems: Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, Definition and types of RTOS; A reference model of Real Time System- Processors, Resources, Temporal parameters, Periodic Task; Aperiodic Task, Sporadic Task; Commonly used approaches to Real Time Scheduling - Clock driven, event driven, Priority based scheduling- Inter-process communication mechanisms – Evaluating

operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE.

3. Textbooks

1. Advanced Concepts in Operating Systems, Singhal Mukesh & Shivaratri N. G., TMH.
2. Distributed Operating Systems, Tanenbaum, A. S., Prentice Hall India.
3. Distributed Operating Systems Concepts and Design, Pradeep K. Sinha, Prentice Hall India.
4. Real-Time Systems, Jane W. S. Liu, Pearson Education.

4. Reference Books

1. Distributed Systems Principles and Paradigms, Andrew S. Tanenbaum and Maarten Van Steen, PHI.
2. Modern Operating Systems, 2ndEdition Tanenbaum, A. S., Prentice Hall 2001.
3. Concurrent Systems, 2nd Edition, Bacon, J., Addison Wesley 1998.
4. Applied Operating Systems Concepts, 1st Edition, Silberschatz, A., Galvin, P. and Gagne, G., Wiley 2000.
5. Distributed Systems: Concepts and Design, 3rd Edition, Coulouris, G. et al, Addison Wesley 2001.

Course Name: Enterprise Application in Java EE					
Course Code: CSEN3232					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3232.1. Identify the basic needs and application of server-based technology like JEE.
CSEN3232.2. Understand the various components available in JEE and their applicability in MVC pattern.
CSEN3232.3. Handling RDBMS using JDBC and JPA in JEE.
CSEN3232.4. Understand various data interchange formats and using XML for data exchange.
CSEN3232.5. Understand and using JEE components in distributed environment.
CSEN3232.6. Developing an enterprise wide web application using components of JEE.

2. Detailed Syllabus

Module 1 [8L]

Client & server-side programming.
Enterprise architecture styles: Single tier, 2-tier, 3-tier, n-tier; Relative comparison of the different layers of architectures. MVC Architecture: Explanation, Need, Drawbacks.
Overview of JEE, Different components & containers.
Overview of Java servlets, Servlet process flow/ Architecture, Understanding Servlet life cycle, Other important objects and methods in Servlet API, Servlet Vs CGI, Developing servlet using IDE.
Short introduction of JSP, Comparison between JSP & servlet.
XML Overview, Different types of XML Parsing, XML Schema, How To use XSD, Namespace, Declaring and Applying Namespaces.

Module 2 [10L]

Java Server Faces: Introduction, Benefits of Java Server Faces, Design goals and Features of JSF, JSF Application Structure, Understanding the JSF Request Processing Lifecycle.
Getting started JSF application using IDE (Netbeans), The key pieces of the JSF pie, Managed beans, JSF User Interface Component Model, Usages of JSF UI Components/tags (form, outputText, inputText, commandButton, inputSecret, commandLink, graphicImage, message, messages, dataTable, column, panelGrid, panelGroup, selectOneListbox, selectBooleanCheckbox, selectOneRadio etc.), Exploring the JSF expression language, Standard and custom validation and converter , Value Binding, Method Binding, FacesContext, FacesMessage, Event Handling.
Navigation model example, Introduction to Facelets, Creating Facelets Views and Mapping Faces Servlet, Facelets Templates, JSF Composite Components, JSF Web Resources, Using HTML5-Friendly Markup in JSF.

Module 3 [10L]

EJB: Introduction, Comparison of EJB & Java Beans, Applications, Drawbacks, Different types of enterprise beans, Services provided by EJB container.
JDBC: Introduction, Database driver, Different approaches to connect an application to a database server,
Establishing a database connection and executing SQL statements, JDBC prepared statements, JDBC data Sources, Developing CRUD operation in JSF application and plain Java Application using JDBC**.**

Module 4 [8L]
Java Persistence API: Overview, Important terms and annotations related to JPA, Java Persistence Query Language, Creating Queries in JPQL, JPQL Static and Dynamic Query Example, JPA JPQL Bulk Data Operations, Using JPA from Web application using JSF, Using JPA in a Java application.
Introduction to Web Services and RestFull Web Services, Differences, Advantages and Disadvantages, RESTful Key Elements, Important annotation of JAX-RS, Developing RESTful Web Services with JAX-RS, Database access using JPA and RestFull Service, Accessing RestFull Service from Java application and Web application using JSF.

3. Textbooks
1. Professional JAVA Server Programming, Allamaraju and Buest, SPD Publication.
2. Beginning J2EE 1.4 Ivor Horton, SPD Publication.
3. Advanced Programming for JAVA 2 Platform Austin and Pawlan, Pearson.

4. Reference Books
1. Internet & Java Programming, Krishnamoorthy & S. Prabhu, New Age Publication.
2. Online resources from reputed sites like Oracle Doc, TutorialPoint, Guru 99, Java Code.
3. Geek, Vogella.com etc.

Course Name: Machine Learning					
Course Code: CSEN3233					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes
After completion of the course, students will be able to:
CSEN3233.1. Learn and understand the basics of machine learning approaches and paradigm.
CSEN3233.2. Understand and describe various machine learning algorithms.
CSEN3233.3. Understand complexity of Machine Learning algorithms and their limitations.
CSEN3233.4. Mathematically Analyse various machine learning approaches and paradigms
CSEN3233.5. Analyse various machine learning techniques to get an insight of when to apply a particular machine learning approach.
CSEN3233.6. Apply common Machine Learning algorithms in practice and implementing their own using real-world data.

2. Detailed Syllabus
Module 1 [9L]
The learning Problem: Example of learning, Components of learning, A simple model, Types of learning;
The Linear Model I: Input Representation, Linear Classification, Linear and Logistic Regression, Nonlinear Transformation.

