HERITAGE INSTITUTE OF TECHNOLOGY

(An Autonomous Institute Under MAKAUT)

COURSE STRUCTURE and DETAIL SYLLABUS

B. Tech in Computer Science and Engineering
(Artificial Intelligence and Machine Learning)
July, 2021

FIRST YEAR
FIRST 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	MATH1101	Mathematics-I	3	1	0	4	4
3	CSEN1001	Programming for Problem Solving	3	0	0	3	3
Total Theory			**9**	**2**	**0**	**11**	**11**
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
Total Practical			**1**	**0**	**11**	**12**	**6.5**
Total of Semester without Honors			**10**	**2**	**11**	**23**	**17.5**
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			**13**	**2**	**13**	**28**	**21.5**

FIRST YEAR
SECOND 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	MATH1201	Mathematics II	3	1	0	4	4
3	ELEC1001	Basic Electrical Engineering	3	1	0	4	4
4	HMTS1202	Business English	2	0	0	2	2
Total Theory			**11**	**3**	**0**	**14**	**14**
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
4	HMTS1252	Language Lab	0	0	2	2	1
Total Practical			**1**	**0**	**11**	**12**	**6.5**
Total of Semester without Honors			**12**	**3**	**11**	**26**	**20.5**
C. Honors							
1	HMTS1011	Communication for Professionals	3	0	0	3	3
2	HMTS1061	Communication for Professionals Lab	0	0	2	2	1
Total Honors			**3**	**0**	**2**	**5**	**4**
Total of Semester with Honors			**15**	**3**	**13**	**31**	**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	CSEN2103	Python Programming	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	CSEN2153	Python Programming 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	MATH2203	Operations Research	4	0	0	4	4
5	AEIE2205	Introduction to Smart Sensing Technology for AI	3	0	0	3	3
6	EVSC2016	Environmental Sciences (Mandatory)	2	0	0	2	0
Total Theory			**20**	**0**	**0**	**20**	**18**
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
Total Practical			**0**	**0**	**8**	**8**	**4**
Total of Semester			**20**	**0**	**8**	**28**	**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	CSEN3104	Introduction to Artificial Intelligence	3	0	0	3	3
4	CSEN3105	Data Mining	3	0	0	3	3
5	CSEN3131-CSEN3140	Professional Elective-I	3	0	0	3	3
	CSEN3133 CSEN3136 CSEN3137 CSEN3139 MATH4122	Web Technologies Introduction to Soft Computing Introduction to Information Retrieval Randomized Algorithms Advanced Linear Algebra					
Total Theory			**17**	**0**	**0**	**17**	**17**
B. Practical							
1	CSEN3151	Database Management Systems Lab	0	0	3	3	1.5
2	CSEN3154	Introduction to AI Lab	0	0	3	3	1.5
3	CSEN3155	Data Mining 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	CSEN3112	Object Oriented Programming	3	0	0	3	3
2	CSEN3162	OOPs 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	CSEN3203	Fundamentals of Machine Learning	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
	CSEN3235 CSEN3236 CSEN3237 CSEN3238	Cloud Computing Big Data Advanced Operation Research Stochastic Theory					
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			**1**	**0**	**0**	**19**	**17**
B. Practical							
1	CSEN3251	Software Engineering Lab	0	0	3	3	1.5
2	CSEN3253	Fundamentals of Machine Learning 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			**1**	**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
	CSEN4132 CSEN4133 CSEN4137 CSEN4138	Cryptography & Network Security Image Processing Fundamentals of Computer Networks Business Analytics					
3		Open Elective-II	3	0	0	3	3
	AEIE4121 AEIE4122 CHEN4121 ECEN4121 ECEN4123 BIOT4026 MATH4121	Instrumentation and Telemetry Linear Control Systems and Applications Industrial Total Quality Management Software Defined Radio Error Control Coding for secure Data Transmission Biology for Engineers Optimization and Multi Valued Analysis					
4		Open Elective-III	3	0	0	3	3
	AEIE4127 BIOT4124 ECEN4127 ECEN4128	Introduction to Embedded System Biosensor Ad Hoc Wireless Networks 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	CSEN4112	Deep Learning	3	0	0	3	3
2	CSEN4162	Deep Learning 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 CSEN4235 CSEN4236	Distributed Algorithms Mobile Computing Pattern Recognition Social Network Analysis Robotics					
2	CSEN4241- CSEN4250	Professional Elective-V	3	0	0	3	3
	CSEN4241 CSEN4242 CSEN4244 CSEN4245 CSEN4246 CSEN4248	Distributed Databases Natural Language Processing Real Time & Embedded System Quantum Computing Computer Vision Compiler Design					
3		Open Elective-IV	3	0	0	3	3
	AEIE4221 AEIE4222 BIOT4221 BIOT4222 CHEN4222 ECEN4223	Process Instrumentation Medical Instrumentation Computational Biology Non-conventional Energy Introduction to Solar and Wind Technology Optical Fiber Communication					
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.	23
4	Professional Core Courses	58
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	ECEN1011	Basic Electronics	3	0	0	3
2		ECEN1061	Basic Electronics Lab	0	0	2	1
3	2nd	HMTS1011	Communication for Professionals	3	0	0	3
4		HMTS1061	Professional Communication Lab	0	0	2	1
5	3rd	MATH2111	Probability and Statistical Methods	4	0	0	4
6	5th	CSEN3112	Object Oriented Programming	3	0	0	3
7		CSEN3162	OOPs Lab	0	0	2	1
8	7th	CSEN4112	Deep Learning	3	0	0	3
9		CSEN4162	Deep Learning 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	CSEN3112	Object Oriented Programming	3	Programming in C++ AND Programming in JAVA	IIT Kharagpur	NPTEL
7	CSEN3162	OOPs Lab	1			
8	CSEN4112	Deep Learning	3	Deep Learning	IIT Kharagpur	Swayam
9	CSEN4162	Deep Learning Lab	1			

Part-II

Detailed Syllabus

1st Year

Course Name: PHYSICS I					
Course Code: PHYS 1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

1. Interpret oscillations under different conditions, with the understanding of Resonance phenomena followed by calculation of Q factor
2. Analyze the Quantum phenomenon like Black body radiation , Compton effect and origin of X-ray spectrum
3. Understand the wave character of light through the phenomenon of interference, diffraction and polarization.
4. Study of various crystal structures and classification of different crystal planes.
5. Explain the working principle of LASER, and apply the knowledge in different lasing system and their engineering applications in holography
6. Understand the dual nature of matter, Heisenberg's uncertainty relation and it's various application.

Module 1 : Mechanics (7+5)= 12L

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 manoeuvres .

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

Module 2 : Optics (4 +3+ 5) = 12 L

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: Electrostatics (8+4) = 12 L

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 centre of a dielectric sphere, charge in front of dielectric slab, Dielectric slab and dielectric sphere in uniform electric field.

Module 4: **(6+3+3)= 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 it's 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.

Books of reference :

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-I					
Course Code: MATH 1101					
Contact Hours per week	**L**	**T**	**P**	**Total**	**Credit Points**
	3	1	0	4	4

Course Outcomes:

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

Module I [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 II [10 L]

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 convergence: 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 III[10 L]

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 IV [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, Stokes Theorem and Gauss Divergence Theorem.

Suggested Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2000.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. K. F. Riley, M. P. Hobson, S. J. Bence. Mathematical Methods for Physics and Engineering, Cambridge University Press, 23-Mar-2006.
4. S. L. Ross, Differential Equations", Wiley India, 1984.
5. G.F. Simmons and S.G. Krantz, Differential Equations, 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: PROGRAMMING FOR PROBLEM SOLVING					
Course Code: CSEN 1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

1. Understand and remember functions of the different parts of a computer.
2. Understand and remember how a high-level language (C programming language, in this course) works, different stages a program goes through.
3. Understand and remember syntax and semantics of a high-level language (C programming language, in this course).
4. Understand how code can be optimized in high-level languages.
5. Apply high-level language to automate the solution to a problem.
6. Apply high-level language to implement different solutions for the same problem and analyze why one solution is better than the other.

Module I: [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 II: [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 III: [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 IV: [10L]
Data Handling in C
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().

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

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

Course Name: PHYSICS I LAB					
Course Code: PHYS 1051					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

1. Transform the theoretical knowledge into experimental set design
2. Understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
3. Analyze the result obtained through experiment.
4. Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.
5. Understand measurement technology, usage of new instruments and real time applications in engineering studies.
6. Develop skills to impart practical knowledge in real time solution.

Minimum of six experiments taking at least one from each of the following four groups :

Group 1 :Experiments in General Properties of matter

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

Group 2: Experiments in Optics

1. Determination of **dispersive power** of the material of a prism
2. Determination of wavelength of light by **Newton's ring** method.
3. Determination of wavelength of light by **Fresnel's biprism method.**
4. Determination of the **wavelength of a given laser** source by diffraction method

Group 3: Electricity & Magnetism experiments

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

Group 4: Quantum Physics Experiments

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

Text Books

1. Advanced Practical Physics (vol. 1 and vol. 2)
B. Ghosh and K. G. Mazumdar.
2. Advanced course in practical physics
D. Chattopadhyay and P.C. Rakshit.

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

Course Outcomes:

After completion of this course the students should be able:

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

Software to be used: GNU C Compiler (GCC) with LINUX
NB: Cygwin (Windows based) may be used in place of LINUX

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

Text Books

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

Course Name: WORKSHOP /MANUFACTURING PRACTICES					
Course Code: MECH 1051					
Contact Hours per week	L	T	P	Total	Credit Points
	1	0	4	5	3

Course Outcomes:

Upon completion of this course

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

(i) Lectures & videos: (13 hours)
Detailed contents

1. Introduction on Workshop and Safety Precautions. **(1 lecture)**
2. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods **(3 lectures)**
3. CNC machining, Additive manufacturing **(1 lecture)**
4. Fitting operations & power tools **(1 lecture)**
5. Electrical & Electronics **(1 lecture)**
6. Carpentry **(1 lecture)**
7. Plastic moulding, glass cutting **(1 lecture)**
8. Metal casting **(1 lecture)**
9. Welding (arc welding & gas welding), brazing **(2 lecture)**
10. Viva-voce **(1 lecture)**

(ii) Workshop Practice :(52 hours)[L : 0; T:0 ; P : 4 (2 credits)]

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

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

Suggested Text/Reference Books:

(i) Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of

Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
(ii) Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
(iii)Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
(iv) Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
(v) Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Name : BASIC ELECTRONICS					
Course Code: ECEN1011					
Contact Hoursper week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

After going through this course, the students will be able to

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

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

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

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

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.

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

Module I [10 L]

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 II [8 L]
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 III [9 L]
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 IV [9 L]
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.

References:

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

Course Name : BASIC ELECTRONICS LABORATORY

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

Course Outcomes:

1. The students will correlate theory with diode behavior.
2. They will design and check rectifier operation with regulation etc.
3. Students will design different modes with BJT and FET and check the operations.
4. They will design and study adder, integrator etc. with OP-AMPs.

List of Experiments (from)

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.

Course Name : CHEMISTRY-I					
Course Code: CHEM 1001					
Contact Hours per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Course Outcomes:

The course outcomes of the subject are

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.
2. An ability to analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.for engineering applications.
3. Have knowledge of synthesizing nano materials and their applications in industry, carbon nano tube technology is used in every industry now-a-days.
4. Understanding of bulk properties and processes using thermodynamic considerations.
5 Elementary knowledge of IR, UV, NMR and X-ray spectroscopy is usable in structure elucidation and characterisation of various molecules.
6. Knowledge of electronic effect and stereochemistry for understanding mechanism of the major chemical reactions involved in synthesis of various drug molecules.

MODULE 1
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.

3**L**

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. 4**L**

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 **3L**

MODULE 2
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.

5**L**

Periodicity

Effective nuclear charge, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, inert pair effect. **3L**

Ionic Equilibria

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

2L

MODULE 3

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.

3L

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).

3L

MODULE 4

Stereochemistry

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

4L

Structure and reactivity of Organic molecule

Inductive effect, resonance, hyperconjugation, electromeric effect, carbocation, carbanion, free radicals, aromaticity. **3L**

Organic reactions and synthesis of drug molecule (4 lectures)

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

3L

Text Books

1. Atkins' Physical Chemistry, P.W. Atkins (10^{th} 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, GourkrishnaDasmohapatra, (3rd Edition)

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

Course Outcomes:

1. Demonstrate the knowledge of probabilistic approaches to solve wide range of engineering problem.
2. Recognize probability distribution for discrete and continuous variables to quantify physical and engineering phenomenon.
3. Develop numerical techniques to obtain approximate solutions to mathematical problems where analytical solutions are not possible to evaluate.
4. Analyze certain physical problems that can be transformed in terms of graphs and trees and solving problems involving searching, sorting and such other algorithms.
5. Apply techniques of Laplace Transform and its inverse in various advanced engineering problems.
6. Interpret differential equations and reduce them to mere algebraic equations using Laplace Transform to solve easily.

Module-I Fundamentals of Probability (10L)

- 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-II Numerical Methods (10L)

- 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 and Modified Euler's Method , Runge-Kutta Method of 4^{th} order.

Module-III Basic Graph Theory (10L)

- Graphs: Digraphs, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Subgraph

- Walks, Paths, Circuits, Euler Graph, Cut sets and cut vertices
- Matrix representation of a graph, Adjacency and incidence matrices of a graph
- Graph isomorphism
- Bipartite graph
- Definition and properties of a tree
- Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees
- Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using DFS, BFS, Kruskal's and Prim's algorithms

Module-IV Laplace Transformation (10L)

- 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

Suggested Books:

1. **Advanced Engineering Mathematics** , E.Kreyszig, Wiley Publications
2. **Introduction to Probability and Statistics for Engineers and Scientists**, S.Ross, Elsevier
3. **Introductory methods of Numerical Analysis**, S.S. Sastry, PHI learning
4. **Introduction to Graph Theory,** D. B. West, Prentice-Hall of India
5. **Engineering Mathematics,** B.S. Grewal, S. Chand & Co.

Course Name: BASIC ELECTRICAL ENGINEERING					
Course Code: ELEC1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes:

After attending the course, the students will be able to

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

Module-I:

DC Network Theorem: Kirchhoff's law, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Norton theorem, Maximum power transfer theorem, Star-Delta conversion. [6L]

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. [5L]

Module-II

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. [10L]

Module-III

Three phase system: Balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams, power measurement by two wattmeter method. [4L]

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. [7L]

Module-IV

Single phase 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 . [6L]

3-phase induction motor: Concept of rotating magnetic field, Principle of operation, Construction, Equivalent circuit and phasor diagram, torque-speed/slip characteristics, Starting of Induction Motor. [4L]

Text Books:

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 Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand& Company

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.

Course Name : BUSINESS ENGLISH					
Course Code: HMTS 1202					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit points**
	2	**0**	**0**	**2**	**2**

Course Outcomes:

The learner will
1. Acquire competence in using English language to communicate.
2. Be aware of the four essential skills of language usage-listening, speaking, reading and writing.
3. Be adept at using various modes of written communication at work.
4. Attain the skills to face formal interview sessions.
5. Write reports according to various specifications.
6. Acquire the skill to express with brevity and clarity

Module- I (6hrs.)
Grammar (Identifying Common Errors in Writing)
- Subject-verb agreement
- Noun-pronoun agreement
- Misplaced Modifiers
- Articles
- Prepositions
- Redundancies

Module- II (6hrs.)
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- III (8hrs)

Business Communication- Scope & Importance

Writing Formal Business Letters:Form and Structure-Parts ofa 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- IV (6hrs)

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

References:

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.

Course Name : CHEMISTRY-I LAB					
Course Code: CHEM 1051					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

Course Outcomes:

The course outcomes of the subject are

1. Knowledge to estimate the hardness of water which is required to determine the usability of water used in industries.
2. Estimation of ions like Fe^{2+}, Cu^{2+} and Cl^- present in water sample to know the composition of industrial water.
3. Study of reaction dynamics to control the speed and yield of various manufactured goods produced in polymer, metallurgical and pharmaceutical industries.
4. Handling physico-chemical instruments like viscometer, stalagmometer, pH-meter, potentiometer and conductometer.
5. Understanding the miscibility of solutes in various solvents required in paint, emulsion, biochemical and material industries.
6. Knowledge of sampling water can be employed for water treatment to prepare pollution free water.

Experiments:

1. Estimation of iron using KMnO4self 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)

Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis-G. H. Jeffery, J. Bassett, J. Mendham, R. C. Denney.
2. Advanced Practical Chemistry- S. C. Das
3. Practicals in Physical Chemistry- P. S. Sindhu

Course Name: BASIC ELECTRICAL ENGINEERING LABORATORY					
Course Code: ELEC1051					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The students are expected to

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

List of Experiments:

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.

Course Name: ENGINEERING GRAPHICS & DESIGN					
Course Code: MECH 1052					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	1	**0**	**4**	**5**	**3**

Course Outcomes:

After going through the course, the students will be able

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

Lecture Plan (13 L)

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)

Detailed contents of Lab hours (52 hrs)

Module 1: 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.
(4 hrs + 4 hrs)

Module 2: Orthographic Projections covering,
Principles of Orthographic Projections - Conventions - Projections of Points and lines inclined to both planes; Projections on Auxiliary Planes. Projection of lamina.
(4 hrs+4 hrs + 4 hrs)

Module 3: Projections of Regular Solids covering,
those inclined to both the Planes- Auxiliary Views.
(4 hrs + 4 hrs)

Module 4: 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.
(4 hrs)

Module 5: 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.

(4 hrs + 4 hrs)

Module 6: 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.

(4 hrs)

Module 7: Customisation& 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;

(2 hrs)

Module 8: 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.

(2 hrs)

Module 9: 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.