Module 2 [9L]
Error and Noise; **Training vs Testing:** From Training to Testing, Dichotomies, Growth Function, key notion: Break Points;
The VC Dimension: The definition, VC Dimension of Perceptrons, Interpreting the VC Dimension, Utility of VC Dimension.
Bias-Variance Tradeoff: Bias and Variance, Learning Curves.

Module 3 [10L]
The linear Model II: Logistic Regression, Nonlinear Transformation, Likelihood measure, Gradient Descent;
Neural Networks: Neural Network Model, Backpropagation algorithm; Introduction to Radial Basis Function, Recurrent Neural Network, Convolution Neural Network and Deep Neural Network**.**

Module 4 [9L]
Support Vector Machines (SVM): The Margin, Maximizing the Margin, The solution, Support Vectors, Nonlinear Transform; Kernel Methods: The Kernel methods, Soft-margin SVM; Overfitting: What is overfitting? Dealing with overfitting; Regularization: Regularization - informal, Regularization – formal, Weight decay, Choosing a regularizer.

3. Textbooks
1. Learning from Data - A short Course, Y. S. Abu-Mostafa, M. Magdon-Ismail, H. T. Lin, AMLbook.com.
2. Computational Intelligence Principles, Techniques and Applications, Konar, Springer, 2012.
3. Machine Learning, First Edition, T. Mitchell, McGraw-Hill, 1997.

4. Reference Books
1. Neural Networks and Learning Machines, Third Edition, S. Haykin, PHI Learning, 2009.
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2010.
3. Deep Learning, Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, MIT Press, 2017.

Course Name: Computational Geometry					
Course Code: CSEN3234					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3234.1. Learn and understand the common algorithms for solving well-known geometric problems.
CSEN3234.2. Learn and understand the common data structures for efficient storage and querying of geometric data.
CSEN3234.3. Identify problems where algorithms for existing geometric problems can be useful.
CSEN3234.4. Learn standard techniques for designing algorithms and data structures for geometric problems.
CSEN3234.5. Develop algorithms and data structures for simple geometric problems.
CSEN3234.6. Implement geometric algorithms.

2. Detailed Syllabus

Module 1 [9L]

Preliminaries: Introduction, Applications, Plane Sweep paradigm and applications. Line Segment Intersection, Intersections amongst orthogonal segments, Bentley-Ottoman algorithm, Red-Blue segment intersections. Finding Maximal Points.
Convex Hull: Different Paradigms: Convex Hulls. Properties. Graham's Scan, Jarvis' March (Gift Wrapping), Quick Hull, Divide and Conquer algorithm (Preparata-Hong), Chan's Algorithm, Randomized Incremental Construction.

Module 2 [10L]

Point Location and Triangulation: Planar Point Location, Polygon Partitioning and Triangulation, Kirkpatrick's method, Trapezoidal Decompositions, Persistent Data Structures.
Voronoi Diagram and Delaunay Triangulation: Closest Pairs. Bi-chromatic Closest Pairs, Fortune's sweep Algorithm, Delaunay triangulations.

Module 3 [9L]

Range Searching: Introduction, Orthogonal Range searching, Priority Search Trees, kd-trees, Range Trees, Interval Trees, Segment Trees.
Non - Orthogonal Range Searching, Half - Plane Range Searching, Simplex Range Searching, Partition Trees, Cuttings, Adding Range Restrictions. Colored Range Searching.
Visibility Problems: Visibility Problems, Polygons and Art Gallery Theorems.

Module 4 [9L]

Arrangements and Duality: Arrangements. Construction. Complexity. Zone Theorem. Levels in an Arrangement. Davenport Schinzel sequences and geometric applications. Complexity of lower and upper envelopes. Duality transformations.
Geometric Optimization: Parametric search and application to geometric optimization.
Geometric Approximation: Dudley's theorem and applications, well-separated pair decompositions and geometric spanners, VC dimension, epsilon-nets and epsilon-approximations**.**

3. Textbooks

1. Computational Geometry: Algorithms and Applications (2nd Edition), M. de Berg, M. van Kreveld, M. Overmars, O. Schwarzkopf, Springer-Verlag, 2000.
2. Computational Geometry, F. Preparata and M. Shamos, Springer-Verlag, 1985
3. Computational Geometry: An Introduction Trough Randomized Algorithms, K. Mulmuley, Prentice-Hall, 1994.

4. Reference Books

1. Discrete and Computational Geometry, S. L. Devadoss and J. O'Rourke, 2011
2. Computational Geometry Lecture Notes, David M. Mount, Department of Computer Science, University of Maryland.

Course Name: Cloud Computing					
Course Code: CSEN3235					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3235.1. Appreciate the benefits and limitations of cloud-based computing environments.
CSEN3235.2. Understand the underlying principles of cloud virtualization, cloud storage, cloud security.
CSEN3235.3. Analyze the suitability and/or applicability of various cloud computing models, platforms, services, solution offerings and tools from some industry leaders.
CSEN3235.4. Gain insight into various distributed computing issues (like performance, scalability, availability, reliability) in light of distributed file systems (such as HDFS, GFS).
CSEN3235.5. Identify security and privacy issues in cloud computing.
CSEN3235.6. Apply Knowledge to provide solution for real life problems.

2. Detailed Syllabus

Module 1 [7L]

Basics of Cloud Computing: Defining a Cloud, Cloud Types – NIST Cloud Reference Model, Cloud Cube Model, Deployment Models – Public, Private, Hybrid, and Community Clouds, Service Models – Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), Characteristics of Cloud Computing, Benefits and Limitations of Cloud Computing.