(4 hrs)

References:

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

Course Name: LANGUAGE LAB					
Course Code: HMTS 1252					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The learner will

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

Module- I (4hrs)

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- II (8hrs)

- 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- III (6hrs)

- Public Speaking: TheSpeech 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- IV (8hrs)

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

References:

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999
4. Sen, S.,Mahendra,A. &Patnaik,P.,Communication and Language Skills, Cambridge University Press, 2015
5. Locker,Kitty O. Business and Administrative Communication McGraw-Hill/ Irwin.
6. Chaney,L.andMartin,J., Intercultural Business Communication. Prentice Hall

Course Name: COMMUNICATION FOR PROFESSIONALS					
Course Code: HMTS 1011					
Contact Hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	**0**	**0**	**3**	**3**

Course Outcomes:

Students will be able to

1. Write business letters and reports
2. Communicate in an official and formal environment.
3. Effectively use the various channels of communication at work place.
4. Use language as a tool to build bridges and develop interpersonal relations in multi-cultural environment.
5. Learn to articulate opinions and views with clarity.
6. Use various techniques of communication for multiple requirements of globalized workplaces.

Module- I (9hrs.)
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 Englishto formderivatives
- Synonyms, Antonyms and standard abbreviations

Module- II (10hrs.)
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- III (10hrs.)
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- IV (10hrs.)
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

References:

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

Course Name: COMMUNICATION FOR PROFESSIONALS LAB					
Course Code: HMTS 1061					
Contact Hours per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

Students will be able to

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

Module- I (4hrs)
Techniques for Effective Speaking
Voice Modulation: Developing correct tone
Using correct stress patterns: word stress, primary stress, secondary stress
Rhythm in connected speech
Module- II (6hrs.)
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- III (6hrs)

- 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- IV (10hrs.)
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.

References:

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

2nd Year

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)

CSEN2101.3Apply 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.)

CSEN2101.5Evaluate 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 $n(Z_n)$ and its examples.

Module 3 [10L]

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

Module 4 [12L]

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

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: Python Programming					
Course Code: CSEN2103					
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:

CSEN2103.1. Learn and understand the basics of the Python Programming Language.
CSEN2103.2. Learn about basic Python data structures.
CSEN2103.3. Learn about the NumPy and pandas libraries in Python.
CSEN2103.4. Learn about the GUI programming using Tkinter and Symbolic computing using SymPy.
CSEN2103.5. Learn about plotting and visualization using Matplotlib.
CSEN2103.6. Learn how to use SciPy for Equation Solving, Optimization, Interpolation, Integration and Ordinary Differential Equation
CSEN2103.7. Learn how to apply Python in building solutions to basic data analysis problems

2. Detailed Syllabus

Module 1 [8L]

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 [10L]

GUI Programming Using Tkinter

Getting Started with Tkinter, Processing Events, The Widget Classes, Canvas widget for displaying shapes, Geometry Managers, Displaying Images, Menus, Popup Menus, Mouse, Key Events, and Bindings, Animations, Scrollbars, Standard Dialog Boxes.
Symbolic Computing using SymPy
Plotting and Visualization using Matplotlib
Using SciPy: Equation Solving, optimization, interpolation, integration, Ordinary differential equation

3. Textbooks

1. Introduction to Programming Using Python, Y. Daniel Liang. Pearson, 2017.
2. Introduction to Python for Engineers and Scientists, Sandeep Nagar, Apress, 2018
3. Python for Data Analysis, Wes McKinney, O'Reilly, 2017.
4. Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib Book by Robert Johansson, Apress, 2019

4. Reference Books

1. Python for Everybody, Charles Severance, 2016.
2. Effective Python, Brett Slatkin, Pearson, 2015.
3. Learn Python The Hard Way, Zed A. Shaw, Addison-Wesley, Third Edition

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: Python Programming Lab					
Course Code:CSEN2153					
Contact Hours per week:	L	T	P	Total	Credit points
	0	0	3	3	1.5

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

CSEN2153.1: learn and understand how to write simple programs in Python, relating to arithmetic and logical problems.
CSEN2153.2: learn and understand how to implement conditional branching, iteration (loops), recursion and function
CSEN2153.3: learn and understand how to do input/output with files in Python and use exception handling
CSEN2153.4: learn and understand how to manipulate strings, use regular expression, and also use Python data structures viz. Lists, Tuples, Dictionaries and Sets
CSEN2153.5. learn and understand how to do processing with NumPy Arrays
CSEN2153.6. learn and understand how to use Pandas data structures (Series, Data Frames) and other features of Pandas

Detailed Syllabus:

Topic 1:

(a) Finding the distance between two points whose coordinates are given
(b) Finding the impedance of a series R-L-C Circuit
(c) Finding the roots of a quadratic equation
(d) Finding the maximum and minimum out of a few numbers given
(e) Finding the value of sine of a given angle from its series expansion
(f) Finding the Time period of a pendulum, whose length varies from 100 to 120 cm in steps of 5 cm.

Topic 2:

Implement programs using functions:

a. Largest number in a list
b. Area of different shapes
c. Circulate the values of n variables
d. Distance between two points whose coordinates are given
e. Roots of a quadratic equation
f. Factorial
g. Fibonacci series
h. GCD

Topic 3:

Implement programs on File I/O and exception handling:

a. Copying a file
    1. Take source file name and destination file name from the user
    2. Use exception handling to report error, if any
    3. Copy thesource text file to the destination.
    4. Report completion status, number of characters copied etc. to the user
b. Finding word count and longest word in a file
c. Use exception handling in nested functions
d. Write a program to show positive use of exception handling

Topic 4:

(a) Write programs to use various in-built functions of Python on string manipulation (reverse, palindrome, character count, replacing characters)
(b) Write programs to show the use of regular expression
(c) Write programs using Python data structures viz. Lists, Tuples, Dictionaries and Sets

Topic 5:

Write programs using various features provided in the NumPy

Topic 6:

Write programs using Pandas data structures and various features provided in Pandas

Text Books:

1. Allen B. Downey, Think Python: How to think like a Computer Scientist, 2nd Edition, O'Reilly, 2016
2. Y. Daniel Liang, Introduction to Programming Using Python, Pearson, 2017

Reference Books:

1. Karl Beecher, Computational Thinking: A Beginners Guide to Problem Solving and Programming, 1st Edition, BCS Learning and Development Limited, 2017

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.

Paper Name: **Operations Research**					
Paper Code: **MATH 2203**					
Contact hours per week:	L	T	P	Total	Credit Points
	4	0	0	4	4

After successfully completing this course the students will be able to:

MATH2203.1 Describe the way of writing mathematical model for real-world optimization problems.
MATH2203.2 Identify Linear Programming Problems and their solution techniques.
MATH2203.3 Categorize Transportation and Assignment problems.
MATH2203.4 Apply the way in which Game theoretic models can be useful to a variety of real-world scenarios in economics and in other areas.
MATH2203.5 Apply various optimization methods for solving realistic engineering problems and compare their accuracy and efficiency.
MATH2203.6 Convert practical situations into non-linear programming problems and solveunconstrained and constrained programming problems using analytical techniques.

Module- I **10L**

Linear Programming Problem (LPP)-I

Formulation of an LPP; Graphical Method of solution of an LPP; Convex Combination and Convex Set; Canonical and Standard form of an LPP; Basic Solution of a system of linear equations; Gaussian Elimination Method to solve a system of linear simultaneous equations; Simplex Method; Big-M Method; Concept of Duality; Mathematical formulation of duals.

Module- II **10L**

Transportation and Assignment Problems

Transportation Problems (TP) ; Representation of Transportation Problems as LPP; Methods of finding initial basic feasible solution of TP: North-West Corner Rule, Matrix Minima Method, Vogel's Approximation Method; Optimality test of the basic feasible solution; Assignment Problems; Hungarian Method.

Game Theory

Strategies; The Minimax and Maximin Criterion; Existence of Saddle Point; Games without a Saddle Point; Mixed Strategies; Symmetric Games; Dominance Principle; Two-Person Zero-Sum Games and their solution using by Graphical Method and Algebraic Method.

Module- III **10L**

Non-Linear Programming Problems (NLPP)-I :Analytical Methods

Single-variable Optimization; Multivariate Optimization with no constraints: Semidefinite Case, Saddle Point; Multivariate Optimization with Equality Constraints: Method of Lagrange Multipliers; Multivariable Optimization with inequality constraints: Kuhn-Tucker Conditions.

Module- IV **10L**

Non-Linear Programming Problem (NLPP)-II: Some Search Algorithms

Unimodal Function; Elimination Methods: Interval Halving Method, Fibonacci Method, Golden Section Method; Interpolation Methods: Quadratic Interpolation Methods; Cubic Interpolation Method, Newton Method, Quasi- Newton Method, Secant Method.

Text Books:

1. *Engineering Optimization* by S. S. Rao, New Age Techno Press.
2. *Operations Research* by T. Veerarajan, Universities Press

Reference Books:

1. *Linear Programming and Game Theory* by J. G. Chakraborty and P. R. Ghosh, Moulik Library.
2. *Operations Research* byKantiSwarup, P. K. Gupta and Man Mohan, S. Chand and Sons.
3. *Operations Research: Theory and Applications* by J. K. Sharma, Macmillan India Ltd.
4. *Algorithms for Minimization without Derivative* by R. P. Brent, Prentice Hall.

Course Name: Introduction to Smart Sensing Technology					
Course Code: AEIE2205					
Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes

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

AEIE2205.1: Identify the sensors for measurement of various physical parameters like displacement, pressure, force, temperature etc.

AEIE2205.2: Interpret the operation of various sensors/transducers used for measurement of physical parameters.

AEIE2205.3: Apply their knowledge to select right kind of sensors/transducer for application in hand.

AEIE2205.4: Analyze the response of the sensors/transducers for fruitful information.

AEIE2205.5: Judge the performance of the sensors.

AEIE2205.6: Design signal conditioning unit for the sensors.

a. Detailed Syllabus

MODULE I – [9L]

Sensors/Transducers: Introduction to sensors, sensing/transduction principles, classifications, basic requirements.
Resistive type: Potentiometer, strain gauge- principle, material, signal conditioning unit (SCU), applications.
Capacitive type: Principle, SCU and applications.

MODULE II – [9L]

Inductive transducers: Variable reluctance type proximity pickup, LVDT.
Piezoelectric transducer: Materials, signals conditioning circuit, frequency response, ultrasonic sensors and applications, seismic accelerometer.
Hall sensors.

MODULE III – [9L]

Temperature sensors: thermocouples, RTD, thermistors and their signal conditioning unit
Optical sensors: Photovoltaic, photoelectric, infrared sensors and their applications.

MODULE IV – [9L]

Intelligent devices: Intelligent instruments, smart sensors and architecture, smart sensor network, smart transmitters.
Introduction to MEMS: Accelerometer, gyroscope, magnetometer.

b. Textbooks

- D. V. S. Murty, *Transducer and instrumentation*, PHI, second edition, 2008.
- A. K. *Ghosh*, Introduction to transducers, PHI, 2015

c. References:

- E. A. Doebelin, *Measurement Systems: Application and Design*, Mc Graw Hill, New York
- H. K. P. Neubert, *Instrument Transducers*, Oxford University Press, London and Calcutta.
- J. P. Bentley, *Principle of Measurement Systems, Pearson Education, Third edition*.
- Jacob Fraden, Handbook of Modern Sensors: Physics, Designs and applications, Third edition, Springer International, 2010.

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 Sortusing 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.

Syllabus of 5th Semester

A. THEORY COURSES

Paper Name: **Database Management Systems**					
Paper 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.

Paper Name: **Formal Language & Automata Theory**					
Paper 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.

Paper Name: **Introduction to Artificial Intelligence**					
Paper Code: **CSEN3104**					
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:

CSEN3104.1. 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.

CSEN3104.2. Comprehend the importance of knowledge as far as intelligence is concerned and the fundamentals of knowledge representation and inference techniques.

CSEN3104.3. Apply this knowledge so that it can be used to infer new knowledge in both certain and uncertain environment

CSEN3104.4. Apply various AI searching algorithms, like state-space search algorithm, adversarial search algorithm, constraint satisfaction search algorithm as and when required.

CSEN3104.5. 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.

CSEN3104.6. 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.

Paper Name: **Data Mining**

Paper Code: **CSEN3105**					
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:
CSEN3105.1 Learn the concepts of data mining and its applications.
CSEN3105.2 Apply preprocessing statistical methods for any given raw data.
CSEN3105.3 Understand and apply different supervised classification algorithms to real-world problems.
CSEN3105.4 Analyze the frequent patterns using association analysis algorithms like Apriori, FP-growth etc.
CSEN3105.5 Understand the concept of ensemble classifiers and their applications.
CSEN3105.6 Understand the concept of clustering and different cluster analysis methods.

2. Detailed Syllabus

Module 1 [9L]

Introduction : Basics of Data Mining? Why do we need data mining? Data mining Architecture, Data mining goals and techniques. Challenges in Data Mining.

Data pre-processing: Data cleaning, Data transformation and Data reduction. Applications

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]

Data mining algorithms: Supervised Classification Techniques: Bayesian Network: Bayes' theorem, Naïve

Bayes and Gaussian Naive Bayes; classifier. K-nearest neighbor . Decision Tree: Gini index, Information gain.

Support Vector Machines (SVM): Maximum margin hyperplanes, Linear SVM: separable case, non-separable case, Non-linear SVM and kernels.

Module 3 [9L]

Ensemble Methods, Association Rule Mining: Ensemble Methods: Bagging, Boosting, Random Forests Association Rule Mining: Introduction, rules and item-set generation Frequent item-set generation, (Apriori principle, candidate generation and pruning), Compact representation of frequent item sets, correlation analysis, 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, K-means++. 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, Third Edition, C. Bishop, Springer, 2006.

3. Neural Networks and Learning Machines, Third Edition, S. Haykin, PHI Learning, 2009.

Professional Elective-I

Paper Name: **Web Technologies**					
Paper 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. Introduction to Web Technology By Pankaj Sharma

2. Web Technology By Gopalan and Akilandeswari

Paper Name: **Introduction to Soft Computing**

Paper Code: **CSEN3136**					
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:

CSEN3136.1. Learn about soft computing techniques and their applications.

CSEN3136.2. Understand Local and Global optimal solutions for complex optimization problems.

CSEN3136.3. Analyze various neural network architectures.

CSEN3136.4. Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.

CSEN3136.5. Understand the genetic algorithm concepts for real life problems.

CSEN3136.6. Identify and select a suitable Soft Computing technology to solve the problem; construct a solution and implement a Soft Computing solution.

2. Detailed Syllabus

Module I [9L]:

Introduction: Introduction to Soft Computing, Different tools and Techniques, Usefulness and applications. **Fuzzy sets and Fuzzy logic:** Introduction - Definition, Fuzzy sets versus crisp sets, Fuzzy Membership Functions, Fuzzification & De-Fuzzification, Fuzzy set theoretic operations, Fuzzy Arithmetic, Extension Principle, Fuzzy numbers, Linguistic variables, Fuzzy logic, Linguistic hedges, Fuzzy rules and fuzzy reasoning, Fuzzy inference systems, Introduction to Rough Set.

Module II [9L]:

Artificial Neural Network: Introduction, Supervised & Unsupervised Learning, basic models, Hebb's learning, Perceptron, Multilayer feed forward network, Back propagation algorithm, Competitive learning, Self-Organizing Feature Maps, Introduction to Convolution and Recurrent neural network,

Module III [9L]:

Evolutionary Algorithms: Introduction to Genetic Algorithm (GA), GA operators, different types of encoding, selection rules, elitist model, Schema theorem and convergence of Genetic Algorithm, Introduction to MOOA, Pareto optimal front, Multi-Objective Genetic Algorithm (MOGA). VEGA, NSGA, NSGA-II.

Module IV [9L]:

Swarm Intelligence Techniques: Introduction, Key Principles of Swarm, Overview of Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony Optimization (ABC) techniques with Applications, Introduction to Granular Computing.

Advance Neural Network Systems: Genetic Algorithm for Neural Network Design and Learning, Basic idea of 3rd generation Neural networks, Spike Neural networks.

3. Textbooks:

1. Davis E. Goldberg, GeneticAlgorithms: Search, Optimization and Machine Learning, Addison Wesley

2. Cin- Teng- Lin , C. S. George Lee, Prentice Hall, Neural Fuzzy Systems: A neuro Fuzzy Synergism to intelligent Systems,

3. B.Yegnanarayana, Artificial Neural Networks, PHI

4. S. Rajasekaranand G.A.Vijaylakshmi Pai.Neural Networks FuzzyLogic, and Genetic Algorithms, Prentice Hall of India

4. Reference Books:

1. TimothyJ.Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill

2. K.H.Lee. First Course on Fuzzy Theory and Applications, Springer-Verlag.

Paper Name: **Introduction to Information Retrieval**					
Paper Code: **CSEN3137**					
Contact hours per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

1. Course Outcomes:

After completion of course, students would be able to:

CSEN3137.1. Identify basic theories and analysis tools as they apply to information retrieval.

CSEN3137.2. Develop understanding of problems and potentials of current IR systems.

CSEN3137.3. Learn and appreciate different retrieval algorithms and systems.

CSEN3137.4. Apply various indexing, matching, organizing, and evaluating methods to IR problem

CSEN3137.5. Be aware of current experimental and theoretical IR research.

CSEN3137.6. Analyze and design solutions for some practical problems.

2. Detailed Syllabus:

Module I: (9L)

Information retrieval model, Information retrieval evaluation; Document Representation – Boolean Model, Posting Lists, Inverted Indices, Skip Lists; Query languages and query operation – proximity search, Phrase Queries Meta- data search; Tolerant Retrieval – B-Trees, Permuterm Index, Edit Distance – Different variations

Module II: (9L)

Indexing Construction and Searching – BSBI, SPIMI, Heap's Law Zip's Law; Scoring and ranking feature vectors, tf-idf various schemes; Evaluation and computations of scores and ranked retrieval; Relevance feedback

Module III: (9L)

Text and multimedia languages, Language Models – Query Likelihood Models; Text Classification and Naïve Bayes- Bernoulli model, feature selection; Vector Space Classification – kNN, Rocchio Classification

Module IV: (9L)

Flat Clustering – K means, K medoids, Evaluation of clustering, Models for clustering; Hierarchical Clustering – Single Link, Complete Link, Group Average and Centroid, Inversion Points, DivisiveClustering – Basics; Latent Sematic Analysis – SVD, Low Rank Approximations;

Web Search Basics, Link Analysis – Page Rank, HITS.

3. Text Books:

1. C. D. Manning, P. Raghavan and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008 (available at http://nlp.stanford.edu/IR-book).

2. Chakrabarti, S. (2002). Mining the web: Mining the Web: Discovering knowledge from hypertext data. Morgankaufman. B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, AddisonWesley, 2009 (available at http://ciir.cs.umass.edu/irbook/).

4. Reference Books:

1. R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011 (2ndEdition).

Paper Name: **Randomized Algorithms**					
Paper Code: **CSEN3139**					
Contact hours per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

1. Course Outcome:

2. Detailed Syllabus:

Introduction. Basic Probability Theory. Moments and deviations, Markov and Chebyshev inequalities. Tail Estimates and the Chernoff Bound. Conditional Expectation and Martingales. The Probabilistic Method. Markov Chains and Random Walks.

Sorting: Randomized Quicksort. Analysis. Comparison with average case analysis of deterministic Quicksort.

Searching: Skip Lists. Randomized Incremental Construction. Randomized Data Structures for dynamic data. Randomized Graph Algorithms. Implementation issues. Derandomization.

Applications: Algorithms for Data Streams.

3. Text Books:

1. Randomized Algorithms by Rajeev Motwani and Prabhakar Raghavan. (Cambridge University Press).

4. Reference Books:

2. Computational Geometry: An Introduction through Randomized Algorithms by Ketan Mulmuley, Prentice Hall.

Paper Name: **Advanced Linear Algebra**					
Paper Code: **MATH4122**					
Contact hours per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

1. Course Outcomes:

After successfully completing this course, the students will be able to:

MATH4122.1. Explain concepts of diagonalization, orthogonal diagonalization and Singular Value Decomposition (SVD).

MATH4122.2. Discuss basis, dimension and spanning sets.

MATH4122.3. Design Gram-Schmidt Orthogonalization Process and QR decomposition using concepts of inner product spaces.

MATH4122.4. Analyze Least squares solutions to find the closest line by understanding projections.

MATH4122.5. Define linear transformations and change of basis.

MATH4122.6. Illustrate applications of SVD such as, Image processing and EOF analysis, applications of Linear algebra in engineering with graphs and networks, Markov matrices, Fourier matrix, Fast Fourier Transform and linear programming.

2. Detailed Syllabus:

Module I: [9L]:

Characteristic equations, Eigen Values and Eigen vectors, Diagonalization, Applications to differential equations, Symmetric matrices, Positive definite matrices, similar matrices, Singular Value Decomposition, Generalized Inverses.

Module II: [9L]:

Definition of Field, Vector Spaces, Elementary Properties in Vector Spaces, Subspaces, Linear Sum of Subspaces, Spanning Sets, Linear Dependence and Independence, Basis and Dimension. Application to matrices and system of linear equations.

Module III: [9L]:

Inner Product Spaces, Concept of Norms, Orthogonality, Projections and subspaces, Orthogonal Complementary Subspaces, Orthogonal Projections, Gram-Schmidt Orthogonalization Process, Least square approximations, QR decomposition.

Module IV: [9L]:

Linear Transformations, kernels and images, The Rank-Nullity-Dimension Theorem. Matrix representation of a Linear Transformation, Change of Basis, Linear space of linear mappings.

3. Text Book:

1. Linear Algebra and its Applications: Gilbert Strang (Thomson Brooks/Cole Cengage Learning)

4. Reference Books:

1. Matrix Computations: Gene H. Golub, Charles F. Van Loan (JHU Press)

2. Linear Algebra: Kenneth M. Hoffman, Ray Kunze (Prentice-Hall)

3. Linear Algebra A Geometric Approach: S. Kumaresan(PHI)

B. PRACTICAL COURSES

Paper Name: **Database Management System Lab**					
Paper 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.

Paper Name: **Introduction to AI Lab**					
Paper Code: **CSEN3154**					
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:

CSEN3154.1. Remember and understand the working principles of PROLOG/ LISP

CSEN3154.2. Apply LIST structure of PROLOG as and when required

CSEN3154.3. Make use of CUT to the programs as and when required

CSEN3154.4. Solve the problems by using accumulator

CSEN3154.5. Apply the principles of reasoning and inference to real world problems

CSEN3154.6. 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.

Paper Name: **Data Mining Lab**					
Paper Code: **CSEN3155**					
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:

CSEN3155.1 Understand the errors and noises present in data and apply various techniques to clean them.

CSEN3155.2 Learn, implement and compare various classification algorithms

CSEN3155.3 Learn, implement and compare various clustering algorithms

CSEN3155.4 Understand and implement a-priori and FP-tree algorithms for association rule mining

CSEN3155.5 Analyze the problem (data) and use appropriate algorithm to data mining problems

CSEN3155.6 Apply data mining algorithms on real-world data

2. Detailed Syllabus

1. Preprocessing of Data

(i) Data set generation

(ii) Identification and cleaning of data

(iii) Noise removal from data

2. Familiarization with

(i) Python

(ii) TensorFlow

3. Classifiers

(i) K-NN

(ii) Naïve Bayes Classifier

(iii) Decision Tree

(iv) Support Vector Machine

4. Clustering Algorithms

(i) K-Means

(ii) DB-Scan

(iii) Hierarchical Clustering

5. Association Rule Mining – Frequent item set and Rule generation

(i) A-priori Algorithm

(ii) FP-Tree

(iii) Rule Generation

3. Textbooks

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

2. Pyhon for Data Analysis, Wes McKinney, O'Reilly, 2017.

4. Reference Books

1. Introduction to Data Mining, P. N. Tan, M. Steinbach and V. Kumar, Pearson Publishers.

Paper Name: **Object Oriented Programming**					
Paper Code: **CSEN3112**					
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:

CSEN3112.1. Understand the principles of object-oriented programming.

CSEN3112.2. Compare the relative merits of C++ and Java as object-oriented programming languages.

CSEN3112.3. Understand the importance of error management and incorporate exception-handling in object-oriented programs.

CSEN3112.4. Apply multithreading techniques to improve performance.

CSEN3112.5. Apply the features of C++ and Java supporting object-oriented programming to develop modular applications.

CSEN3112.6. Analyze 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.

Paper Name: **Object Oriented Programming LAB**					
Paper Code: **CSEN3162**					
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:

CSEN3162.1. Apply object-oriented principles or features in software design process to develop C++ and Java programs for real life applications.

CSEN3162.2. Reduce the complexity of procedural language by employing operator overloading, inheritance and exception handling techniques for developing robust and reusable software.

CSEN3162.3. Develop programs using stream classes for various I/O operations and design concurrent programs using threads to maximize the use of processing power.

CSEN3162.4. Design applications for text processing using String class and develop user interactive applications using event handling.

CSEN3162.5. 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

Paper Name: **Software Engineering**					
Paper 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.

Paper Name: **Fundamentals of Machine Learning**					
Paper Code: **CSEN3203**					
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:

CSEN3203.1. Learn and understand the basics of machine learning approaches and paradigm.
CSEN3203.2. Understand and describe various machine learning algorithms.
CSEN3203.3. Understand complexity of Machine Learning algorithms and their limitations.

CSEN3203.4. Mathematically analyse various machine learning approaches and paradigms
CSEN3203.5. Analyse various machine learning techniques to get an insight of when to apply a particular machine learning approach.
CSEN3633.6. 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.

Paper Name: **Economics for Engineers**					
Paper 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.

Professional Elective-II

Paper Name: **Cloud Computing**					
Paper 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.

Paper Name: **Big Data**					
Paper 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.

3. MapReduce Design Patterns, Donald Miner and Adam Shook. O'Reilly, 2012.

Paper Name: **Advanced Operation Research**					
Paper Code: **CSEN3237**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcome:

2. Detailed Syllabus:

Advanced Linear Programming:

The Revised Simplex Algorithm, Complexity of the Simplex Algorithm, Bounded Variable Technique, Decomposition Principle, Karmarkar Interior Point Algorithm

Sensitivity Analysis:

Introduction, Change in the Cost Vector, Changes in the Right – Hand Side Vector, Change in the Constraint Matrix, Special Cases, Parametric Programming

Project Management:

Introduction, Critical Path Method, Critical Path Determination, Optimal Scheduling by CPM, Project Evaluation & Review Technique

Sequencing Problems:

Introduction, Problem of n – Jobs & 2 Machines, Problem of n – Jobs & m – Machines, 2 – Jobs on Ordered m – Machines

Integer Programming:

Introduction, Branch & Bound Algorithm, Traveling Salesman Problem, Cargo Loading Problem

Dynamical Programming:

Introduction, Formulation, Recursive Relations, Continuous Cases, Discrete Cases, Forward Recursions, Linear Programming vs Dynamic Programming

Non – Linear Programming:

Introduction, Lagrange Multipliers Method, Convex Non- Linear Programming Problem, Kuhn – Tucker Theory, Quadratic Programming, Separable Programming, Duality in Non – Linear Programming

Search Techniques:

Unimodal Function, Dichotomous Search Method, Fibonacci Search Method, Golden Section Method, Steepest Descent Method, Conjugate Gradient Method

Geometric Programming:

Introduction, Unconstrained Posynomial Optimization, Constrained Posynomial Optimization,

Goal Programming:

Introduction, Standard Form of LGPP, Partitioning Algorithm, Grouping Algorithm

Random Number & Simulation:

(a) Random Number

Introduction, Random Number Generations – Methods, Generation of Pseudo Random Numbers

[a) Mid - Square Method, b) Congruential Method], Problems

(b) Simulation

Introduction, Advantages and Limitations of Simulations Techniques, Monte Carlo Simulation, Application

Books:

1. H. A. Taha: Operation Research-An Introduction, Maxwell Macmillan.

2. Wayne L. Winston: Operation Research-Applications and Algorithms, Thomson.

3. Hiller Liberman: An Introduction to Operation Research, TMH

4. H. S. Kasana and K. D. Kumar: Introductory Operations Research [Theory and Application] Springer International Edition.

5. S. Bhaskar: Operations Research, Anuradha Agencies

6. K. Kannan: Operarions Research, Anuradha Agencies

7. V. K. Kapoor: Operarions Research, Anuradha Agencies

8. Kanti Swaroop: Operarions Research, Anuradha Agencies

Paper Name: **Stochastic Theory**					
Paper Code: **CSEN3238**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Open Elective-I

Paper Name: **Fundamentals of Sensors and Transducers**					
Paper 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
AEIE3222.1. Select the best fit transducers, including those for measurement of temperature, strain, motion, position and light intensity
AEIE3223.1. Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like displacement stress, force, acceleration flow, etc.
AEIE3224.1. Acquire knowledge on high temperature sensing systems used in steel, aluminum, copper plants.
AEIE3225.1. Acquire knowledge on Smart sensors.
AEIE3226.1. Identify different types 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.

Paper Name: **Designing with Processors and Controllers**					
Paper Code: **ECEN3222**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After completing the course the student will be able to:

1. Understand microprocessors and microcontrollers – their operation and programming.

2. Identify RISC processors from CISC processors and apply them in circuits.

3. Analyse operations of different serial and parallel buses and interrupts.

4. Evaluate different hardware designs and memory configurations.

5. Write RTOS for complex processor-based designs.

6. Design processor and controller based intelligent systems for real life problems.

2. Detailed Syllabus:

Module I [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 II [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 III [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 IV [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.

3. Text Books:

1. David Simon, "An Embedded Software Primer", (Addison Wesley), 2000.

2. Jack Ganssle, "The Art of Designing Embedded Systems", (Newnes), 1999.

3. G. Osborn, ―Embedded microcontroller and processor design‖, (Pearson)

4. S. Heath, ―Embedded System design ―, (Elsevier)

5. Steve Furber, ARM System-on-Chip Architecture, (Pearson)

4. Reference Books:

1. Shibu, ―Introduction to Embedded Systems‖ K. V. (TMH)

2. Frank Vahid, Tony Givargis, ―Embedded System Design – A unified hardware and software introduction:‖ (John Wiley)

3. Rajkamal ―Embedded Systems‖: (TMH)

4. L. B. Das ―Embedded Systems‖ (Pearson)

5. RTS: Real-Time Systems, by C.M. Krishna and Kang G. Shin, McGraw-Hill, 1997, ISBN 0-07-057043.

6. J. A. Stankovic and K. Ramamritham, Advances in Hard Real-Time Systems, IEEE Computer Society Press, Washington DC, September 1993, 777 pages. Selected papers and references

Paper Name: **Analog And Digital Communication**					
Paper Code: **ECEN3223**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After completing the course the student will be able to:

1. Explain the necessity of communication, its history, evolution, the role of efficient communication in the present day.
2. Understand & apply the concepts of various types of signals, techniques for signal transmission and signal modulation from the knowledge gathered earlier.

3. Identify various parameters associated with Amplitude and frequency Modulation, time and frequency domain representations, side band frequencies etc and apply these knowledge to solve numerical problems.
4. Apply sampling theorem to sample analog signal properly and differentiate among pulse modulation & demodulation techniques and understand PCM, DPCM.
5. Analyze performance of various digital modulation & demodulation techniques and understand concept of OFDM and Spread Spectrum Modulation system.
6. 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

2. Detailed Syllabus:

Module I –[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 II –[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 III –[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 IV –[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. Text Books:

1. Taub and Schilling , ―Principles of Communication Systems‖, 2nd ed., Mc-Graw Hill

2. B.P.Lathi -Communication Systems- BS Publications

3. V Chandra Sekar – Analog Communication- Oxford University Press

4. Reference Books:

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

2. Proakis & Salehi Fundamentals of Communication Systems- Pearson

3. Singh &Sapre—Communication Systems: 2/e, TMH

4. P K Ghosh- Principles of Electrical Communications- University Press

5. L.W.Couch Ii, ―Digital and Analog Communication Systems‖, 2/e, Macmillan Publishing

6. Blake, Electronic Communication Systems- Cengage Learning

7. S Sharma, Analog Communication Systems- Katson Books

Paper Name: **Computational Mathematics**					
Paper Code: **MATH3221**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

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.Analyze the properties of networks by invoking graph theoretic concepts such as connectivity, matchings, colouring 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 I:

Sums: Sums and recurrences, manipulation of sums, multiple sums, general methods, finite and infinite calculus, infinite sums 9L

Module II:

Binomial coefficients and special numbers: Basic identities involving binomial coefficients. Bernoulli numbers, Euler numbers, harmonic numbers, Fibonacci numbers, recurrence relations for these numbers. 9L

Module III:

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). 9L

Module IV:

Generating functions:Basic manoeuvres, well-known sequences and their generating functions, using generating functions to solve recurrences, generating functions for special numbers. 9L

3. Text Books:

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

4. Reference Books:

2. Douglas B. West, Introduction to Graph Theory', Pearson

Paper Name: **Scientific Computing**					
Paper Code: **MATH3223**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After successfully completing this course the students will be able to:

MATH3223.1: Analyze 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 I

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 II

Eigen Value problems:

- QR algorithm
- Power Method
- Linear least square data fitting
- Singular Value Decomposition

Module III

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 IV

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. Text Books:

1. Trefethen L. N. and Bau D. Numerical Linear Algebra, SIAM

2. Watkins D. S. Fundamentals of Matrix Computation, Wiley

3. Smith G. D. Numerical Solutions to Partial Differential Equations, Oxford University Press

4. Jain M. K. and Iyengar S.R.K. Numerical methods for scientific and engineering computation

5. Conte S. D. and Boor C. D. Elementary Numerical Analysis - An Algorithmic Approach, McGraw Hill

6. Atkinson K. E. Introduction to Numerical Analysis,John Wiley

4. Reference Books:

1. Golub G. H. and Van Loan C.F. Matrix Computation, John Hopkins U. Press, Baltimore

2. Stewart G. W. Introduction to Matrix Computations, Academic Press

3. Demmel J.W. Applied numerical linear algebra, SIAM, Philadelphia

4. Jain M.K. Numerical Solutions of Differential Equations

5. Smith, Numerical solutions of partial Differential Equations (Finite difference methods)

6. Heath M. T., Scientific Computing: An Introductory Survey, McGraw Hill

7. Joe D. Hoffman, Numerical Methods for Engineers and Scientists, McGraw Hill

8. W. Layton and M. Sussman, Numerical Linear Algebra.

Paper Name: **Indian Constitution and Civil Society (Mandatory)**					
Paper Code: **INCO3016**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	2	0	0	2	0

1. Course Outcomes

The learner will be able to:

1. Analyze the historical, political and philosophical context behind the Indian Constitution making process

2. Appreciate the important principles characterizing the Indian Constitution and institute comparisons with other constitutions

3. Understand the contemporaneity and application of the Indian Constitution in present times

4. Critique the contexts for constitutional amendments in consonance with changing times and society

5. Establish the relationship between the Indian Constitution and civil society at the collective as well as the individual levels

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 II-6L

Salient Features of the Indian constitution. Comparison with the constitutions of other countries

Module III-6L

Relevance of the Constitution of India. Constitution and Governance. Constitution and Judiciary. Constitution and Parliament- Constitutional amendments.

Module IV-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. C.M.Elliot, (ed.), Civil Society and Democracy, OUP, Oxford, 20012..

2. David Held et.al (ed),The Idea of the Modern State, Open Univ. Press, Bristol, 1993

3. Neera Chandoke, State and Civil Society, Sage, Delhi, 19953

Paper Name: **Software Engineering Lab**					
Paper 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

Paper Name: **Fundamentals of Machine Learning Lab**					
Paper Code: **CSEN3253**					
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:

CSEN3253.1. Write code the machine learning algorithm in C or Python.