Module 2 [10L]

Cloud Services and/or Applications: IaaS – Basic Concept and Characteristics, Virtual Machine Instances / Images, examples of IaaS solutions, PaaS – Basic Concept and Characteristics, Tools and Development Environment with examples, SaaS – Basic Concept and Characteristics, Open SaaS and SOA, examples of SaaS solutions, Identity as a Service (IDaaS)**.**

Module 3 [10L]

Cloud Solution Offerings: Concepts of Abstraction and Virtualization; Virtualization: Taxonomy of Virtualization Techniques; Hypervisors: Machine Reference Model for Virtualization.
Solution Offerings from Industry Leaders; Amazon: some AWS Components and Services – Compute (EC2), Storage [Simple Storage Service (S3), Elastic Block Store (EBS), Simple Queue Service (SQS)], Database (Relational, NoSQL, SimpleDB), Content Distribution (CloudFront), Deployment (Elastic Beanstalk)
Google: quick look at Google Applications Portfolio – AdWords, Analytics, overview of GWT, a few Google APIs, some key services of GAE.

Module 4 [9L]

Cloud Storage and Security: Cloud-based Storage: Block Devices and File Devices, Managed Storage and Unmanaged Storage, File Systems – GFS and HDFS.
Cloud Security: Security Concerns, Security Boundary, Security Service Boundary, Security Mapping Overview, Data Security – Storage Access, Storage Location, Tenancy, Encryption, Auditing, Compliance, Identity Management (awareness of Identity Protocol Standards)**.**

3. Textbooks

1. Cloud Computing Bible, Barrie Sosinsky, Wiley India Pvt. Ltd, 2012.
2. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill, 2013.
3. Cloud Computing: Theory and Practice, Dan Marinescu, Morgan Kaufmann, 2014.
4. Cloud Computing: A Hands-on Approach, A Bahga and V Madisetti, 2014.
5. Cloud Computing: A Practical Approach for Learning and Implementation, A Srinivasan and J Suresh, Pearson, 2014.
6. Cloud Computing, U S Pande and Kavita Choudhary, S Chand, 2014.
7. Cloud Computing for Dummies, J Hurwitz, M Kaufman, F Halper, R Bloor, John Wiley & Sons, 2014.
8. Cloud Computing, Kris Jamsa, Jones & Bartlett Learning, 2015.

4. Reference Books

1. The NIST Definition of Cloud Computing: Recommendations of the National Institute of Standards and Technology, Peter Mell and Timothy Grance, National Institute of Standards and Technology Special Publication 800-145, 2011.
2. Introduction to Cloud Computing Architecture: White Paper (1st Edition), Sun Microsystems Inc., 2009.
3. A Survey on Open-source Cloud Computing Solutions, Patrícia Takako Endo, Glauco Estácio Gonçalves, Judith Kelner, Djamel Sadok, VIII Workshop on Clouds, Grids and Applications at UFPE, Brazil.

4. GFS: Evolution on Fast-Forward – Kirk McKusick (BSD/BFFs) interviews Sean Quinlan (former GFS Tech Leader), CACM, 2009-2010.
5. The Google File System (GFS), Sanjay Ghemawat, Howard Gobioff, Shun-Tak Leung, 2011.
6. The Hadoop Distributed File System: Architecture and Design, Dhruba Borthakur, Apache Software Foundation, 2007.

Course Name: Big Data					
Course Code: CSEN3236					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:
CSEN3236.1. Develop understanding of the MapReduce paradigm.
CSEN3236.2. Solve Matrix-Vector problems using the MapReduce paradigm.
CSEN3236.3. Solve Relational Algebra operations using the MapReduce paradigm.
CSEN3236.4. Solve basic algorithmic problems in Graph Theory using the MapReduce paradigm.
CSEN3236.5. Solve problems in Text Processing using the MapReduce paradigm.
CSEN3236.6. Implement MapReduce solutions using the Hadoop framework.

2. Detailed Syllabus

Module 1 [9L]
Introduction: Big Data Analysis. The new software stack. Distributed file system. Physical organization of compute nodes. Large-scale file system organization; Introduction to the MapReduce paradigm. Map tasks. Grouping by keys. Reduce tasks. Combiners. Details of MapReduce execution. Coping with node failures; Basic MapReduce Algorithm Design Local Aggregation. Pairs and Stripes. Computing Relative Frequencies. Secondary Sorting.

Module 2 [9L]
Matrix and Relational Algebra Operations Using MapReduce: Matrix-Vector Multiplication by MapReduce. Case of large vectors. Matrix Multiplication using cascade of two MapReduce operations. Single pass matrix multiplication; Relational-Algebra Operations. Computing Selections by MapReduce. Computing Projections by MapReduce. Union, Intersection, and Difference by MapReduce. Computing Natural Join by MapReduce. Grouping and Aggregation by MapReduce.

Module 3 [9L]
Advanced Processing using MapReduce: Graph Algorithms using MapReduce: Shortest Paths, Friends-of-Friends. PageRank computation in MapReduce. Parallel Breadth First Search. Issues in Graph Processing; Text Processing Using MapReduce. EM Algorithms. Hidden Markov Models. Viterbi, Forward and Backward Algorithms. HMM Training in MapReduce. Word Alignment with MapReduce; Design Patterns using MapReduce. Summarization patterns, Filtering patterns, Data organization patterns, Join Patterns, Meta patterns, Input output patterns.

Module 4 [9L]
Big Data Solution Frameworks: Starting Hadoop. Components of Hadoop. HDFS. Working with files in HDFS. MapReduce using Hadoop. Streaming in Hadoop. Advanced MapReduce: Chaining MapReduce jobs, Joining data from different sources. MapReduce programs in local mode and pseudo-distributed mode. Moving data into and out of Hadoop. Applying MapReduce patterns to Big Data. Streamlining HDFS for Big Data.
The Hadoop Ecosystem. Pig, Hive, HBase, Sqoop, Zookeeper, Flume, Oozie, Avro.
Fast Big Data Processing with Apache Spark.