CSEN3253.2. Understand and conceptualize the methods of machine learning and its applications.

CSEN3253.3.Design simple algorithms for pattern classification, code them with Python programming language and test them with benchmark data sets.

CSEN3253.4.Write program analyze and evaluate simple algorithms for pattern classification.

CSEN3253.5.Analyze and evaluate simple algorithms of estimation.

CSEN3253.6. Design complex machine learning algorithms using tools like Excel, R, TensorFlow, Weka.

2. List of Experiments:

- Regression (single and Multiple Variables) linear and non-liner;
- Logistic regression
- Classifiers - K-NN; Naïve Bayes Classifier; Perceptron; Multi Layer Perceptron.
- Clustering Algorithms - K-Means; DB-Scan
- Familiarization with a few ML Tools Excel; WEKA; R; Python; TensorFlow
- Applications of ANN and SVM using ML tools

Paper Name: **Term Paper and Seminar**					
Paper 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.

4th Year

Paper Name: **Principles of Management**					
Paper Code: **HMTS4101**					
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:

HMTS4101.1. Study the evolution of Management.

HMTS4101.2. Understand various management functions and have some basic knowledge on different aspects of management.

HMTS4101.3. Understand the planning process in an organization.

HMTS4101.4. Understand the concept of organizational structure.

HMTS4101.5. Demonstrate the ability to direct, lead and communicate effectively.

HMTS4101.6. Analyze and isolate issues and formulate best control methods.

2. Detailed Syllabus

Module 1 [8L]

Management: Definition, nature, purpose and scope of management. Skills and roles of a Manager, functions, principles; Evolution of Management Thought: Taylor Scientific Management, Behavioural Management, Administrative Management, Fayol's Principles of Management, Hawthorne Studies.

Types of Business organization -Sole proprietorship, partnership, company-public and private sector enterprises -Organization culture and Environment –Current trends and issues in Management.

Module 2 [8L]

Planning: Types of plans, planning process, Characteristics of planning, Traditional objective setting, Strategic Management, premising and forecasting.

Organizing: Nature and Purpose-Formal and informal, organizational chart, organization structure-types-line and staff authority, departmentalization, delegation of authority, centralization and decentralization.

Controlling: Concept, planning-control relationship, process of control, Types of Control, Control Techniques Human Resource Management-HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management.

Module 3 [8L]

Directing: Foundations of individual and group behaviour –motivation –motivation theories –motivational-Techniques –job satisfaction –job enrichment –leadership –types and theories of leadership –Communication –process of communication–barrier in communication –effective communication –communication and IT

Decision-Making: Process, Simon's model of decision making, creative problem solving, group decision-making.

Coordinating: Concepts, issues and techniques.

Module 4 [8L]

Leading: Managing Communication: Nature & function of communication, methods of interpersonal communication, barriers of effective communication, direction of communication flow, role of technology in managerial communication

Motivating Employees: Define motivation, compare and contrast early theories of motivation, compare and contrast contemporary theories of motivation & current issues.

Being an Effective Leader Define leader/ leadership, compare and contrast early theories of leadership, understand three contingency theories, understand modern views on leadership. Motivation, Leadership, Communication, Teams and Teamwork.

Management by Objectives (MBO): Management by exception; Styles of management: (American, Japanese and Indian), McKinsey's 7-S Approach, Self-Management.

3. Reference Books

1. Stephen P. Robbins and Mary Coulter, "Management", Pearson Education, 2017, 13th edition.

2. Koontz H. and Weihrich H., "Essentials of Management", Mcgraw Hill Int. Ed., 2015,10th edition.

3. Bhat And Kumar A. "Management: Principles, Processes & Practices", Oxford University Press, 2016, 2nd edition.

4. Robbins, Coulter, and DeCenzo, "Fundamentals of Management", Pearson Education, 2016, 9th edition.

5. Richard L. Daft, "Management", Cengage Learning, 10th edition

Professional Elective - III

Paper Name: **Cryptography & Network Security**					
Paper Code: **CSEN4132**					
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:

CSEN4132.1. Learn the various types of attacks and their characteristics.

CSEN4132.2. Learn the basics of number theory to understand the mathematical background of cryptography.

CSEN4132.3. Understand the basic concept of encryption and decryption for secure data transmission.

CSEN4132.4. Analyze and compare various cryptography techniques.

CSEN4132.5. Understand the concept of digital signature and its applications.

CSEN4132.6. Learn the basic principle of network security designs using available secure solutions (such as PGP, SSL, IPSec, etc)

2. Detailed Syllabus

Module 1 [9L]

Introduction Need for Security, Security approaches, Principles of Security, Types of attack, Plain text & Cipher text, Substitution Techniques, Transposition Techniques, Encryption & Decryption, Symmetric & Asymmetric key Cryptography, Key Range & Key Size.

Brief Introduction of Number Theory - Euclidean algorithm, Euler's totient function, Fermat's theorem and Euler's generalization, Chinese Remainder Theorem, primitive roots and discrete logarithms, Quadratic residues, Legendre and Jacobi symbols.

Module 2 [9L]

Symmetric Key Cryptography Overview, Block Cipher, DES algorithm, AES algorithm, IDEA algorithm, Blowfish, RC5 algorithm.

Asymmetric Key Cryptography Overview, RSA, Key Management – Key Distribution, Diffie-Hellman Key Exchange Algorithm, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Module 3 [9L]

Authentication Methods Message Digest, Kerberos. Digital Signatures Algorithms (DSA, ElGamal signature, ECDSA), Digital Signature Standard, Authentication Protocols.

Module 4 [9L]

Email Security PGP, MIME, S/MIME.

Protocols IP Sec-Architecture, AH protocol, Encapsulating Security Payload (ESP) Protocol, ISAKMP Protocol, Oakley Key Determination Protocol, VPN.

Web Security SSL, Firewalls.

3. Reference Books

1. Cryptography and Network Security: Principles and Practice, 7/E, William Stallings, Pearson.

2. Cryptography and Network Security, 3rd Edition, Atul Kahate, McGraw Hill Education (India) Private Limited.

3. Cryptography and Information Security, 2nd Edition, V. K. Pachghare, PHI Learning Private Limited

Paper Name: **Image Processing**					
Paper Code: **CSEN4133**					
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:

CSEN4133.1. Understand the general terminology, basic concepts and applications of digital image processing.

CSEN4133.2. Implement two dimensional filters in both spatial and frequency domain for image enhancement.

CSEN4133.3. Analyze and develop various image restoration techniques.

CSEN4133.4. Evaluate the methodologies for image segmentation, compression etc.

CSEN4133.5. Implement various morphological algorithms.

CSEN4133.6. Apply image processing algorithms in practical applications.

2. Detailed Syllabus

Module 1 [8L]

Introduction: Background, Digital Image Representation, Fundamental steps in Image Processing, Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display.

Digital Image Formation: A Simple Image Model, Geometric Model- Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization - Uniform & Non uniform.

Mathematical Preliminaries: Neighbor of pixels, Connectivity, Relations, Equivalence & Transitive Closure; Distance Measures, Arithmetic/Logic Operations, Fourier Transformation, Properties of the two-dimensional Fourier Transform,

Discrete Fourier Transform, Discrete Cosine & Sine Transform.

Module 2 [8L]

Image Enhancement: Spatial Domain Method, Frequency Domain Method, Contrast Enhancement -Linear & Nonlinear Stretching, Histogram Processing; Smoothing - Image Averaging, Mean Filter, Low-pass Filtering; Image Sharpening. Highpass Filtering, High-boost Filtering, Derivative Filtering, Homomorphic Filtering; Enhancement in the frequency domain -Low pass filtering, High pass filtering.

Digital Image Transforms: Basis for transformation, Introduction to Fourier Transform, DFT, FFT, Properties of Fourier Transform, DCT, Walsh Transform, Hadamard Transform, Haar Transform.

Module 3 [7L]

Image Restoration: Degradation Model, Discrete Formulation, Algebraic Approach to Restoration - Unconstrained & Constrained; Constrained Least Square Restoration, Restoration by Homomorphic Filtering, Geometric Transformation -

Spatial Transformation, Gray Level Interpolation.

Image Compression: Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, Run length coding, Bit-plane encoding, Bit-allocation, JPEG, Lossless predictive coding, Lossy predictive coding.

Module 4 [10L]

Morphological Image Processing: Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Reconstruction by dilation and erosion.

Image Segmentation: Point Detection, Line Detection, Edge detection, Combined detection, Edge Linking & Boundary Detection - Local Processing, Global Processing via The Hough Transform; Thresholding – Iterative thresholding, Otsu‘s method, multivariable thresholding, Region Oriented Segmentation - Basic Formulation, Region Growing by Pixel

Aggregation, Region Splitting & Merging, Watershed algorithm.

3. Reference Books

1. Digital Image Processing, Gonzalves, Pearson

2. Digital Image Processing, Jahne, Springer India

3. Digital Image Processing & Analysis, Chanda &Majumder, PHI

4. Fundamentals of Digital Image Processing, Jain, PHI

5. Image Processing, Analysis & Machine Vision, Sonka, VIKAS

6. Getting Started with GIS- Clarke Keith. C; PE.

7. Concepts & Techniques of GIS - Lo C.P, Albert, Yeung K.W- PHI.

Paper Name: **Pattern Recognition**					
Paper Code: **CSEN4135**					
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:

CSEN4135.1. Learn and understand feature, pattern and the problem of pattern recognition.

CSEN4135.2. Understand and describe the difference between supervised and unsupervised learning.

CSEN4135.3. Understand and apply pattern recognition algorithm that utilizes supervised learning.

CSEN4135.4. Understand and apply pattern recognition algorithm that utilizes unsupervised learning.

CSEN4135.5. Analyze pattern recognition algorithms and techniques.

CSEN4135.6. Design simple pattern recognition systems.

2. Detailed Syllabus

Module 1 [9L]

Introduction – Definitions, Representations of Patterns and Classes, overview of different approaches, Metric and non-metric measures. Feature selection criteria and algorithms; Minimum distance classifiers, k-NN rule, Discriminant functions (linear and non-linear), parametric and nonparametric learning.

Module 2 [9L]

Decision Trees, Bayesian classification, Decision Boundaries, training and test sets, Neural network models for pattern recognition - Perceptron, Multi-layer Perceptron, some applications.

Module 3 [9L]

Clustering techniques – Unsupervised learning, basic hierarchical and non-hierarchical clustering algorithms, c-means, fuzzy c-means, DBSCAN, Concepts of hierarchical clustering, Clustering Large datasets.

Module 4 [9L]

Dimensionality reduction, principal components analysis, independent component analysis, some applications, some advanced topics with applications, (e.g., neuro-fuzzy approach, genetic algorithms, data mining).

3. Reference Books

1. Devi V.S.; Murty, M.N., Pattern Recognition: An Introduction, Universities Press, Hyderabad, 2011.

2. R. O. Duda, P. E. Hart and D. G. Stork: Pattern Classification and Scene Analysis, 2nd ed., Wiley, New York, 2000.

3. 2. J. T. Tou and R. C. Gonzalez: Pattern Recognition Principles, Addison-Wesley, London, 1974.

4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

5. K. Fukunaga: Introduction to Statistical Pattern Recognition, 2nd eel, Academic Press, New York, 1990.

6. A. K. Jain and R. C. Dubes: Algorithms for Clustering Data, Prentice Hall, Englewood Cliffs, 1988.

7. Neural Networks and Learning Machines, Simon Haykin, Third Edition, PHI Learning, 2009.

Paper Name: **Fundamentals of Computer Networks**					
Paper Code: **CSEN4137**					
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:

CSEN4137.1. Learn the terminology and concepts of the OSI reference model, TCP-IP reference model and the need for the layered architecture.

CSEN4137.2. Understand the concepts of protocols, network interfaces, and design/performance issues in local area networks and wide area networks

CSEN4137.3. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies

CSEN4137.4. Demonstrate various types of routing techniques

CSEN4137.5. Defend and argue the various quality of service measures to improve network throughput.

CSEN4137.6. 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; Classful 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.

Paper Name: **Business Analytics**					
Paper Code: **CSEN4138**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Open Elective-II

Paper Name: **Instrumentation and Telemetry**					
Paper Code: **AEIE4121**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After the completion of the course students will be able to

1. Understand different blocks of generalized measurement system.

2. Clarify operation of indigenous sensors and transducers.

3. Gain knowledge of measurement system for industrial parameters like pressure, flow, level and temperature.

4. Design various signal conditioning circuits for sensors.

5. Select telemetry system required for a given application.

6. Justify the need of process data multiplexing and de-multiplexing in telemetry.

2. Detailed Syllabus

Module I – [8L]

Generalized measurement system. Introduction to telemetry principles: Basic systems, classifications, non electrical telemetry systems, voltage and current telemetry systems.

Sensors and transducers: resistive, capacitive, inductive, magnetostrictive, piezoelectric, hall sensor, optical, and applications.

Module II – [10L]

Measurement of pressure and vacuum: Introduction, diaphragm, capsule, bellows, bourdon tube, DP transmitters, Mcleod gauge, pirani gauge.

Flow rate measurement: head type flow meters – orifice, pitot tube, venturimeter; electromagnetic flow meters; ultrasonic flow meters.

Level measurement: float and displacers type instruments, resistive and capacitive type level instrument; D/P type sensors; ultrasonic level instruments.

Temperature measurement: thermocouple, RTD, thermistors, pyrometer.

Module III – [10L]

Data handling system: signal conditioning circuits, instrumentation amplifiers, ADC, DAC. Basic classification of telemetry systems: voltage, current, position, frequency and time, components of telemetry and remote control systems, sampling theorem, sample and hold, quantization error, data conversion, coding, introduction to fiber optic communication system.

Module IV – [8L]

Multiplexing; time division multiplexers and de-multiplexer theory, scanning procedures, frequency division multiplexers with constant and proportional bandwidth, de-multiplexers.

Fundamentals of radio-telemetry system, RF link system design, pipeline telemetry; power system telemetry, PSK, QPSK , FSK, IEEE 802.11, Introduction to IoT.

3. References:

1. D. Patranabis, Telemetry principles, TMH, New Delhi

2. E. L. Gruenberg, Handbook of Telemetry and Remote control, Mc Graw Hill

3. B. P. Lathi, Modern Digital and Analog Communication Systems, Oxford University Press

4. Ginz Beng "Fundamentals of Automation and Remote Control".

5. Feng Zhao and Leonidas. J. Guibas, Wireless Sensor Networks: An Information Processing Approach, Morgan Kaufmann.

6. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press.

Paper Name: **Linear Control Systems and Applications**					
Paper Code: **AEIE4122**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

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

1. Derive mathematical model of physical and simulated systems.

2. Execute block diagram reduction and signal flow graph to calculate overall system gain.

3. Investigate the time response of systems and calculate performance indices.

4. Analyze the stability of linear systems using Routh stability criterion and root locus method.

5. Explain frequency response of a process and determine stability using Bode plot.

6. Understand the concept and utility of control actions and its usages

2. Detailed Syllabus:

Module-I [9L]

Concepts of control systems: open loop and closed loop control systems, effect of feedback in control system; mathematical model of physical system: differential equation representation of physical systems, transfer function, block diagram representation and reduction, signal flow graphs.

Module-II [8L]

Standard test signals, time response analysis: transient and steady state response of first order and second order processes, steady state error coefficients, performance indices, effect of pole–zero addition in system response.

Module- III [10L]

Stability analysis: characteristic equation and concept of stability; Routh stability criterion; root locus technique and stability analysis from root locus plot.

Introduction to frequency domain analysis; Bode plot for stability analysis: minimum and non- minimum phase system, concept of phase margin and gain margin.

Module –IV [9L]

Control elements: dc servomotors, ac servomotors, dc motor speed and position control.

Basic control actions: P, PI, PD and PID controller and applications. Case study: Level and flow control.

3. References:

1. Nagrath I. J. and Gopal M., Control System Engineering, 5th Ed., New Age International Private Ltd. Publishers.

2. Kuo B. C., Automatic Control Systems, 8th Ed., Wiley India

3. Ogata K., Modern Control Engineering, 4th Ed., Pearson Education.

4. Dorf R. C. and Bishop R. H., Modern Control Systems; Pearson Education.

5. Norman S. N., Control Systems Engineering, 4th Ed., Wiley India.

6. B.W. Bequette, Process Control Modeling, Design and Simulation, Prentice Hall of India, New Delhi.

Paper Name: **Industrial Total Quality Management**					
Paper Code: **CHEN4121**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Prerequisites: Mathematics I , Mathematics II

1. Course Outcomes:

After completion of the course students will be able to:

1. identify and control the quality of processes and hence that of products or goods & services by applying basic statistical tools.

2. draw various types of Control Charts and analyze to ascertain the state of the process.

3. develop different sampling plans to evaluate the quality of various types of defects.

4. apply the techniques of Quality Circles and Kaizen in order to enhance work culture and Total Quality status in an organization.

2. Detailed Syllabus:

Module I [10L]

Basic concepts:

Three paradigms of management and evolution of concept of quality management,

Organization:

Its basic objectives and goal, Mission and Vision, customer and secondary customer, Deming's wheel, bottom line: profit vs quality, historical developments with contribution of different scientists. Basic statistical concepts associated with quality management, measurement of central tendency and dispersion, range versus variance, Random variables and expected value calculations, quality and process capability, probability distributions, concept of statistical quality control.

Module II [10L]

Tools and techniques for improvement in TQM: type A and type B techniques with a special reference to SWOT Analysis, brainstorming, stratification, Pareto Analysis, Ischikawa diagram, check sheet. Use of control charts and process engineering techniques for implementing the quality plan: X—R chart, moving average chart, p-chart and c-chart.