3. Textbooks

1. Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeff Ullman. Cambridge University Press. 2011.
2. Hadoop – The Definitive Guide, Tom White. 4th Edition, 2015.
3. Data-Intensive Text Processing with MapReduce, Jimmy Lin and Chris Dyer. Morgan and Claypool Publishers. 2010.

4. Reference Books

1. Hadoop in Action, Chuck Lam. Manning Publishers. 2011.
2. Hadoop in Practice, Alex Holmes. Manning Publishers. 2012.
MapReduce Design Patterns, Donald Miner and Adam Shook. O'Reilly, 2012.

LIST OF COURSES FOR OPEN ELECTIVE-I

Paper Code	Paper Name
AEIE3221	Fundamentals of Sensors and Transducers
ECEN3221	Artificial Intelligence In Radio Communication
ECEN3222	Designing with Processors and Controllers
ECEN3223	Analog and Digital Communication
MATH3221	Computational Mathematics
MATH3223	Scientific Computing
CHEN3221	Water and Liquid Waste Management

Course Name: Fundamentals of Sensors and Transducers					
Course Code: AEIE3221					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

AEIE3221.1. Use different methods for converting a physical parameter into an electrical quantity

AEIE3221.2. Select the best fit transducers, including those for measurement of temperature, strain, motion, position and light intensity

AEIE3221.3. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like displacement stress, force, acceleration flow, etc.

AEIE3221.4. Acquire knowledge on high temperature sensing systems used in steel, aluminum, copper plants.

AEIE3221.5. Acquire knowledge on Smart sensors.

AEIE3221.6. Identify different type of sensors used in real life applications and paraphrase their importance.

2. Detailed Syllabus

Module 1 [10L]

Definition, principle of sensing & transduction, classification of transducers.

Resistive Transducers: Potentiometric transducer; Construction, symbol, materials, Loading effect, error calculations, sensitivity. Strain gauge; Theory, type, materials, gauge factor, temperature compensation and dummy gauge, adhesive,

Inductive sensor: Principle, common types, Reluctance change type, Mutual inductance change type, transformer action type

LVDT: Construction, material, I/O characteristics curve offset, discussion.

Module 2 [6L]

Capacitive sensors: Variable distance-parallel plate type, variable area- parallel plate, variable dielectric constant type, calculation of sensitivity.

Piezoelectric transducers: piezoelectric effect, charge and voltage co-efficient and relationships, crystal model, materials, natural & synthetic type, charge amplifier, ultrasonic sensors: Liquid velocity and level measurements, Microphone, response characteristics**.**

Module 3 [12L]

Thermal sensors: Resistance Temperature Detector (RTD): materials, temperature range, R-T characteristics configurations, applications

Thermistors: materials, shape, R-T characteristics, ranges and accuracy specification.

Thermocouple: Thermo laws, types, temperature ranges, series and parallel configurations, cold junction compensation, compensating cables.

Thermal Radiation sensors: types, constructions and comparison. Semiconductor type IC and PTAT type.

Module 4 [8L]

Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response, applications. Geiger counters, Scintillation detectors, Introduction to smart sensors.

3. Textbooks

1. Sensor and transducers, D. Patranabis, 2nd edition, PHI
2. Transducers and Instrumentation, D.V.S Murty, 2nd edition, PHI.

4. Reference Books

1. Instrument transducers, H.K.P. Neubert, Oxford University press.

2. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill.

Course Name: Artificial Intelligence In Radio Communication					
Course Code: ECEN3221					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

ECEN3221.1. Understand difference between passive radios and cognitive radios.

ECEN3221.2. Explain difference between SDR and cognitive Radios

ECEN3221.3. Apply in AI in radios.

ECEN3221.4. Analyze weakness on cognitive radios

ECEN3221.5. Develop radios based on Genetic Algorithm (GA).

ECEN3221.6. Evaluate radio performance.

2. Detailed Syllabus

Module 1 [10L]

SDR- history, concept (reconfigurable radios) ,SDR- benefits, problems, GNU radio design. Cognitive Radios- brief history, basic concept;Cognitive Radio Design, Cognitive Engine Design. AI in wireless communication; AI techniques in radios.

Module 2 [10L]

Optimization of Radio Resources,
Multi-objective optimization- BER, Transmit Power, Bandwidth, Spectral Efficiency, Interference, SINR, dependence.

Module 3 [8L]

Genetic Algorithms for Radio optimization,
Review, simple example, multi-objective GA, Wireless system- GA, simple CBDT example.

Module 4 [8L]

Cognitive Radio Network, Distributed AI,
Example- Cognitive Engine, System Design, Interference, Over-the-air results.

3. Textbooks

1. Artificial Intelligence in Wireless Communications, Thomas W Rondeau, Charles W Bostian, Artech House, 2009.
2. Cognitive Radio Techniques: Spectrum Sensing, Interference Mitigation and Localization, Kandeepan Sithamparanathan, Andrea Giorgetti, Artech House, 2012.

4. Reference Books

1. Cognitive Radio Technology, Martin Bates, Bruce A Fettee, Elsevier Science & Technology.

All Titles are available with British Council Library Online.

Course Name: Designing with Processors and Controllers					
Course Code: ECEN3222					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

5. Course Outcomes

After completion of the course, students will be able to:

ECEN3222.1. Understand microprocessors and microcontrollers – their operation and programming.
ECEN3222.2. Identify RISC processors from CISC processors and apply them in circuits.
ECEN3222.3. Analyse operations of different serial and parallel buses and interrupts.
ECEN3222.4. Evaluate different hardware designs and memory configurations.
ECEN3222.5. Write RTOS for complex processor-based designs.
ECEN3222.6. Design processor and controller based intelligent systems for real life problems.

6. Detailed Syllabus

Module 1 [8L]

Designing with microprocessors and microcontrollers- the issues and solutions, Embedded systems VS General computing systems, Purpose of Embedded systems, optimizing design metrics, prominent processor and controller technology, RISC vs CISC.

Module 2 [10L]

Devices and Communication Buses: I/O types, serial and parallel communication devices, wireless communication devices, timer and counting devices, watchdog timer, real time clock, serial bus communication protocols UART RS232/RS85, parallel communication network using ISA, PCI, PCT-X, Internet embedded system network protocols, USB, Bluetooth. Different types of I/O devices and interfacing: Keypad, LCD, VGA. Introduction to I/O interfaces: Interrupts, Interrupt hardware, Enabling and disabling interrupts, Concepts of handshaking, Polled I/O, Memory mapped I/O, Priorities, Stack and Queues. Vectored interrupts, Direct memory access, few types of Sensors and actuators.

Module 3 [10L]

Memory: SRAM, DRAM, EEPROM, FLASH, CACHE memory organizations, (direct, associative, set associative mapping), Virtual memory, organization, mapping and management techniques, Fundamental issues in Hardware software co-design, Unified Modeling Language (UML), Hardware Software trade-offs DFG model, state machine programming model, model for multiprocessor system. Introduction to ARM architecture, Processor design, ARM organization and implementation.

Module 4 [8L]

Real Time Operating Systems: Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, qualities of good RTOS. Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling, best effort current best practice in scheduling (e.g. Rate Monotonic vs. static schedules), Real-world issues: blocking, unpredictability, interrupts, caching, Examples of OSs for embedded systems - RT Linux, VRTX, Mobile phones, RFID.

7. Textbooks

1. The Art of Designing Embedded Systems, Jack Ganssle, (Newnes), 1999.
2. An Embedded Software Primer, David Simon, (Addison Wesley), 2000.
3. Embedded microcontroller and processor design: G. Osborn (Pearson).
4. Embedded System design: S. Heath (Elsevier).
5. ARM System-on-Chip Architecture, Steve Furber, (Pearson).

8. Reference Books

1. RTS: Real-Time Systems, C.M. Krishna and Kang G. Shin, McGraw-Hill, 1997.
2. Advances in Hard Real-Time Systems,J. A. Stankovic and K. Ramamritham, IEEE Computer Society Press, Washington DC, September 1993.
3. Introduction to Embedded Systems: Shibu K. V. (TMH).
4. Embedded System Design – A unified hardware and software introduction: Frank Vahid, Tony Givargis, (John Wiley)
5. Embedded Systems: Rajkamal (TMH).
6. Embedded Systems: L. B. Das (Pearson).
7. Selected papers and references.

Course Name: Analog and Digital Communication					
Course Code: ECEN3223					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

ECEN3223.1. Understand & apply the concepts of various types of signals, techniques for signal transmission and signal modulation from the knowledge gathered earlier.

ECEN3223.2. Identify various parameters associated with Amplitude and frequency Modulation, time and frequency domain representations, side band frequencies etc. and apply these knowledges to solve numerical problems.

ECEN3223.3. Apply sampling theorem to sample analog signal properly and differentiate among pulse modulation & demodulation techniques and understand PCM, DPCM.

ECEN3223.4. Analyze performance of various digital modulation & demodulation techniques and understand concept of OFDM and Spread Spectrum Modulation system.

ECEN3223.5. Analyze various multiplexing and Multiple access techniques and compare modern multiple access schemes, explain the concept of frequency reuse, channel assignment strategies and make use of wireless communication tools

ECEN3223.6. Compare and Analyze different communication systems.

2. Detailed Syllabus

Module 1 [10L]

Introduction: Signal Analysis and Transmission: Overview of communication: base-band transmission, various types of signals, analog signal, digital signal, fundamental limitations in communication system - noise, power and bandwidth. Fourier series and Fourier Transformation representations, Modulation and its need and types; Time domain and frequency domain analysis. AMPLITUDE MODULATION: Modulation principle and definitions, spectrum and power considerations, DSB, SSB, VSB and AM principles. Different type of modulator circuits.

DEMODULATOR Basic principle of coherent detections, envelope detectors.

FREQUENCY AND PHASE MODULATION Principles and definitions, Relationship between frequency and phase modulations. Phase and frequency deviations, Spectrum of FM signal, bandwidth considerations. Effect of modulation index on bandwidth, Narrow band and sideband FM and PM principles, RADIO RECEIVER Basic block diagram of TRF, Superhetrodyne principle.

Module 2 [10L]

Digital Transmission: Sampling theorem, sampling rate, aliasing and aperture effect; analog pulse modulation -PAM (ideal, natural & flat topped sampling),PWM, PPM; basic concept of pulse code modulation, block diagram of PCM; quantizer; non-uniform quantizer, conceptual idea of A-law &μ-law companding; encoding, coding efficiency, source, line coding channel coding & properties, NRZ & RZ, AMI, manchester coding PCM, DPCM, Delta modulation, adaptive delta modulation (basic concept and applications); baseband pulse transmission, matched filter (its importance and basic concept), error rate due to noise;, nyquist criterion for distortion-less transmission.

Module 3 [8L]

Digital Modulation Techniques: Types of Digital Modulation, coherent and non-coherent Binary Modulation Techniques, Bit rate, baud rate; information capacity generation and detection, digital carrier modulation techniques: ASK, PSK and FSK, DPSK. Concept of QAM and M-ary Communication, M-ary phase shift keying, (QPSK), Generation, detection, , Offset Quadrature Phase shift Queuing (OQPSK), Minimum Shift Keying (MSK), Basic Concept of OFDM and Spread Spectrum Modulation.