Module III [10L]

Principles of Acceptance sampling: Single–double and multiple sampling, AOQ, AQL, LTPD, Chain sampling plan, Dodge-Romig plan.

Philosophy and concept of quality circle: Formation, steering committee, power and functions of leader, dy. Leader, coordinator, facilitator, case studies.

Module IV [10L]

Principles of Kaizen and Gemba principles. Concept of Six Sigma standards, case studies.

Different standards:

ISO, BS and Bureau of Indian Standards, details of ISO 9000 series, ISO 14000 series and SA 8000, OSHAS 18000 and the certification authorities.

3. Text Books:

1. Grant, Eugene and Leavenworth, Richard, Statistical Quality Control, TMH, 7th Edition2012.

2. Udpa, S R , Quality Circles: Progress through Participation, TMH, 1992.

3. Bedi, Kanishka, Quality Management, Oxford University Press.

4. Books of reference:

1. H. Lal Total Quality Management- A Practical Approach (1st Edition): New Age International, 1990.

2. Sundararaju, S. M., Total Quality Management – A Primer: TMH, 1995.

3. Mitra, Amitava, Fundamentals of Quality Control and Improvement, 2nd Edition.; Prentice- Hall of India, 1998.

4. Subburaj Ramasamy, Total Quality management, Mc-Graw Hill Education (India) Pvt. Ltd, 2012.

Paper Name: **Industrial Pollution Control**					
Paper Code: **CHEN4122**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Paper Name: **Software Defined Radio**					
Paper Code: **ECEN4121**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After completing the course the student will be able to:

1. Understand the technological differences between families of radios.

2. Explain the function of reconfigurable hardware.

3. Analyze the processing techniques required for software defined radio.

4. Evaluate the effects of probability in communication reliability.

5. Analyze the synchronization requirements in SDR and SDR based networks.

6. Analyze functioning of different families of radios.

2. Detailed Syllabus

Module – I [10 L]

Introduction to SDR, Brief history of development of SDR, RF architectures applied in SDR, Processing architectures suitable for SDR, Software environment for SDR. SDR- benefits, problems, GNU radio design.

Module – II [12 L]

Signals and Systems in relation to SDR, Probability in Communications- the effects on reliability, Understanding SDR hardware, Timing and Carrier synchronization, Frame synchronization, Channel coding.

Receive techniques for SDR, Transmit Power, Bandwidth, Spectral Efficiency, Interference.

Module – III [8 L]

OFDM, introduction and implementation of the general model, Channel estimation, Equalization,Power allocation techniques for bits.

Module – IV [6 L]

SDR – some applications, future directions.SDR-3000 series Software Defined Radio Transceiver Systems Smart Antenna API for SDR

Networking and SDR- some case histories, Vehicular networking.

3. Suggested Books:

1. Software Defined Radio for Engineers By T.Collins, Robin Getz, Di Pu, and Alexander M. Wyglinski, Artech House, 2015

2. Cognitive Radio Techniques : Spectrum Sensing, Interference Mitigation and Localization-By Sithamparanathan, Kandeepan; Giorgetti, Andrea, Artech House, 2012

3. Cognitive Radio Technology-By Bates, Martin; Fettee, Bruce A, Elsevier Science &Technology

4. Software Defined Radios : From Smart(er) to Cognitive By Liesbet Van Der Perre, Michael Timmers and SofiePollin, Springer

The titles (2) and (3) are available with British Council Library- on line.

Paper Name: **Error Control Coding for Secure Data Transmission**					
Paper Code: **ECEN4123**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After completing the course the student will be able to:

1. Find the equations for entropy, mutual information and channel capacity for all types of channels, utilizing their knowledge on the elements.

2. Analyze a discrete memory less channel, given the source and transition probabilities.

3. Demonstrate encoder and decoders for Linear Block Codes, Cyclic codes, etc.

4. Apply the concept of modern linear algebra for the error control coding technique.

5. Select decoding algorithms for efficient decoding of Block codes and Convolution codes.

6. Develop overall understanding about different types of codes applied to both source and channel end during data transmission.

2. Detailed Syllabus

Module 1 [10L]

Information theory : Uncertainty and information, measure of information, Self and conditional Information, mutual information and entropy, Fixed length code, Variable length code, Prefix code, Instantaneous code, Kraft Inequality.

Source Code: Source coding theorem, Huffman codes, Shanon- Fano coding, Arithmetic code, Lempel-Ziv algorithm.

Channels: Discrete memory less channel, Channel matrix for different channel models- Lossless channel, Deterministic channel, Noise-less channel, Deterministic channel capacity, channel coding, information capacity theorem, The Shannon limit.

Module 2 [7L]

Block code: Hamming codes Minimum distance, Error detecting and Error-correcting capabilities of block code.

Linear Block Code: Definition & properties of linear block codes, Generator and parity check matrices, Encoding of a linear block code, Decoding of a linear block code, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities.

Module 3 [10L]

Cyclic Code: Definition & properties of cyclic codes, Code Polynomials, Generator Polynomials, Division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes.

Galois Field: Introduction to Linear Algebra: Groups, Fields, binary field arithmetic, Introduction to Galois Field, Primitive elements, generator polynomials in terms of minimal polynomials, Calculation of minimal polynomial.

BCH Code: Concept of BCH Codes, Encoding and Decoding, Reed Solomon Codes.

Module 4 [8L]

Convolution code: Polynomial description of convolution codes, Distance notions for convolution codes and the generating function. Encoding of convolution codes: Systematic and Non-systematic convolution Codes. Decoding of convolution codes: Viterbi decoder, distance and performance bounds for convolution codes. Structural properties of convolution codes: state diagram, state table, state transition table, tree diagram, and trellis diagram.

3. Text Books:

1) Introduction to Error Control Codes - S Gravano; Oxford Press.

2) Information theory, coding and cryptography - Ranjan Bose; TMH.

3) Information and Coding - N Abramson; McGraw Hill.

4. References:

1) Introduction to Information Theory - M Mansurpur; McGraw Hill.

2) Information Theory - R B Ash; Prentice Hall.

3) Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall

Paper Name: **Biology for Engineers**					
Paper Code: **BIOT4223**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

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

1. Understand the basic structure and function of cells and cellular organelles.

2. Understand the fundamental concepts of cellular reproduction and cell metabolism.

3. Characterize the different types of proteins, lipids and carbohydrates.

4. Analyze the mechanism of inheritance of characters through generations.

5. Understand and implement the working principles of enzymes and their applications in biological systems and industry.

6. Design and evaluate different environmental engineering projects with respect to background knowledge about bioresources, biosafety and bioremediation.

2. Detailed Syllabus

MODULE-I: Basic Cell Biology [9L]

Prokaryotic and Eukaryotic cells, Cell theory; Cell structure and function, Cell organelles, Structure and function of DNA and RNA, Central Dogma; Genetic code and protein synthesis, differences between eukaryotic and prokaryotic protein synthesis

MODULE-II: Biochemistry and Cellular Aspects of Life [9L]

Biochemistry of carbohydrates, proteins and lipids; Cell metabolism – Glycolysis, TCA cycle, Fermentation; Cell cycle and cell death; Stem cells and their applications, Basics of Mendelian Genetics

MODULE-III: Enzymes and Industrial Applications [9L]

Enzymes – significance, co-factors and co-enzymes, classification of enzymes; Enzyme kinetics, enzyme inhibition, models for enzyme action; Restriction enzymes; industrial applications of enzymes; enzymes in human gene therapy and disease diagnostics

MODULE-IV: Biodiversity and Bioengineering Innovations [8L]

Molecular motors, Basics of neural networks; Tissue Engineering; Basic concepts of environmental biosafety, bioresources, biodiversity, bioprospecting, bioremediation, biosensors; recent advances in engineering designs inspired by examples in biology

3. Text Books:

1. Wiley Editorial, "Biology for Engineers: As per Latest AICTE Curriculum," Wiley-India, 2018.

2. S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.

4. References:

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, "Biochemistry," W.H. Freeman and Co. Ltd., 6th Ed., 2006.

2. Robert Weaver, "Molecular Biology," McGraw-Hill, 5th Edition, 2012.

3. Jon Cooper, "Biosensors A Practical Approach" Bellwether Books, 2004.

4. Martin Alexander, "Biodegradation and Bioremediation," Academic Press, 1994.

5. Kenneth Murphy, "Janeway's Immunobiology," Garland Science; 8th edition, 2011.

Paper Name: **Optimization and Multi Valued Analysis**					
Paper Code: **MATH4221**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Open Elective - III

Paper Name: **Introduction to Embedded System**					
Paper Code: **AEIE4127**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course outcome:

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

AEIE4127.1. Explain the definitions, components and requirements of the Embedded System.

AEIE4127.2. Acquire knowledge in the area of embedded system using AVR microcontroller.

AEIE4127.3. Develop the interfacing and communication techniques of the Embedded System.

AEIE4127.4. Learn the basic concept of RTOS.

AEIE4127.5. Understand the message passing technique, task synchronization techniques.

AEIE4127.6. Develop algorithms for real time applications of Embedded System.

2. Detailed Syllabus

Module I- [10L]

Introduction to an embedded system: Definition of Embedded Systems, Embedded System V/S General Computing System, Challenges in Embedded System Design, Design Process, Requirements, Examples Of Embedded Systems. Embedded System Architecture: Harvard Vs Princeton, CISC Vs RISC. Introduction to AVR, PIC, ARM and Arduino based systems.

Module II- [10L]

Overview of AVR microcontroller: Introduction to AVR (ATmega328p-pu) microcontroller, pin layout, architecture, program memory, Data Direction register (DDRx), Port Registers (PORTx), PWM registers (8-bit), ADC registers, interrupts, basics of communication, overview and interfacing I/O devices with I 2 C Bus, UART and Serial Peripheral Interchange (SPI) bus.

Module III- [8L]

Embedded operating systems: Operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling; task communication: shared memory, message passing, remote procedure call and sockets, task synchronization: task communication/synchronization issues, task synchronization techniques, device drivers, how to choose an RTOS.

Module IV- [8L]

Hardware Interfacing and Programming with ATmega 328p: Interfacing of LCD, interfacing with analog sensors (i.e LM35, ADXL 335 accelerometer), interfacing of stepper motor, interfacing with a keyboard and MPU6050 (MEMS Accelerometer and Gyroscope) using I 2 C bus.

3. References:

1. Raj Kamal, “Embedded System-Architecture, Programming, Design”, Mc Graw Hill, 2013.

2. Shibu K.V, “Introduction to Embedded Systems”, Tata McGraw Hill, 2009.

3. Elliot Williams, AVR Programming: Learning to Write Software for Hardware, Maker Media, Incorporated, 2014.

4. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, “The AVR Microcontroller and Embedded Systems: Using Assembly and C”; Pearson, 2014.

5. Dhananjay Gadre, “Programming and Customizing the AVR Microcontroller”; McGraw Hill Education, 2014.

6. Silberschatz Galvin Gagne, “Operating System Concepts”, WILEY, 2014.

Paper Name: **Biosensor**					
Paper Code: **BIOT4124**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

At the end of this course students will be able to:

BIOT4124.1. State types of bio-recognition elements and describe the fundamental components required to make a viable biosensor.

BIOT4124.2. Illustrate types of enzyme immobilization methods used to make a biosensor and immobilize it to a transducer for the construction of biosensor.

BIOT4124.3. Describe each types of biosensing element in relation to their uses in biosensors.

BIOT4124.4. Understand the classification, construction and working principle of various transducers.

BIOT4124.5. Understand the concepts, types, working principles and practical applications of important biosensors.

BIOT4124.6. Explain the working principle of different types of inhibition based biosensors.

2. Detailed Syllabus

Module I: Introduction to biological system and Biosensors [9L]

Biosensor: principle, general characteristics; Proteins and enzymes: basic properties, denaturation and renaturation, immbobilization of enzymes; Advantages and limitations of biosensors; Classification of biosensors based on bioreceptor; Immobilization and coupling of bioreceptors.

Module II: Bio-recognition based sensors [9L]

Principle, operation and limitation of: Microbial sensor, Immunological sensor, Nucleic acid sensor. Other bioreceptors (e.g. animal, plant tissue); Different types of inhibitors: principles, operations, applications and limitations.

Module III: Biosensor based on transducer [9L]

Classification of biosensor based on transducer; Calorimetric, Electrochemical (potentiometric, amperometric), Optical, Piezoelectric, Semiconductor biosensor: principle, construction, calibration and limitations.

Module IV: Application of biosensor [8L]

Clinical and diagnostics sector, Industrial sector: Food, Environmental, defense sector; commercially available biosensor.

3. Reference books:

1. Biosensors by Tran Minh Canh. London. Chapman and Hall, 1993.

2. Biosensors Fundamentals and applications, Turner, A.P.F, Karube.I. and Wilson, G.S, Oxford Univ. Press.

3. Engineering Biosensors, kinetics and design applications by Ajit Sadana. San Diego, Academic Press, 2002.

4. D.Thomas and J.M. Laval – Enzyme Technology in concepts in Biotechnology by Balasubramaniam et al, Univ. Press, 1996.

Paper Name: **Statistical Methods in Design of Experiments**					
Paper Code: **CHEN4123**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Paper Name: **Ad Hoc Wireless Networks**					
Paper Code: **ECEN4127**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcome:

After completing the course the student will be able to:

1. Understand the under lying technologies of wireless communication networks.

2. Analyze the various design issues and challenges of Ad hoc Networks.

3. Different routing protocols and their operations will be clear to them.

4. Learn about the contention in MAC layer and ways to solve them.

5. Students will be familiar with the network design strategies to assure adequate QoS.

6. Apply their knowledge to develop new and improved applications.

2. Detailed Syllabus

Module I: [10L]

 Introduction [2L]

Ad hoc wireless networks, Applications of Ad hoc wireless networks. Issues in Ad hoc wireless networks, Static and mobile Ad hoc network, Indoor Outdoor network model.

 MAC Protocols [8L]

Issues in designing a MAC protocol for Ad hoc wireless Networks, Hidden and Exposed terminal problem, Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas, IEEE802.11 in Ad hoc mode.

Module II: [8L]

 Routing Protocols [8L]

Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Proactive & Reactive routing protocol, Unicast & Multicast routing algorithm. Location aided routing, Link reversal routing, Hybrid routing algorithm, Energy aware routing algorithm, Hierarchical routing, QoS aware routing.

Module III [6L]

 Transport Layer Protocols [6L]

 Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless Networks, Classification of transport layer solutions, TCP over Ad hoc wireless Networks.

Module IV [12L]

 QoS in Ad hoc wireless network [8L]

Issues and challenges in providing QoS in Ad hoc wireless networks, Classification of QoS solutions, QoS in wireless ad hoc network – analysis of degradation of receiver sensitivity, practical solutions.

 Energy Management Schemes [4L]

Battery management, transmission power management, System power management schemes.

3. Text Books:

1) ―Ad Hoc Wireless Networks – Architectures and Protocols‖ - C.Siva Ram Murthy and B.S. Manoj –Pearson Education.

4. Reference Books:

1) ―Ad Hoc Mobile Wireless Networks – Protocols and Systems‖ - Chai K. Toh – Prentice Hall.

2) ―Ad hoc wireless Networking‖, Xiuzhen Cheng, Xiao Hung, DingZhu Du, Kluwer Academic publishers.

3) ―Mobile Ad Hoc Networking‖ – Stefano Basagni, Marco Conti, Silvia Giardano, Ivan Stojmenovic –Wiley India

Paper Name: **Introduction to VLSI Design**					
Paper Code: **ECEN4128**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

After completing the course the student will be able to:

1. Learn about VLSI Technology Growth as driven by Moore's law

2. Understand Various VLSI Design Methodologies

3. Design Digital Combinational logic, Circuits and Layout using CMOS Technology

4. Design Digital Sequential logic and Circuits using CMOS Technology.

5. Learn RTL Design using Verilog Hardware Description Language

6. Learn Basic Building Blocks of Analog Circuit using CMOS Technology

2. Detailed Syllabus

Module I- [4L]

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

Module II- [14L]

Digital VLSI Circuits: Unit1: MOS Transistor Characteristics, MOS as Digital Switch, NMOS Logic Family, CMOS Logic Family, CMOS Inverter Characteristics (VTC), Inverter Delay & Noise, NAND and NOR gates, Complex Logic Circuits, Pass Transistor Logic & Transmission Gate, CMOS Sequential Circuits, CMOS D-Latch and D-Flip-Flop

Unit2: CMOS Cross Section, Layout and Mask layers, Layout Design Rule, Inverter Layout, Lambda Rule vs Micron Rule, Std Cell Layout Topology, Stick Diagram, Euler Path Algorithm

Module III-[6L]

Hardware Description Language: Introduction to Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed Mode. Front-end

Design Flow using Verilog (Behavioral, RTL and Gate Level), Combinational and sequential circuits with various examples, FSM Example: Mealy Machine and Moore Machine.

Module IV- [12L]

Analog VLSI Circuits: Unit1: MOS large signal model, Transconductance gain, MOS small signal model, MOS switch, MOS Diode, MOS Resistor, CMOS Current Source/Sink, Active Load, Voltage Dividers, CMOS Current Mirror

Unit2: CMOS Differential Amplifiers with passive and active load, Differential Gain, Common Mode Gain, CMRR, Switched Capacitor Filter and Integrator.

3. Text Book:

1. CMOS VLSI Design, A Circuits and Systems Perspective (4th Edition) Author: Neil Weste, David Harris. Addison-Wesley, Pearson

2. Design of Analog CMOS Integrated Circuit, B. Razavi, Mc, GrawHill .

3. Fundamentals of Digital Logic with Verilog Design, 3rd Edition, Brown and Vranesic, Mc, GrawHill .

4. Reference Book:

1. Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, 2nd Ed., Oxford.