Module 4 [8L]

Multiplexing: -TDM, FDM. Multiple Access Techniques and Radio Communication: Multiple access techniques, TDMA, FDMA and CDMA in wireless communication systems, advanced mobile phone system (AMPS), global system for mobile communications (GSM), cellular concept and frequency reuse, channel assignment and handoff, Bluetooth, introduction to satellite communication.

3. Textbooks

1. Principles of Communication Systems, 2nd ed., Taub and Schilling, Mc-Graw Hill
2. Communication Systems,B.P.Lathi , BS Publications
3. Analog Communication, V Chandra Sekar, Oxford University Press

4. Reference Books

1. Communication System,4/e, Carlson, Mc-Graw Hill.

2. Fundamentals of Communication Systems, Proakis&Salehi, Pearson.
3. Communication Systems: 2/e, Singh &Sapre, TMH.
4. Principles of Electrical Communications, P K Ghosh University Press.
5. Digital and Analog Communication Systems, 2/e, L.W.Couch Ii, Macmillan Publishing.
6. Electronic Communication Systems, Blake, Cengage Learning.
7. Analog Communication Systems, S Sharma, Katson Books.

Course Name: Computational Mathematics					
Course Code: MATH3221					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	3	**0**	**0**	**3**	**3**

1. Course Outcomes

After completion of the course, students will be able to:

MATH3221.1. Identify patterns in data in the form of recurrences and using the latter to evaluate finite and infinite sums.
MATH3221.2. Explain combinatorial phenomena by using binomial coefficients, generating functions and special numbers.
MATH3221.3. Solve computational problems by applying number theoretic concepts such as primality, congruences, residues etc.
MATH3221.4. Analyse the properties of networks by invoking graph theoretic concepts such as connectivity, matchings, coloring etc.
MATH3221.5. Combine the concepts of recurrences, sums, combinatorics, arithmetic and graph theory in order to comprehend computational methods.
MATH3221.6. Interpret mathematically the algorithmic features of computational situations.

2. Detailed Syllabus

Module 1 [9L]

Sums: Sums and recurrences, manipulation of sums, multiple sums, general methods, finite and infinite calculus, infinite sums.

Module 2 [9L]

Binomial coefficients and special numbers: Basic identities involving binomial coefficients. Bernoulli numbers, Euler numbers, harmonic numbers, Fibonacci numbers, recurrence relations for these numbers.

Module 3 [9L]

Integer functions and arithmetic: Floors and ceilings, the binary operation 'mod', divisibility, primes, relative primality, the congruence relation 'mod', residues, Euler phi function, Fermat's Little Theorem, Wilson Theorem, primitive roots, the law of quadratic reciprocity, (Statement only).

Module 4 [9L]

Generating functions: Basic maneuvers, well-known sequences and their generating functions, using generating functions to solve recurrences, generating functions for special numbers.

3. Textbooks

1. Concrete Mathematics, Ronald Graham, Donald Knuth, Oren Patashnik, Addison-Wesley.

4. Reference Books

1. Elementary Number Theory, David Burton, McGraw Hill.

Course Name: Scientific Computing					
Course Code: MATH3223					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

MATH3223.1. Analyse certain algorithms, numerical techniques and iterative methods that are used for solving system of linear equations.

MATH3223.2. Implement appropriate numerical methods for solving advanced engineering problems dealing with interpolation, integration and differentiation.

MATH3223.3. Apply the knowledge of matrices for calculating eigenvalues and eigenvectors and their stability for reducing problems involving Science and Engineering

MATH3223.4. Develop an understanding to reduce a matrix to its constituent parts in order to make certain subsequent calculations simpler.

MATH3223.5. Develop the concept of predictor-corrector methods in solving Initial Value Problems numerically.

MATH3223.6. Apply numerical techniques in solving Boundary Value Problems where the analytical methods fail.

2. Detailed Syllabus

Module 1 [9L]

System of Linear Equations: Linear systems, solving linear systems; Gauss elimination, pivoting and scaling, Gauss-Jordan method; Symmetric positive define systems and indefinite systems, Cholesky factorization; Iterative method: Gauss Jacobi and Gauss Seidel, Error prediction and acceleration.

Module 2 [9L]

Eigen Value problems: QR algorithm; Power Method; Linear least square data fitting; Singular Value Decomposition.

Module 3 [9L]

Interpolation, Integration & Differentiation: Purpose of interpolation, Choice of interpolating function, Polynomial interpolation, Piecewise polynomial interpolation: cubic spline interpolation, General form of quadrature rule; Newton-Cotes rule, Gaussian quadrature rule, Numerical Differentiation: Methods Based on Finite Difference approximations.

Module 4 [9L]

Initial Value & Boundary Value Problem: Multistep method to solve Initial Value Problem and its stability, Predictor-corrector method: Adam Moulton method, Milne's Method, Solving Boundary Value Problems: Finite Difference Method, Shooting Method.

3. Textbooks

1. Numerical Linear Algebra, Trefethen L. N. and Bau D., SIAM.
2. Fundamentals of Matrix Computation, Watkins D. S., Wiley.
3. Numerical Solutions to Partial Differential Equations, Smith G. D., Oxford University Press.
4. Numerical methods for scientific and engineering computation, Jain M. K. and Iyengar S.R.K.
5. Elementary Numerical Analysis - An Algorithmic Approach, Conte S. D. and Boor C. D., McGraw Hill.
6. Introduction to Numerical Analysis, Atkinson K. E., John Wiley.

4. Reference Books

1. Matrix Computation, Golub G. H. and Van Loan C.F., John Hopkins U. Press, Baltimore.
2. Introduction to Matrix Computations, Stewart G. W., Academic Press.
3. Applied numerical linear algebra, Demmel J.W., SIAM, Philadelphia.
4. Numerical Solutions of Differential Equations, Jain M.K.
5. Numerical solutions of partial Differential Equations (Finite difference methods), Smith.
6. Scientific Computing: An Introductory Survey, Heath M. T., McGraw Hill.
7. Numerical Methods for Engineers and Scientists, Joe D. Hoffman, McGraw Hill.
8. Numerical Linear Algebra, W. Layton and M. Sussman.