2. Digital Integrated Circuit, Design Perspective, Author: .M. Rabaey, Prentice-Hall

3. CMOS Digital Integrated Circuits, Analysis and Design, Author: Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition), 2006

B. SESSIONAL COURSES

Paper Name: **Industrial Training / Internship**					
Paper Code: **CSEN4191**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	0	0	8	8	2

Paper Name: **Project-I**					
Paper Code: **CSEN4195**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	0	0	8	8	4

1. Course Outcomes

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

CSEN4195.1. Demonstrate a sound technical knowledge of their selected project topic.

CSEN4195.2. Understand the problems from the related domain, formulate them formally, analyze the complexity of the problem and apply their knowledge to solve it.

CSEN4195.3. Design engineering solutions to complex problems utilizing a systematic approach.

CSEN4195.4. Communicate effectively with their peer groups and the community at large in written as well as in oral form.

CSEN4195.5. Demonstrate their knowledge, skills, and techniques to solve various real-life problems related to the engineering domain.

C. HONORS COURSE

Paper Name: **Deep Learning**					
Paper Code: **CSEN4112**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcome:

On completion of the course the student should be able to:

CSEN4112.1. Learn foundations on deep learning and neural networks.

CSEN4112.2. Understand and describe various type of Learning methods.

CSEN4112.3. Identify the underlying mathematical relationships within and across Deep learning algorithms and Learning paradigm.

CSEN4112.4. Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.

CSEN4112.5. Evaluate models generated outcomes and compare results of several Learning methods.

CSEN4112.6. Implement deep learning algorithms, formulate and solve real-world problems.

2. Detailed Syllabus

Module 1 [6L]

Introduction [2L]:

What is a Neural Network? Supervised and unsupervised Learning with Neural Network, Why Deep Learning? Examples of deep learning projects.

Basics of Neural network [4L]:

Binary Classification, Logistic Regression and Cost Function, Gradient Descent, Derivatives and examples, Computation Graph, Gradient descent on m examples, Vectorization, Explanation of logistic regression cost function.

Module 2 [12L]

Learning with Neural Networks [4L]:

Modeling a specified input-output relationship, Learning from data: Empirical risk minimization and gradient descent, Training the network, Back propagation, Calculus of back propagation, Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

Convolution Neural Network [3L]: Shift invariance and Convolutional Neural Networks, Models of vision, Convolutional Neural Networks, Learning in CNNs, transpose

Convolution Recurrent Neural Networks [4L] : Time Series (back Propagation) and Recurrent Networks, Stability and Memory, Long Short-Term Memory Networks(LSTMs), Loss Functions in RNNs, Sequence Prediction, Connectionist Temporal Classification, Sequence prediction, Sequence To Sequence Prediction, Gated Recurrent Unit (GRU) Networks, Bidirectional LSTMs, Bidirectional RNNs

Graph Neural Networks [1L]: Transformers and GNNs

Module 3 [9L]:

Unsupervised deep Learning I [2L]: Learning Representations, AutoEncoder, Variational Auto Encoders Unsupervised deep learning II (Generative Adversarial Networks)[4L]: Attacking neural networks with Adversarial Examples and Generative Adversarial Networks , Explaining and Harnessing Adversarial Examples, Generative Adversarial Nets, Conditional GAN, Super-Resolution GAN, Cycle GAN

Generative Models[3L]: Hopfield network, types of Boltzmann Machines-Restricted Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, Deep Belief Networks (DBNs), Deep Boltzmann Machines (DBMs),

Module 4 [9L]:

Deep Reinforcement Learning[2L]: Policy gradients, hard attention, Q-Learning Algorithm, Actor-Critic Algorithm, multi-agent RL

Meta learning[2L]: Multi-task Deep Learning, Multi-view Deep Learning, Meta RL, Gradient based Meta-Learning, Meta-RL as partially ordered RL, Examples of Meta-learning applications

Deep Learning projects and Case studies [5L]: Image/Video Captioning, Autonomous Driving, Speech and Audio Applications, Sentiment Analysis and prediction, Cancer Detection.

3. Recommended books:

1.Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning, MIT Press, 2016.

2. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4 . Academic Press, 2008.

3. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach . Prentice Hall Series in Artificial Intelligence. 2003.

4. Raúl Rojas, Neural Networks: A Systematic Introduction, 1996

5. Bishop, C. M. Neural Networks for Pattern Recognition . Oxford University Press. 1995.

6. Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning . Springer. 2001.

7. Koller, D. and Friedman, N. Probabilistic Graphical Models . MIT Press. 2009.

8. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification . Wiley-Interscience. 2nd Edition. 2001.

Paper Name: **Deep Learning Lab**					
Paper Code: **CSEN4162**					
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:

CSEN4162.1 Understand and conceptualize the methods of deep learning and its applications.

CSEN4162.2 Hands on coding with programming language

CSEN4162.3 Familiar with various deep learning libraries in Python and TensorFlow.

CSEN4162.4 Familiar with various statistical measures to validate deep learning model performance.

CSEN4162.5 Working on benchmark data sets available for specific problems.

CSEN4162.6 How to improve accuracy while working on a specific problem.

2. List of Experiments:

- Implementation of following DL approaches.
- Convolutional Neural Networks (CNNs)
- Autoencoders (AE)
- Long Short-Term Memory Networks (LSTMs)
- Recurrent Neural Networks (RNNs)
- Deep Belief Networks (DBNs)
- Restricted Boltzmann Machines (RBMs)
- Python and TensorFlow installation / setup
- Applications of DL methods in other real-life problems.

3. Textbooks

- Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville published by MIT Press

4. Reference Books

- Grokking Artificial Intelligence Algorithms by Rishal Hurbans published by Manning Publications
- Deep Learning From Scratch: Building with Python from First Principles by Seth Weidman published by O`Reilley

Professional Elective - IV

Paper Name: **Distributed Algorithms**
Paper Code: **CSEN4231**

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:

CSEN4231.1. Learn the basics of distributed algorithms, designed to run on multiple processors, without any tight centralized control

CSEN4231.2. Understand various kinds of distributed computing environments, including shared-memory and network based environments

CSEN4231.3. Identify problems solvable in distributed computing environments and also identify certain tasks that cannot be carried out in certain kinds of distributed settings

CSEN4231.4. Design distributed algorithms and analyze the correctness, performance, and fault-tolerance of their algorithms; also, will be able to prove lower bounds and other impossibility results in distributed settings.

CSEN4231.5. Learn the applications of distributed algorithms in many practical systems ranging from large computer networks to multiprocessor shared-memory systems, including problems of communication, data management, resource management, synchronization, and distributed agreement.

2. Detailed Syllabus

Module 1 [8L]

Synchronous networks: Model – Leader election (symmetry-breaking) – Network searching, Broadcast and converge-cast. Shortest paths, spanning trees – Processor failures: Stopping and Byzantine – Fault-tolerant consensus: Algorithms and lower bounds – Other problems: Commit, k-agreement, Approximate agreement. Distributed commit.

Module 2 [8L]

Asynchronous model – Interaction State Machines (I/O automata), Proving Correctness of Distributed algorithms.

Asynchronous networks, no failures: Model – Leader election, network searching, spanning trees, revisited. – Synchronizers (used to run synchronous algorithms in asynchronous networks) – Logical time, replicated state machines. – Stable property detection (termination, deadlock, snapshots).

Module 3 [10L]

Asynchronous shared-memory systems, no failures: Model – Mutual exclusion algorithms and lower bounds – Practical mutual exclusion algorithms – Resource allocation, Dining Philosophers Problem. Asynchronous shared-memory, with failures – Impossibility of consensus – Atomic (linearizable) objects, atomic read/write objects, atomic snapshots – Wait-free computability; wait-free consensus; wait-free vs. f-fault-tolerant objects.

Module 4 [10L]

Shared-memory multiprocessor programming – Contention, caching, locality – Reader/writer locks – List algorithms: locking algorithms, optimistic algorithms, lock-free algorithms – Transactional memory Asynchronous networks, with failures –Asynchronous networks vs. asynchronous shared-memory – Impossibility of consensus, revisited – Failure detectors and consensus – Paxos consensus algorithm, Self-stabilizing algorithm, Partially-synchronous systems – Models – Timing-based Mutual exclusion, consensus – Clock synchronization

3. Textbooks

1. Distributed Algorithms, (The Morgan Kaufmann Series in Data Management Systems), Nancy A. Lynch

4. Reference Books

1. Introduction to Reliable and Secure Distributed Programming, Christian Cachin, Rachid Guerraoui, Luís Rodrigues.

2. Distributed Algorithms - An Intuitive Approach, Wan Fokkink.

3. Introduction to Distributed Algorithms, Gerard Tel.

Paper Name: **Mobile Computing**					
Paper Code: **CSEN4232**					
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:

CSEN4232.1. To learn the wireless and mobile networking fundamentals.

CSEN4232.2. To learn the evolution of different generations of mobile networks.

CSEN4232.3. To analyze different inter-networking challenges and solutions in wireless mobile networks.

CSEN4232.4. To analyze the modifications necessary in normal IP and TCP protocols to make them mobility enabled.

CSEN4232.5. To understand the basics of MANET, WAN, LAN and PAN.

CSEN4232.6. To learn WAP basics.

2. Detailed Syllabus

Module 1 [10L]

Introduction to Mobile Communication: Introduction to mobile wireless communication and systems, Description of cellular system. Channel interferences. Channel assignment schemes. Concept of 1G. Multiple Access Technologies in cellular communication: Time division multiple access (TDMA), Frequency division multiple access (FDMA), Code Division Multiple Access (CDMA). Second generation (2G) Network: Global system for mobile communication (GSM). 2.5G Wireless Networks-GPRS, CDMA (IS 95), Third Generation 3G Wireless Networks-UMTS, Fourth Generation 4G Wireless Networks LTE Advanced.

Module 2 [10L]

Mobile Network and Transport Layer: Wireless LAN – IEEE 802.11. PAN-Bluetooth- Piconet, Scatternet, Connection Establishment, Protocol Stack. Recap of Mobile IP. Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP, ATCP, Transmission / Timeout Freezing Selective Retransmission, Transaction oriented TCP.

Module 3 [8L]

Mobile Routing and Application Protocols: Mobile Ad hoc Networks (MANETs): Overview, Properties of a MANET, routing and various routing algorithms- DSR, WRP, DSDV, AODV, ZRP. Multicast Routing Algorithms: MAODV, ODMR Wireless Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, wireless markup Languages (WML).

Module 4 [10L]

Advanced Issues in Mobile Network: Wireless Sensor Network. Fifth Generation (5G) Wireless Networks: MIMO System Design and Channel Allocation schemes; Convex Optimization based treatment. Cognitive Radio and Internet of Things. SDN.

3. Textbooks

1. Wireless Networks: Applications and Protocols, T.S. Rappaport, Pearson Education

2. Wireless Communications, A. Goldsmith, Cambridge University Press.

3. Wireless Communication: Stallings, Pearson.

4. Mobile Communications, Jochen Schiller, 2nd Edition, Pearson Education, India.

5. NPTEL Materials from the course of Convex Optimization offered by Aditya P. Jagannatham.

6. Prototyping and Load Balancing the Service Based Architecture of 5G Core using NFV by Vamshi Kiran Buyakar, Harsh

Agarwal, Bheemarjuna Reddy Tamma, and Antony Franklin (Indian Institute of Technology Hyderabad), published in

IEEE NETSOFT 2019

Paper Name: **Pattern Recognition**					
Paper Code: **CSEN4233**					
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:

CSEN4233.1. Learn and understand feature, pattern and the problem of pattern recognition.

CSEN4233.2. Understand and describe the difference between supervised and unsupervised learning.

CSEN4233.3. Understand and apply pattern recognition algorithm that utilizes supervised learning.

CSEN4233.4. Understand and apply pattern recognition algorithm that utilizes unsupervised learning.

CSEN4233.5. Analyze pattern recognition algorithms and techniques.

CSEN4233.6. Design simple pattern recognition systems.

2. Detailed Syllabus

Module 1 [9L]

Introduction – Definitions, Representations of Patterns and Classes, overview of different approaches, Metric and non-metric measures. Feature selection criteria and algorithms; Minimum distance classifiers, k-NN rule, Discriminant functions (linear and non-linear), parametric and nonparametric learning.

Module 2 [9L]

Decision Trees, Bayesian classification, Decision Boundaries, training and test sets, Neural network models for pattern recognition - Perceptron, Multi-layer Perceptron, some applications.

Module 3 [9L]

Clustering techniques – Unsupervised learning, basic hierarchical and non-hierarchical clustering algorithms, c-means, fuzzy c-means, DBSCAN, Concepts of hierarchical clustering, Clustering Large datasets.

Module 4 [9L]

Dimensionality reduction, principal components analysis, independent component analysis, some applications, some advanced topics with applications, (e.g., neuro-fuzzy approach, genetic algorithms, data mining).

3. Reference Books

1. Devi V.S.; Murty, M.N., Pattern Recognition: An Introduction, Universities Press, Hyderabad, 2011.

2. R. O. Duda, P. E. Hart and D. G. Stork: Pattern Classification and Scene Analysis, 2nd ed., Wiley, New York, 2000.

3. 2. J. T. Tou and R. C. Gonzalez: Pattern Recognition Principles, Addison-Wesley, London, 1974.

4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

5. K. Fukunaga: Introduction to Statistical Pattern Recognition, 2nd eel, Academic Press, New York, 1990.

6. A. K. Jain and R. C. Dubes: Algorithms for Clustering Data, Prentice Hall, Englewood Cliffs, 1988.

7. Neural Networks and Learning Machines, Simon Haykin, Third Edition, PHI Learning, 2009.

Paper Name: **Social Network Analysis**					
Paper Code: **CSEN4235**					
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:

CSEN4235.1. Learn the basic knowledge related to social network and its application.

CSEN4235.2. Understand the use of various measures and metrics in social network analysis.

CSEN4235.3. Identify the computational aspect of various problems in social network analysis

CSEN4235.4. Design and analyze algorithms of social network analysis

CSEN4235.5. Evaluate and apply the working principle of various computational models in social network analysis.

2. Detailed Syllabus

Module 1 [9L]

Introduction: Motivating challenges in analyzing social networks. Measures and Metrics: Degree centrality, Eigen vector centrality, Katz centrality, Page Rank, hubs and authorities (HITS), closeness centrality, betweenness centrality, groups of vertices, transitivity, reciprocity, signed edges and structural balance, similarity, homophily and assortative mixing. Large Scale Structure of Networks: Components, shortest paths and the small world effect, degree distributions, power laws and scale-free networks, distributions of centrality measures, clustering coefficients.

Module 2 [9L]

Random Networks Understanding mean number of edges, mean degree, degree distribution, clustering coefficient, giant component, small components, and average path lengths for the following models- Erdos-Renyi Network, Small-world networks and Watts-Strogatz model, Preferential attachment and Barabasi-Albert model.

Module 3 [8L]

Propagation of Information Networks Contagion Models: Models of disease spread –SI, SIS, SIR, SIRS and related literature. Outbreak detection. Influence Maximization: Influence spread models -independent cascade model, linear threshold model. Maximizing propagation of influence under different setups –greedy approximation algorithm by Kempe et.al. and related literature.

Module 4 [10L]

Community Detection What is a community? Notion of disjoint and overlapping communities. Goodness measures –modularity. Benchmarks and comparing with the benchmarks (F-measure, NMI, Omega index), Strength of weak ties and related models. Clique Percolation model. Modularity maximization, Clauset-Newman-Moore (CNM) method, Louvain Method. Label propagation algorithm and its variants. Random walks, Entropy-based method: Infomap. Community preserving sparsification of social networks.

3. Textbooks

1. Networks: An Introduction, Mark Newman, Oxford University Press.

2. Social Network Analysis: Methods and Applications, S.Wasserman, K. Faust., Cambridge University Press, 1994.

4. Reference Books

1. Networks, Crowds and Markets: Reasoning About a Highly Connected World, David Easley, Jon Kleinberg, Cambridge University Press 2010.

Paper Name: **Robotics**					
Paper Code: **CSEN4236**					
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:

CSEN4236.1. To understand the concept of Robot mechanical structure, modelling and control

CSEN4236.2. To understand the Kinematics of Robotic structure

CSEN4236.3. To realise and remember the concept of sensors, actuators and motion control

CSEN4236.4. To apply the knowledge of programming in developing an automated system

CSEN4236.5. To understand the concepts of Force Control and Visual Servoing

CSEN4236.6. To develop algorithms for robotic motion planning.

2. Detailed Syllabus

Module 1 [10L]

Introduction: Robot Mechanical Structure; Industrial Robotics; Advanced Robotics; Robot Modelling, Planning and Control

Kinematics: Pose of a Rigid Body; Rotation Matrix; Composition of Rotation Matrices; Euler Angles; Angle and Axis; Unit Quaternion; Homogeneous Transformations; Direct Kinematics; Kinematics of Typical Manipulator Structure; Joint Space and Operational Space; Kinematic Calibration; Inverse Kinematics Problem.

Module 2 [10L]

Trajectory Planning: Path and Trajectory; Joint Space Trajectories; Operational Space Trajectories.

Actuators and Sensors: Joint Actuating System; Drives; Proprioceptive Sensors; Exteroceptive Sensors.

Control Architecture: Functional Architecture; Programming Environment; Hardware Architecture. Motion Control: The Control Problem; Joint Space Control; Decentralized Control; Computed Torque Feed Forward Control; Centralized Control; Operational Space Control; Comparison Among Various Control Schemes.

Module 3 [8L]

Force Control: Manipulator Interaction with Environment; Compliance Control; Impedance Control; Force Control; Constrained Motion; Natural and Artificial Constraints; Hybrid Force/Motion Control.

Visual Servoing: Vision for Control; Image Processing; Pose Estimation; Stereo Vision; Camera Calibration; The Visual Servoing Problem; Position-based Visual Servoing; Image-based Visual Servoing; Comparison Among Various Control Schemes; Hybrid Visual Servoing.

Module 4 [8L]

Mobile Robots: Nonholonomic Constraints; Kinematic Model; Chained Form; Dynamic Model; Planning; Path and Timing Law; Motion Control; Odometric Localization. Motion Planning: The Canonical Problem; Configuration Space; Planning via Retraction; Planning via Cell Decomposition; Probabilistic Planning; Planning via Artificial Potentials; The Robot Manipulator Case.

3. Reference Books

1. Robotics Modelling, Planning and Control, Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, Springer Publications.

2. Principles of Robot Motion, Theory, Algorithms and Implementation, Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, The MIT Press, Cambridge, Massachusetts, London, England.

Professional Elective – V

Paper Name: **Distributed Databases**					
Paper Code: **CSEN4241**					
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:

CSEN4241.1. Understand the basic concepts of database, communication network, and distributed database.

CSEN4241.2. Identify the concepts of creating and maintaining databases in a distributed environment Understand and use the various core module

CSEN4241.3. Learn to design a distributed database using horizontal and vertical fragmentation.

CSEN4241.4. Learn to manage distributed transactions and concurrency control.

CSEN4241.5. Design all types of distributed queries using query optimization techniques.

2. Detailed Syllabus

Module 1 [6L]

Definition of Distributed database (DDB), DDB features, comparison with centralized databases, Distributed Database Management Systems (DDBMSs), Review of Relational algebra and SQL, Review of basic concepts of computer networks.

Reference architecture of DDB, Distribution Transparency (for Read-only and Update applications), Integrity constraints in DDB.

Module 2 [10L]

A Framework for Distributed Database Design, Types of Data Fragmentation, Design of Database Fragmentation, Allocation of Fragments. Equivalence Transformations for Queries, Operator Graph, Transforming Global Queries into Fragment Queries, Distributed Grouping, and Aggregate Function Evaluation.

Module 3 [14L]

A Framework for Transaction Management, Supporting Atomicity of Distributed Transactions, Concurrency Control for Distributed Transactions, Commit protocols. Foundations of Distributed Concurrency Control, Distributed Deadlocks. Basic concepts of Reliability, Non-blocking Commitment protocols, Reliability, and Concurrency control.

Module 4 [6L]

A framework for Distributed Query Processing, A framework for Distributed Database administration – Catalog Management, Authorization, and Protection. The basic concept of Parallel Databases.

3. Textbooks

1. Stefano Ceri and Giuseppe Pelagatti: Distributed Databases – Principles and Systems, 1st Edition, Tata McGraw-Hill.

2. M Tamer Ozsu and Patrick Valduriez, ―Principles of Distributed Database Systems, 2nd Edition, Pearson Education.

4. Reference Books

1. Silberschatz, Korth and Sudarshan: Database System Concepts, TMH.

2. Ramakrishnan and Gehrke: Database Management Systems, TMH.

3. Elmasri and Navathe: Fundamentals of Database Systems, Pearson.

Paper Name: **Natural Language Processing**					
Paper Code: **CSEN4242**					
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:

CSEN4242.1. Learn various models, methods, and algorithms of Natural Language Processing (NLP) to build an automation tool to solve like, speech recognition, machine translation, spam filtering, text classification, spell checking etc.

CSEN4242.2. Understand and estimate the parameters of the probabilistic models.

CSEN4242.3. Identify problems solvable in language automation environments and also identify certain tasks that are challenging to carry out with traditionally existing statistical models.

CSEN4242.4. Understand the linguistic phenomena and will explore the linguistic features relevant to each NLP task.

CSEN4242.5. Identify the opportunities for research await and prepare to conduct research in NLP or related fields.

2. Detailed Syllabus

Module 1 [9L]

Introduction to NLP: Natural language processing issues and strategies. Tools of NLP, Linguistic organization of NLP, NLP as an Application domain.

Word Classes: Regular Expressions: Chomsky hierarchy, CFG and different parsing techniques. Morphology: Inflectional, derivational, parsing and parsing with FST, Combinational Rules. Joint and conditional probability. Probabilistic Language modeling and it's Applications.

Module 2 [11L]

Language Modeling and Naïve Bayes: Markov models, N- grams. Estimating the probability of a word and smoothing. Counting words in Corpora, simple N-grams, smoothing (Add One, Written-Bell, Good-Turing).Part of Speech Tagging and Hidden Markov Models: Part of Speech tagging, Indian Language on focus Morphology Analysis, Accuracy Measure and Probability, HMM, Viterbi algorithm for finding most likely HMM Path. HMM tagging, transformation-based tagging. Probabilistic Context Free Grammars: Weighted context free grammars.

Module 3 [8L]

Semantics: Representing Meaning: Unambiguous representation, canonical form, expressiveness, meaning structure of language. Semantic Analysis: NLP and IR, How NLP has used IR Towards Latent Semantic. Lexical Semantics: Lexemes (synonymy, hyponymy etc), WordNet, metonymy and their computational approaches Supervised and Unsupervised methods. Word Sense Disambiguation: Selectional restriction based, machine learning based and dictionary-based approaches.

Module 4 [8L]

Pragmatics: Information Theory: Entropy, Cross-entropy, information gain. Reference resolution and phenomena, syntactic and semantic constraints. Pronoun resolution algorithm, text coherence, and discourse structure. Natural Language Generation: Introduction to language generation, architecture, discourse planning (text schemata, rhetorical relations). Resource Constrained WSD, Parsing Algorithms, Parsing Ambiguous Sentences, Probabilistic Parsing Algorithms.

3. Textbooks

1. D. Jurafsky., J. H. Martin., Speech and Language Processing – An introduction to Language processing, Computational Linguistics, and Speech Recognition, Pearson Education.

4. Reference Books

1. Allen, James, Natural Language Understanding, Benjamin/Cummings, 2ed.

2. Bharathi, A., Vineet Chaitanya and Rajeev Sangal., Natural Language Processing- "A Pananian Perspective", Prentice Hall India, Eastern Economy Edition.

3. Eugene Cherniak, Statistical Language Learning, MIT Press, 1993.

4. Manning, Christopher and Heinrich Schutze., Foundations of Statistical Natural Language Processing, MIT Press.

5. Cognitively Inspired Natural Language Processing, Abhijit Mishra, Pushpak Bhattacharyya, Springer

Paper Name: **Real Time & Embedded System**					
Paper Code: **CSEN4244**					
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:

CSEN4244.1. Identify the issues that are involved in designing an embedded system.

CSEN4244.2. Understand the interfacing protocols and handle the interfacing devices

CSEN4244.3. Do device-level programming.

CSEN4244.4. Know the design considerations of an RTOS and handle its interrupts.

CSEN4244.5. Critically appreciate system requirements in terms of hardware, drivers, Operating Systems binding, and protocol stack implementation.

2. Detailed Syllabus

Module 1 [10L]

Examples of Embedded Systems, Classification of Embedded Systems, Skills required for an Embedded System designer. Sensors and Actuators, Embedded Processors with examples. Memory Architecture revisited (Technologies, Hierarchy, Models). Input and Output, Revisiting I/O Hardware, Interrupts, DMA, etc. Serial/Parallel devices, Sophisticated interfacing features, Timers/Counters/Watchdog timers, Real-Time Clocks, Network Interface Cards, Wireless devices, etc.

Serial and Parallel interfacing protocols --- RS232/RS485, I2C, SPI, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, ZigBee, Wireless sensor networks, Sigma-Delta, PCI, etc. Network protocols, Wireless and mobile system protocols.

Module 2 [7L]

Need of RTOS in embedded systems, Foreground/Background systems, multitasking. Review of Process management, Timer functions and scheduling, Events, Memory management, Devices, File and I/O subsystem management. Multitasking Issues, critical sections, Semaphores, Message Queues, Mailboxes, Pipes Functions, Sockets, File maps, etc. Handling of interrupts in RTOS environment. Features of Real Time Operating Systems, Soft versus Hard RTOS-s, RTOS Task Scheduling Models, Interrupt Latency, RTOS Security Issues.

Module 3 [7L]

Introduction to Device Drivers, Device Driver types and issues involved. Programmed-I/O, Interrupt Servicing, Multiple Interrupts, Top and Bottom halves of ISR. Interrupt latency and Deadlines, Direct Memory Access, Device Driver Programming.

Module 4 [8L]

Arduino Systems, Open-Source Hardware, Rapid Prototyping, Hands-on implementation. MSP430 family RISC CPU architecture, Compiler-friendly features, Instruction set, Clock/Memory subsystems, etc. Study of one RTOS like RTLinux. Writing a Linux/Windows Network Device Driver. Quantitative Analysis and Verification of Embedded Systems. Common Lisp as an embedded extension language.

3. Reference Books

1. William Stallings, Computer Organization and Architecture, Pearson, 2016 (10th ed).

2. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, MIT Press, 2017.

3. Ajoy Ray and K. Bhurchandi, Advanced Microprocessors and Peripherals, Tata Mcgraw Hill Education Private Limited, 2006.

4. Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, Linux Device DriversLinux Device Drivers, Third Edition, O'Reilly Media, Inc., 2005.

5. Doug Abbott, Linux for Embedded and Real-time Applications, Elsevier, 2017.

4. Reference Books

1. Allen, James, Natural Language Understanding, Benjamin/Cummings, 2ed.

2. Bharathi, A., Vineet Chaitanya and Rajeev Sangal., Natural Language Processing- "A Pananian Perspective", Prentice Hall India, Eastern Economy Edition.

3. Eugene Cherniak, Statistical Language Learning, MIT Press, 1993.

4. Manning, Christopher and Heinrich Schutze., Foundations of Statistical Natural Language Processing, MIT Press.

Paper Name: **Quantum Computing**					
Paper Code: **CSEN4245**					
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:

CSEN4245.1. Understand the major mathematical representations of quantum operations,

CSEN4245.2. Distinguish between classical and quantum computation

CSEN4245.3. Describe a few key applications of quantum computing

CSEN4245.4. Implement basic quantum algorithms,

CSEN4245.5. Understand and describe quantum information concepts

CSEN4245.6. Identify key aspects of quantum supremacy over conventional computation.

2. Detailed Syllabus

Module 1 [9L]

Introduction and Overview: Brief history and postulates of quantum theory; Heisenberg Uncertainty Principle; Recapitulation of the basic principles of classical computation.

Quantum Mechanics: Cbits and Qbits; Reversible operations on Cbits and Qbits; Quantum measurements – Positive operator valued measures and Projective measurements; General features and some simple examples.

Module 2 [9L]

Linear Algebra and Hilbert Spaces: Basis vectors- Orthogonal and Orthonormal vectors; Inner product spaces, Completeness and Separable Hilbert spaces; Unitary operations and Projectors; Tensor Products.

Fundamental quantum notions: No-cloning theorem; Quantum entanglement; Quantum nonlocality – Bell's inequality.

Module 3 [10L]

Quantum Circuits: Pauli and Hadamard gates; Prototype examples; Reversible computing. Quantum Algorithms: Deutsch-Josza algorithm; Simon's problem; Quantum Fourier transform; Shor's period-finding algorithm; Grover's algorithm for searching.

Module 4 [8L]

Quantum Computers: Physical qubits; Noise and Decoherence. Basic aspects of quantum information theory: Shannon and von-Neumann entropy; Conditional entropy, relative entropy and Mutual information. Basics of Quantum Cryptography.

3. Reference Books

1. N. David Mermin, Quantum Computer Science – An Introduction, Cambridge University Press, 2007.

2. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge (2002).

3. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd (2012).

4. Lecture Notes

1. John Preskill's lecture notes: http://www.theory.caltech.edu/people/preskill/ph229/

2. David Mermin's lecture notes: http://people.ccmr.cornell.edu/_mermin/qcomp/CS483.html

Paper Name: **Computer Vision**					
Paper Code: **CSEN4245**					
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:

CSEN4246.1. Understand the fundamental problems of computer vision.

CSEN4246.2. Gain knowledge on various techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.

CSEN4246.3. Recognize objects and represent shapes.

CSEN4246.4. Analyze and track motions.

CSEN4246.5. Utilize the programming and scientific tools for implementation.

2. Detailed Syllabus

Module 1 [9L]

Introduction: overview of computer vision, related areas, and applications; overview of software tools; overview of course objectives.; introduction to OpenCV.

Image formation and representation: imaging geometry, radiometry, digitization, cameras and projections, rigid and affine transformations.

Filtering: convolution, smoothing, differencing, and scale space.

Module 2 [9L]

Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors.

Object recognition and shape representation: alignment, appearance-based methods, invariants, image eigenspaces, data-based techniques.

Model fitting: Hough transform, line fitting, ellipse and conic sections fitting, algebraic and Euclidean distance measures.

Module 3 [7L]

Camera calibration: camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.

Epipolar geometry: introduction to projective geometry; epipolar constraints; the essential and fundamental matrices; estimation of the essential/fundamental matrix.

Model reconstruction: reconstruction by triangulation; Euclidean reconstruction; affine and projective reconstruction.

Module 4 [7L]

Motion analysis: the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation; motion segmentation through EM.

Motion tracking: statistical filtering; iterated estimation; observability and linear systems; the Kalman filter; the extended Kalman filter.

3. Reference Books

1. Computer Vision: Algorithms and Applications, R. Szeliski, Springer, 2011.

2. Computer Vision: A Modern Approach, D. Forsyth and J. Ponce, Prentice Hall, 2nd ed., 2011.

3. Introductory techniques for 3D computer vision, E. Trucco and A. Verri, Prentice Hall, 1998.

4. Lecture Notes

1. John Preskill's lecture notes: http://www.theory.caltech.edu/people/preskill/ph229/

2. David Mermin's lecture notes: http://people.ccmr.cornell.edu/~mermin/qcomp/CS483.html

Paper Name: **Compiler Design**					
Paper Code: **CSEN4248**					
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:

CSEN4248.1. This course will enable a student to understand the major phases of compilation including the front- and backend. They are expected to have an overview of how a real-life compiler works.
CSEN4248.2. After completion of this course, the students are expected to develop knowledge of Lex and YAAC tools.
CSEN4248.3. The students should be able to understand various necessary tasks related to compiler construction, like token identification, grammar writing, type conversion, and storage management.
CSEN4248.4. Students will learn to generate intermediate codes and actual machine codes targeting a particular architecture.
CSEN4248.5. Students should acquire a detailed idea regarding optimization of generated code across various phases of the compilation process.
CSEN4248.6. After completion of this course, students should be able to apply various optimization techniques for dataflow analysis.

2. Detailed Syllabus

Module 1 [9L]

Introduction to compiler: Analysis of a source program; Different phases of compilation; Cousins of a compiler.A simple one-pass Compiler

Lexical Analysis: Role of a lexical analyzer, Tokens, Patterns, Lexemes. Input buffering, Specifications of a token, Recognition of tokens. A language for specifying lexical analyzer: Design of a lexical analyzer generator (Lex / Flex).

Module 2 [12L]

Syntax Analysis: Role of a parser, Context free grammars. Top-down Parsing, Non-recursive Predictive parsing (LL(1)). Bottom-up parsing, Handles, Viable prefix, Various forms of LR parsers: SLR(1), LR(0), LR(1). Construction of LALR(1) parsing table using/avoiding LR(1) parsing tables. Parser generators (YACC / Bison).

Type Checking: Type systems; Specification of a simple type checker, Equivalence of type expressions, Type conversions.

Run-Time Environment Source Language Issues: Procedures, Activation Trees, Control stacks, Scope of variable declarations. Storage Organization: Sub-division of run-time memory, Activation Records.

Storage Allocation strategies: Static allocation, stack allocation, heap allocation. Scope: Blocks; with and without Nested Procedures, Access Links, Displays, Parameter passing. Symbol tables: organization; data structures used.

Module 3 [7L]

Syntax Directed Translation: Syntax directed definitions: Synthesized attributes, Inherited attributes. Construction of Syntax trees: Expressions, DAG for Expressions. Bottom-up evaluation of S-Attributed definitions: Synthesized attributes on a parser stack. L-Attributed definitions: Translation schemes. Top-down Translation: Elimination of left recursion. Bottom-up

Evaluation of Inherited Attributes: Removing embedding actions, inheriting attributes, simulating the evaluation of inherited attributes, Replacing inherited attributes by synthesized attributes.

Intermediate Code Generation: Intermediate Languages: Graphical representation, Three-address code: different types.

Translation into three-address code, Quadruples / Triples / Indirect Triples, their comparisons. Translation of declarations statements: Procedures, Records, Assignment statements. Addressing array elements, Boolean expressions, Control statements.

Back patching. Procedure calls.

Module 4 [8L]

Code generation: Issues in the design of a code generator: Memory management; Instruction selection; The target machine. Run-time storage management. Basic blocks and flow graphs: Transformations on basic blocks; Flow graphs; Loops; A simple code generator: Algorithm; Conditional statements. Register allocation and assignment. The DAG representation of basic blocks.

Code optimization: Principal source of optimization: Common sub-expression, Copy propagation, Dead code elimination, Loop optimization, Code motion, Induction variables. Loops in flow graphs: Dominators, Natural loops, Inner loops. Peephole optimization.

3. Reference Books

1. Aho, Sethi, Ullman: Compilers: Principles, Techniques and Tools: 2 nd Edition, Pearson Education.
2. Holub - "Compiler Design in C" – PHI
3. Tremblay and Sorenson Compiler Writing-McgrawHill International.
4. Chattopadhyay, S- Compiler Design (PHI)

Paper Name: **Process Instrumentation**					
Paper Code: **AEIE4221**					
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:

AEIE4221.1 Acquire knowledge about the characteristics of different process instruments.

AEIE4221.2 Explain the working principle and functions of displacement, strain, pressure, temperature, flow and level measuring instruments.

AEIE4221.3 Formulate the mathematical equation of the linear processes and derive their response.

AEIE4221.4 Apply their knowledge of controllers and final control element in various control schemes for effective process control.

AEIE4221.5 Gain knowledge of industrial signal transmission and transmitters.

AEIE4221.6 Choose proper automation system for specific application.