Course Name: Water and Liquid Waste Management					
Course Code: CHEN3221					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

CHEN3221.1. Identify the importance of Legislative orders prevalent in India concerning Water and Liquid Waste Management

CHEN3221.2. Describe the methodology of Establishing and Operating Water and Liquid Waste intensive processes.

CHEN3221.3. Use the principles of Water Management in order to conserve water and solve water-shortage problems prevalent in India.

CHEN3221.4. Design the Water Treatment and Wastewater Treatment plants following the standard code of practice.

2. Detailed Syllabus

Module 1 [9L]

Introduction to Water Quality and its Storage. Methodology of Water flow measurement. Classification and various Water and Wastewater Standards prevalent in India. Legislative aspects including Water Act. 1974 and its revisions. Consent to Establish and Consent to operate water intensive industries. Water conservation methodologies in 1) Process industry, 2) Construction industry and 3) Service industry. Rainwater Harvesting and various recharge techniques. Principles of Water Audit.

Module 2 [9L]

Water pollution: Sources, sampling and classification of water pollutants, determination of basic parameters and computations associated with: BOD, COD, TS, TDS, SS; Waste water treatment: primary, secondary, tertiary and advanced; aerobic treatment with special reference to activated sludge, trickling filter, RBDC and RBRC, EA; non-conventional: WSP, anaerobic treatment with special reference to AFFR, UASB, numerical problems associated with all topics sited here.

Module 3 [9L]

Preliminaries of Water treatment processes, Basic design consideration: Pre-design, Raw water intake, Screening and aeration, Water conveyance, Coagulation, Flocculation and Precipitation, Sedimentation, filtration, color, taste and odor control, Disinfections and fluoridation, Water quality -- Physico Chemical and Bacteriological quality. Water Treatment Plant with design criteria: Slow sand bed and Rapid sand bed filter, layout, Process control, Non-conventional water treatment processes and its design, numerical problems associated with all topics sited here.

Module 4 [9L]

Liquid Waste Management in selected process industries – fertilizer, refineries and petrochemical units, pulp and paper industries, Tanneries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Root Zone and Reed Bed Treatment for Effluents of small scale industries, Ranking of wastewater treatment alternatives. Case Studies.

3. Textbooks

1. Introduction to Environmental Engineering and Science, Wendell P. Ela, Gilbert M. Masters, PHI, Ed 3rd Edition.
2. Wastewater Engineering, Metcalf & Eddy, Tata Mc-Graw Hill – 2002.
3. Wastewater treatment for pollution control, S.J. Arceivala, TMH, 2nd Edition.
4. Water Treatment Principles and Design, J.M. Montogomery, John Willey and Sons.

4. Reference Books

1. Pollution Control in Process Industries, S.P. Mahajan, Tata Mc Graw Hill, 2008.
2. Introduction to Environmental Engineering, M. Davis, D. Cornwell, Tata Mc GrawHill, 2012.
3. Standard Methods for Examination of Water and Wastewater, APHA / AWWA, 20th Edition.
4. Manual of Water Supply and Treatment: CPHEEO, Ministry of Urban Development, Govt. of India, 1999.
5. Water Treatment Plant Design, 5th Edition: ASCE and AWWA, 1912.
6. Design of Water treatment Plant - Part I, A G Bhole, Indian Water Works Association.

Course Name: Indian Constitution and Civil Society					
Course Code: INCO3016					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**0**

1. Course Outcomes

After completion of the course, students will be able to:

INCO3016.1. Analyze the historical, political and philosophical context behind the Indian Constitution-making process

INCO3016.2. Appreciate the important principles characterizing the Indian Constitution and institute comparisons with other constitutions

INCO3016.3. Understand the contemporaneity and application of the Indian Constitution in present times

INCO3016.4. Critique the contexts for constitutional amendments in consonance with changing times and society

INCO3016.5. Establish the relationship between the Indian Constitution and civil society at the collective as well as the individual levels

INCO3016.6. Consciously exercise the rights and the duties emanating from the Indian Constitution to one's own life and work.

2. Detailed Syllabus

Module 1 [6L]

Introduction to the Constitution of India-Historical Background; Making of Indian Constitution -the process of framing the constitution, the constituent assembly.

Module 2 [6L]

Salient Features of the Indian constitution; Comparison with the constitutions of other countries.

Module 3 [6L]

Relevance of the Constitution of India; Constitution and Governance; Constitution and Judiciary; Constitution and Parliament-Constitutional amendments.

Module 4 [6L]

Constitution and Society- democracy, secularism, justice; Constitution and the individual citizen- Fundamental Rights, Directive Principles of state policy and Fundamental Duties.

3. Reference Books

1. Civil Society and Democracy, C.M.Elliot, (ed.), OUP, Oxford, 20012.
2. The Idea of the Modern State, David Held et.al (ed), Open Univ. Press, Bristol, 1993.
3. State and Civil Society, Neera Chandoke, Sage, Delhi, 1995.

B. LABORATORY COURSES

Course Name: Software Engineering Lab					
Course Code: CSEN3251					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3251.1. Prepare SRS document for sample application system as per IEEE guidelines.

CSEN3251.2. Design sample software application problem using various UML diagrams (e.g. Use Case Diagram, Class Diagram, Sequence Diagram etc.) using tools like Microsoft Visio.

CSEN3251.3. Design test cases for sample application module(s).

CSEN3251.4. Estimate the project size, duration and cost for sample application system using industry standard method like FPA.

CSEN3251.5. Prepare project schedule.