2. Detailed Syllabus

Module 1[9L]

Introduction to process and instrumentation, static and dynamic characteristics of instruments, active and passive transducers; measurement methods and applications: displacement, strain, pressure, temperature, flow and level measurement.

Module 2 [9L]

Introduction to process control, open and closed loop process, mathematical model and transfer function, dynamic behavior of first and second order processes; feedback controllers: on-off controllers, basic control modes, PID controllers.

Module 3 [9L]

Control system instrumentation: transducers and transmitters, two wire and four wire transmitters, smart transmitters, final control elements; feedforward, ratio and cascade control; basic concept of stability.

Module 4 [9L]

Introduction to process automation, brief idea and application of PLC, DCS and SCADA; case study: boiler drum level control/ distillation column control.

3. Reference Books

1. B. G. Liptak, Instrumentation Engineers Handbook (Measurement), Chilton Book Co.; 1994.

2. John P. Bentley, Principles of Measurement Systems, Third edition, Addison Wesley Longman Ltd., UK, 2000.

3. E.O. Doebelin, Measurement Systems - Application and Design, Fourth edition, McGraw-Hill International Edition, New

York, 1992.

4. U. A. Bakshi, A.V.Bakshi; Instrumentation Engineering; Technical Publications; 2009.

5. Harold E. Soisson; Instrumentation in Industry; John Wiley & Sons Canada, Limited, 1975.

6. B.E. Noltingk, Instrumentation Reference Book, 2nd Edition, Butterworth Heinemann, 1995.

7. L.D. Goettsche, Maintenance of Instruments and Systems – Practical guides for measurements and control, ISA, 1995.

Paper Name: **Medical Instrumentation**					
Paper Code: **AEIE4222**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course Outcomes:

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

AEIE4222.1. Explain the fundamental principles and applications of different transducers used for body parameter measurements.

AEIE4222.2. Understand the physiology of biomedical systems and different methods in the design of biomedical instruments.

AEIE4222.3. Learn the different methods of medical imaging systems, concepts related to the operations and analysis of biomedical instruments.

AEIE4222.4. Learn various therapeutic devices.

AEIE4222.5. Design various type bio-telemetry system.

AEIE4222.6. Aware of the importance of electrical safety and apply it in the design of different assisting.

2. Detailed Syllabus

Module I–[8L]

Transduction Principles: Transducers- Definition, principles of sensing and transduction, characteristics, classification, concept of signal conditioning; Body Temperature transducers- thermoresistive, thermoelectric, semiconductor, chemical thermometry and operating specifications; Blood Pressure transducer- Strain gauge type, variable capacitance type, LVDT and operating specifications; Blood Flow transducers- based on piezoelectric effects, electromagnetic effects, operating specifications; Acoustic Transducers- Heart sound.

Module II-[10L]

Bio-potentials and electrodes: Bio-potentials- Origin and electrical activity of cells, resting and action potentials of cells; Electrodes- Electrode theory and half-cell potential, Electrode-Electrolyte interface, types of electrodes: surface, needle and micro electrodes and respective applications. Electrode impedance, electrode jellies and creams; Measurement of electrical activities in Cardiovascular system- ECG, Einthoven's triangle, electrodes, amplifiers, cardiac pace-maker, defibrillator, Measurement of electrical activities in muscles and brain: EMG, EEG.

Module III-[10L]

Biomedical imaging: ultrasound imaging, radiography, CT scan, MRI and applications, Plethysmography; Assisting and therapeutic instruments: Pacemakers, defibrillators, Hearing aids. Ventilators, Heart-lung machine, Diathermy;

Module IV-[8L]

Philosophy of biotelemetry and patient safety: transmission and reception aspects of biological signals via long distances; electrical safety of patients; Measurements of blood pH, pCO2, pO2.

References:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Second edition, Prentice-Hall India, 1997.

2. R.S. Khandpur, Handbook of Biomedical Instrumentation, 2 Edition, Tata McGraw Hill New Delhi, 1987.

3. John G. Webster, Medical Instrumentation application and design, Third edition, Wiley, 1997.

4. S. K. Venkata Ram, Biomedical Electronics and Instrumentation, Galgotia Publication Pvt. Ltd., New Delhi.

5. Geddes L.A and Baker L.E, Principles of Applied Biomedical Instrumentation, Third edition, Wiley-Interscience, 1989.

Paper Name: **Computational Biology**					
Paper Code: **BIOT4221**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course outcomes:

At the end of this course students will be able to:

BIOT4221.1. Acquire basic understanding of structures and functions of different biomolecules.

BIOT4221.2. Obtain knowledge about the different metabolic pathways.

BIOT4221.3. Explain different biological data and biological databases.

BIOT4221.4. Understand classification of databases and how the biological data are stored in those databases.

BIOT4221.5. Obtain the knowledge of different algorithms and programming languages to manage biological data.

BIOT4221.6. Apply different tools and software for analysis of biological data.

2. Detailed Syllabus

Module-I: Introduction to Biomolecules [10L]

Introduction to biochemistry and molecular biology; Biomolecules: structure, function and metabolic pathways.

Module-II: Scope of Computational Biology [10L]

Definition of computational biology; origin and development of computational biology; Nature and Types of biological data; Data Structures: Sequences (GENbank files), Secondary structures, Super-secondary structures (Motifs), Tertiary structures (Pubchem and PDB structure files); Interaction Networks, Photographic Data: Fingerprints (DNA and MS), Microarray data; Biological databases.

Module-III: Preferred Algorithms, Programming languages and Operating systems [10L]

Principles of Pattern recognition: Use of Hidden Markov Model and Artificial Neural Networks in computational biology; Significance of Python and C/C++; Operating system: Bio-Linux (Selected Bioinformatics packages)

Module-IV: Applications of Computational biology [10L]

Molecular Modeling and Dynamics: introduction to Open MM library; GROMACS as an example of GUI in the public domain; computer based drug design (public domain and proprietary); Mathematical modeling of cell growth kinetics; Embedded systems for computational biology: High throughput data collection, processing and analysis; LC-MS, DNA microarrays and other applications (e.g. mobile microscopy and high throughput micro-PCR); Systems biology and Metabolic Engineering.

3. Text books:

1. Introduction to Bioinformatics, by Arthur M. Lesk (International Fourth Edition) (2014), Oxford University Press.

2. Essential Bioinformatics, by Jin Xiong, Cambridge University Press (2006).

4. Reference books:

1. Biochemistry: Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, 7th edition, Academic Press.

2. Introduction to Bioinformatics: T K Attwood, D J Parry-Smith and S. Phukan (2008) Pearson.

3. Fundamentals of Database Systems, 5th Edition, R. Elmasri and S.B. Navathe (2009)

4. Bioinformatics-A Machine Learning Approach- By Baldi and Brunak, 2nd Edition (2006), John Wiley Inc.

5. Dynamics of Proteins and Nucleic Acids: J. Andrew McCammon and Stephen C. Harvey, Cambridge University Press (1998).

6. Molecular Modelling: Principles and Applications-2nd Edition, Andrew R. Leach-Pearson (2016)

7. Molecular Modelling and Drug Design-K.Anand Solomon-1st edition (2011)-MJP Publishers.

Paper Name: **Non-conventional Energy**					
Paper Code: **BIOT4222**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

1. Course outcomes:

At the end of this course students will be able to:

BIOT4222.1. Understand the concept and necessity of non-conventional energy as an alternative source of energy.

BIOT4222.2. Comprehend and apply the concepts of solar energy to design Photovoltaic cells and wind energy to design wind turbine.

BIOT4222.3. Classify and design different biogas production processes.

BIOT4222.4. Design a production process for biodiesel.

BIOT4222.5. Understand the concept of hydrogen energy as a clean fuel and characterize the hydrogen production process.

BIOT4222.6. Comprehend the importance and classification of hydrogen fuel cells.

2. Detailed Syllabus

Module I: Non-conventional energy: Different forms [10L]

Solar energy: Solar energy balance, production of electricity, photovoltaic systems.

Wind Energy: Wind energy conversion systems, power generation. Calculations on wind turbine.

Hydro thermal energy: Basics of hydro thermal energy. Energy from waves and tides.

Module II: Biogas [10L]

Biomass as a renewable energy source; types of biomass – forest, agricultural and animal residues, industrial and domestic organic wastes.

Classification of biogas production processes: combustion, pyrolysis, gasification and other thermo-chemical processes. Production of alcohol and biogas from biomass. Biogas from anaerobic digestion.

Module III: Bio-diesel [10L]

Bio-diesel: Fundamentals; Trans-esterification of vegetable oils for biodiesel production; Characterization of biodiesel; Biodiesel from different sources; Economics, current trends and future prospects in usage of biodiesel.

Module III: Hydrogen as energy source [10L]

Hydrogen energy: Hydrogen energy system and analysis; Hydrogen infrastructure; Safety, codes and standards.

Hydrogen production: Electrolysis; Thermochemical; Hydrogen from fossil fuel, biomass and renewable sources of energy. Problems on combustion of fuels.

Hydrogen storage: Carbon storage materials; Metal hydrides and chemical hydrides; Cryogenic hydrogen storage. Hydrogen fuel cells: Principle, importance and classification.

3. Texts/References:

1. J.E. Smith, Biotechnology, 3rd ed. Cambridge University Press.

2. S. Sarkar, Fuels and combustion, 2nd ed., University Press.

3. Donald L. Klass, Biomass for renewable energy, fuels and chemicals, Academic Press.

Paper Name: **Nanotechnology**					
Paper Code: **CHEN4221**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Paper Name: **Introduction to Solar and Wind Technology**					
Paper Code: **CHEN4222**					
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:

CHEN4222.1. Understand different technologies used for solar collectors.

CHEN4222.2. Students will be able to evaluate the performance and efficiency of different devices that extract power from solar energy.

CHEN4222.3. Students will be able to understand the main components of wind energy system and its functions.

CHEN4222.4. Understand the different types of wind turbines.

2. Detailed Syllabus

Module 1: [10L]

Introduction to Radiation heat transfer: Blackbody radiation, Stefan-Boltzmann Law, Wien's Displacement Law, emissivity, absorptivity, radiation view factor, radiation shield. Solar radiation: sun earth geometric relationship, solar angles, sun's trajectories in different seasons, zenith solar time, air mass, solar beam, total solar radiation & diffuse radiation, solar radiation on different surfaces at different angles, extraterrestrial radiation. Attenuation of solar radiation by the atmosphere, beam and diffuse components of hourly and daily radiation, clearness index.

Module 2: [10L]

Solar Thermal Collector: Flat plate collector, Unglazed, Single- a n d d o u b l e - g l a z e d solar collectors, Optical losses and thermal losses, thermal analysis and performance characteristics. Concentrating solar collectors: General description; concentrators, receivers, Orienting/tracking requirements, Paraboloid dish collectors, Scheffler dish, Linear Fresnel Reflector Collector.

Introduction to Solar PV: Crystal structure, band theory, energy band diagrams, Fermi level, intrinsic and extrinsic semiconductor, Standard solar cell structure, I-V characteristics, FF, Voc, Isc, Pmax, conversion efficiency, losses in solar cell, Rs, Rsh, impact of radiation and temperature; Silicon wafer based solar PV technology, Single and poly crystalline silicon solar cells; Thin film technology of solar cell, Merits and demerits of thin film technologies.

Module 3: [10 L]

Basics of Wind Energy Conversion: Power available in the wind spectra, Wind turbine power and torque, Classification of wind turbines: Horizontal axis and Vertical axis, Characteristics of wind rotors, Aerodynamics of wind turbines (Airfoil, Aerodynamic theories, Axial momentum theory, Blade element theory, Strip theory), Rotor design, Rotor performance.

Analysis of wind regimes: The wind (Local effects, Wind shear, Turbulence, Acceleration effect, Time variation), Measurement of wind (Ecological indicators, Anemometers, Cup anemometer, Propeller anemometer, Pressure plate anemometer, Pressure tube anemometers, Sonic anemometer, Wind direction), Analysis of wind data (Average wind speed, Distribution of wind velocity, Statistical models for wind data analysis; Weibull distribution, Rayleigh distribution),Energy estimation of wind regimes (Weibull based approach, Rayleigh based approach).

Module 4: [10L]

Wind energy conversion systems: Wind electric generators (Tower, Rotor, Gear box, Power regulation, Safety brakes, Generator; Induction generator, Synchronous generator. Fixed and variable speed operations, Grid integration), Wind farms, Offshore wind farms, Wind pumps (Wind powered piston pumps, Limitations of wind driven piston pumps; The hysteresis effect, Mismatch between the rotor and pump characteristics, Dynamic loading of the pump's lift rod, Double acting pump, Wind driven roto-dynamic pumps, Wind electric pumps). Performance of wind energy conversion systems: Power curve of the wind turbine, Energy generated by the wind turbine (Weibull based approach, Rayleigh based approach), Capacity 26 factor, Matching the turbine with wind regime, Performance of wind powered pumping systems (Wind driven piston pumps, Wind driven roto-dynamic pumps, Wind electric pumping systems)

3. Textbooks:

1. Sukhatme S. &Nayak J., Solar Energy: Principles of Thermal Collection and Storage, Third Edition, Tata McGraw Hill, 2008.

2. Solanki C.S.; Solar Photovoltaics – Fundamentals, Technologies and Applications; PHI Learning, 3rd edition, 2015.

3. Efstathios E. (Stathis) Michaelides, Renewable Energy Sources, Springer, 2012.

4. Sathyajith Mathew, Wind Energy: Fundamentals, Resource Analysis and Economics, Springer, 2006.

4. Reference Books:

1. Goswami D.Y., Kreith F. &Kreider J.F.; Principles of solar Engineering, Taylor and Francis, Philadelphia, 2000.

2. N.K. Bansal and M.K. Kleeman, Renewable Sources of Energy and Conversion Systems, Tata McGraw-Hill, 1984.

Paper Name: **Optical Fiber Communication**					
Paper Code: **ECEN4223**					
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:

ECEN4223.1. Apply the basic idea of electronics, physics and solid state devices and explain the operation of different components in an optical communication system.

ECEN4223.2. Understand the properties of optical fiber and categorize the transmission characteristics of a wave through the optical fiber.

ECEN4223.3. Analyze the structure of various optical sources and can classify them according to the performance, efficiency and application.

ECEN4223.4. Explain the operation of optical detectors and can analyze the performance parameters of a detector.

ECEN4223.5. Recognize the current optical technologies used for long distance communication and their application in optical networks.

ECEN4223.6. Solve the problems related to optical fiber communication and can justify the physical significance of the solutions.

2. Detailed Syllabus

Module 1 [8L]

Introduction to communication systems: Principles, Components; Different Forms of Communications, Advantages of Optical Fiber Communication, Spectral Characteristics. Optical Fiber: Cylindrical Wave Guide Structure (qualitative discussions only), Fabrication and Related Parameters, Single and Multimode Operation; Attenuation and losses, Material and Wave Guide Dispersion. Fiber Splices, Fiber Optic Connectors, OTDR.

Module 2 [10L]

Optical Sources Light Emitting Diode: Principle, Structures, Power and Efficiency, Surface Emitting LED And Edge Emitting LED, Super Luminescent Diode (SLD), Coupling of LEDs to Fibers. Laser diodes: Principle, Modes, Double Heterostructure, Gain and Index Guiding, Distributed Lasers, Narrow Line Width Lasers.

Module 3 [12L]

Detectors & Other Network Components: Photo Detectors: Photo Diodes, Optical Detection Principles, Efficiency, Responsively, Bandwidth. WDM System: Preamplifiers; Noise Sources, Wavelength Division Multiplexing: Building Blocks; Multiplexing; Intensity Modulation/Direct Detection System; Principle of Regeneration. Optical amplifiers& Filters: EDFA, SOA, Raman Amplifier, Fabry-Perot Filters.

Module 4 [6L]

Optical Network: Network Topologies: LAN, MAN, WAN; Topologies: Bus, Star, Ring; Ethernet; FDDI; Telecom Networking: SDH/SONET, SONET/SDH Layers, SONET Frame Structure, SONET/SDH Physical Layer.

3. Textbooks:

1. Fiber Optics and Optoelectronics, R. P. Khare, Oxford University Press

2. Optical Fiber Communication: John M. Senior (Pearson)

3. Optical Networks – A Practical Perspective: Rajiv Ramaswami, K. N. Sivarajan, Galen H. Sasaki (Morgan-Kaufman)

4. Optical Communication Systems: John Gawar (PHI).

4. Reference Books:

1. Optical Fiber Communication: Gerd Kaiser (TMH)

Paper Name: **Quantum Physics**					
Paper Code: **PHYS4121**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	3	0	0	3	3

Paper Name: **Project - II**					
Paper Code: **CSEN4295**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	0	0	16	16	8

1. Course Outcomes

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

CSEN4295.1. Demonstrate a sound technical knowledge of their selected project topic.

CSEN4295.2. Understand the problems from the related domain, formulate them formally, analyze the complexity of the problem and apply their knowledge to solve it.

CSEN4295.3. Design engineering solutions to complex problems utilizing a systematic approach.

CSEN4295.4. Communicate effectively with their peer groups and the community at large in written as well as in oral form.

CSEN4295.5. Demonstrate their knowledge, skills, and techniques to solve various real-life problems related to the engineering domain

Paper Name: **Comprehensive Viva-voce**					
Paper Code: **CSEN4297**					
Contact hours per week:	**L**	**T**	**P**	**Total**	**Credit Points**
	-	-	-	-	1

1. Course Outcomes

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

CSEN4297.1. Understand and demonstrate their overall technical knowledge in the program domain.

CSEN4297.2. Apply the fundamental knowledge of Computer Science Engineering in advanced problems.

CSEN4297.3. Present their ideas clearly and precisely.

CSEN4297.4. Analyze a situation and identify possible practical solutions to implement it.

CSEN4297.5. Communicate effectively and face interviews with confidence.