CSEN3251.6. Plan the staffing for sample application system.

2. Detailed Syllabus

Exercises and Assignments on:

1. Preparation of Software Requirement Specification for sample application system(s) as per IEEE guidelines.
2. Designing a system using UML Diagrams for sample application problems: Use Case Diagrams, Class Diagrams and Sequence Diagrams using tools.
3. Designing Test Cases for sample application module(s).
4. Estimation of Project Size for sample application system(s) – Function Point Analysis (FPA).
5. Preparation of Project Schedule and Staffing Plan for sample software project(s).

3. Textbooks

1. Uml: A Beginner's Guide, Jason T. Roff, McGraw-Hill, 2002.
2. Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3rd Edition, Craig Larman, 2004.

4. Reference Books

1. The IFPUG Guide to IT and Software Measurement edited by IFPUG, CRC Press, 2012.

Course Name: Computer Networks Lab					
Course Code: CSEN3252					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	0	**0**	**3**	**3**	**1.5**

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3252.1. Learn the terminology and concepts of network management in Linux platform by understanding shell commands and implementing the same.

CSEN3252.2. Understand the concepts of protocols, network interfaces, and design/performance issues through programs.

CSEN3252.3. Understanding the need of dividing stream of data into smaller units and implementing program to send such data units across a network.

CSEN3252.4. Demonstrate various types of protocols to transfer packets of data from a source to destination machine.

CSEN3252.5. Understand the need of different types of Transport Layer Protocols and implement them through socket programming.

CSEN3252.6. Learn how to synthesize the learning gathered from different network layers to build useful, relevant and user-friendly applications with the objective to solve real life problems.

2. Detailed Syllabus

1. Implement Simple TCP Client Server Application.
2. Implement TCP Echo Server Client Application.
3. Implement TCP Chat Server Client Application.
4. Implement a File Server Client application.
5. Implement UDP Echo Server Client Application.
6. Implement UDP Time Server Client Application.
7. Implement multithreaded chat program.
8. Implement Web based protocol (looking up URLs, retrieving & examining content, posting a form etc.).
9. Implement Multicasting / Broadcasting socket I/O.
10. Implement Sliding Window Protocol using Non-Blocking I/O (try the Selective Repeat).
11. Implement Secured TCP echo protocol.
12. Experimenting on cross-platform network-based communication issues.

3. Textbooks

1. Computer Networks, Andrew S. Tanenbaum, Pearson Education, Fourth edition.
2. Data and Computer Communication, William Stallings, Prentice hall, Seventh edition.
3. High speed Networks and Internets, William Stallings, Pearson education, Second edition.

4. Reference Books

1. Cryptography and Network security, William Stallings, PHI, Third edition.
2. ISDN and Broadband ISDN with Frame Relay and ATM, William Stallings.
3. Computer Networking: A Top Down Approach, 5th Ed., Kurose & Ross.

C. SESSIONAL COURSES

Course Name: Term Paper and Seminar					
Course Code: CSEN3293					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	4	4	2

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3293.1. Students will demonstrate the ability to prepare appropriately to participate effectively in class discussion.

CSEN3293.2. Students will demonstrate the ability to follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments.

CSEN3293.3. Further, students will be able to challenge and offer substantive replies to others' arguments, comments, and questions, while remaining sensitive to the original speaker and the classroom audience.

CSEN3293.4. Students will learn to prepare materials on a topic relevant to the course and demonstrate critical faculties with the text discussed.

2. Detailed Syllabus

Discussion and presentation on various technical topics.

Open Elective-I course(s) to be offered by CSE Department

Course Name: Fundamentals of RDBMS					
Course Code: CSEN3221					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

1. Course Outcomes

After completion of the course, students will be able to:

CSEN3221.1. Identify the basic concepts and various data model used in database design. Be able to model an application's data requirements using conceptual modeling tools like ER diagrams and design database schemas based on the conceptual model.

CSEN3221.2. Formulate relational algebra expression for queries and evaluate it using the concept of query processing and optimization.

CSEN3221.3. Create RDBMS schema mapping various business validations and formulate queries based on that schema using SQL to satisfy business requirements.

CSEN3221.4. Apply normalization and various types of dependencies for evaluating a relational database design.

CSEN3221.5. Apply and relate the concept of transaction, concurrency control and recovery in database.

CSEN3221.6. Understand with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

2. Detailed Syllabus

Module 1 [8L]

Introduction: Concept & Overview of DBMS, Data Models, Database Languages, Role of database administrator and database Users, Three Tier architecture of DBMS.

Entity-Relationship Model: Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Module 2 [10L]

Relational Model:

Structure of relational Databases, Relational Algebra, Extended Relational Algebra Operations, Views, Modifications of the Database.

Relational Database Design: Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies.

Module 3 [8L]

SQL and Integrity Constraints: Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, views, Nested Subqueries, Stored procedures and triggers.

Module 4 [10L]

Internals of RDBMS: Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

File Organization & Index Structures: File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

3. Textbooks

1. Database System Concepts, Henry F. Korth and Silberschatz Abraham, Mc.Graw Hill.
2. Fundamentals of Database Systems, Elmasri Ramez and Novathe Shamkant, Benjamin Cummings Publishing Company.
3. Database Management System, Ramakrishnan, McGraw-Hill.
4. Transaction Processing: Concepts and Techniques, Gray Jim and Reuter Address, Moragan Kauffman Publishers.
5. Advanced Database Management System, Jain, CyberTech.
6. Introduction to Database Management, Vol. I, II, III, Date C. J., Addison Wesley.
7. Principles of Database Systems, Ullman JD., Galgottia Publication.

4. Reference Books

1. Principles of Database Management Systems, James Martin, 1985, Prentice Hall of India, New Delhi.
2. Fundamentals of Database Systems, Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition.
3. Database Management Systems, Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill.