UNIVERSITY OF KALYANI
Department of Computer Science & Engineering
Kalyani, Nadia, W. Bengal – 741 235

University of Kalyani
Department of Computer Science & Engineering

Syllabus

Bachelor of Technology
on
Computer Science & Engineering

Department of Computer Science & Engineering

Curriculum Structure
BachelorofTechnologyon Computer Science & Engineering

A. Definition of Credit

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit

Curriculum Structure

Bachilor of Technology on Computer Science & Engineering

A. Definition of Credit

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credit

B. Range of credits

A range of credits from 150 to 160 for a student to be eligible to get B.Tech Degree in Engineering. A student will be eligible to get B. Tech Degree *with Honours*, if he/she completes an additional 20 credits. The guidelines to acquire the additional credit points are given in Annexure-I.

C. Guidelines regarding Mandatory Induction Program for the new students

The guidelines for Mandatory Induction Program are given in Annexure-II.

Curriculum Structure for B. Tech. in Computer Science and Engineering
To Be Effective from AY 2022-23

Part – I (Common with all B.Tech. courses of KU)

Semester I (First Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Basic Science Courses	PH 101	Physics	3	1	0	4
2.	Basic Science Courses	MA 101	Mathematics-I	3	1	0	4
3.	Engineering Science Courses	EE 101	Basic Electrical Engineering	3	1	0	4
Practical							
4.	Basic Science Courses	PH 191	Physics Lab	0	0	3	1.5
5.	Engineering Science Courses	EE 191	Basic Electrical Engineering Lab	0	0	2	1
6.	Engineering Science Courses	ME 191	Engineering Graphics & Design Lab	1	0	4	3
7.	Mandatory Courses	NSS 191	NSS	0	0	1	0
						Total Credits	17.5

Semester II (First Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Basic Science Courses	CH 201	Chemistry	3	1	0	4
2.	Basic Science Courses	MA 201	Mathematics-II	3	1	0	4
3.	Engineering Science Courses	IT 201	Programming for Problem Solving	3	0	0	3
4	Humanities and Social Sciences including Management courses	HU 201	English	2	0	0	2
Practical							

5.	Basic Science Courses	CH 291	Chemistry Lab	0	0	3	1.5
6.	Engineering Science Courses	ME 291	Workshop/ Manufacturing Practices	1	0	4	3
7.	Engineering Science Courses	IT 291	Programming for Problem Solving Lab	0	0	4	2
8.	Humanities and Social Sciences including Management courses	HU 291	Linguistic Lab	0	0	2	1
						Total Credits	20.5

Part – II through Part - IV

Semester III (Second Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Engineering Science Courses	EC 301	Basic Electronic Circuits & Devices	3	0	0	3
2.	Professional Core Courses	CS 301	Data structure & Algorithms	3	0	0	3
3.	Professional Core Courses	CS 302	Digital Logic & Circuits	3	0	0	3
4.	Basic Science Courses	MA 301	Mathematics-III	2	0	0	2
5.	Humanities & Social Sciences including Management Courses	HU 301	Economics for Engineers	3	0	0	3
6.	Mandatory Courses	MC 301	Constitution of India	3	0	0	0
Practical							
7.	Engineering Science Courses	EC 391	Basic Electronic Circuits & Devices Lab	0	0	4	2
8.	Professional core Courses	CS 391	Data structure & Algorithms Lab	0	0	4	2
9.	Professional core Courses	CS 392	Digital Logic & Circuits Lab	0	0	4	2
10	Professional Core Courses	CS 393	IT Workshop (Python/R/Matlab)	0	0	4	2
						Total Credits	22

Semester IV (Second Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Professional core Courses	CS 401	Discrete Mathematics	3	1	0	4
2.	Professional core Courses	CS 402	Computer Organization & Architecture	3	0	0	3
3.	Professional core Courses	CS 403	Microprocessor & its Applications	3	0	0	3
4.	Professional core Courses	CS 404	Object Oriented Programming	3	0	0	3
5.	Humanities & Social Sciences including Management Courses	HU 401	Organizational Behaviour Management	3	0	0	3
6.	Mandatory Courses	MC 401	Environmental Science	3	0	0	0
Practical							
7.	Professional core Courses	CS 491	Computer Organization & Architecture Lab	0	0	4	2
8.	Professional core Courses	CS 492	Microprocessor & Its Applications Lab	0	0	4	2
9.	Professional core Courses	CS 493	Object Oriented Programming in C++ Lab	0	0	4	2
						Total Credits	22

Semester V (Third Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Professional core Courses	CS 501	Operating Systems	3	0	0	3
2.	Professional core Courses	CS 502	Database Management Systems	3	0	0	3
3.	Professional core Courses	CS 503	Design & Analysis of Algorithms	3	0	0	3
4.	Professional core Courses	CS 504	Formal Language & Automata	3	0	0	3

			Theory				
5.	Engineering Science Courses	SS 501	Signals & Systems	3	0	0	3
6.	Professional Elective Courses	PEC 501	Elective I	3	0	0	3
Practical							
7.	Professional core Courses	CS 591	Operating Systems Lab	0	0	4	2
8.	Professional core Courses	CS 592	Database Management Systems Lab	0	0	4	2
9.	Professional core Courses	CS 593	Design & Analysis of Algorithms Lab	0	0	4	2
						Total Credits	24

Semester VI (Third Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Professional core Courses	CS 601	Compiler Design	3	0	0	3
2.	Professional core Courses	CS 602	Data Communication & Computer Networks	3	0	0	3
3.	Professional Elective Courses	PEC 601	Elective II	3	0	0	3
4.	Professional Elective Courses	PEC 602	Elective III	3	0	0	3
5.	Open Elective Courses	OEC 601	Open Elective I	2	0	0	2
Practical							
6.	Project	CS 681	Project-I	0	0	6	3
7.	Professional core Courses	CS 691	Data Communication & Computer Networks Lab	0	0	4	2
8.	Professional core Courses	CS 692	Elective II Lab	0	0	2	1
9.	Professional core Courses	CS 693	Elective III Lab	0	0	2	1
10.	Professional core Courses	CS 694	Java Programming Lab	0	0	4	2
						Total Credits	23

Semester VII (Fourth Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Professional Elective Courses	PEC 701	Elective IV	3	0	0	3
2.	Professional Elective Courses	PEC 702	Elective V	3	0	0	3
3.	Basic Science Courses	BIO 701	Biology for Engineers	2	1	0	3
4.	Open Elective Courses	OEC 701	Open Elective II	3	0	0	3
Practical							
5.	Project	CS 781	Project-II	0	0	12	6
6.	Internship/Training	CS 771	Summer Internship / Vocational Training & Seminar	-	-	-	2
						Total Credits	20

Semester VIII (Fourth Year)							
Sl. No.	**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credit**
				L	**T**	**P**	
Theory							
1.	Professional Elective Courses	PEC 801	Elective VI	3	0	0	3
2.	Open Elective Courses	OEC 801	Open Elective III	3	0	0	3
3.	Open Elective Courses	OEC 802	Open Elective IV	3	0	0	3
Practical							
4.	Project	CS 881	Project-III	0	0	16	8
						Total Credits	17

Professional Elective Courses

Elective I: Graph Theory / Software Engineering / Advanced Computer Architecture / Computer Graphics / Artificial Intelligence

Elective II: Advanced Algorithms / Soft Computing / Cloud Computing / 5G Communication and Computing

Elective III: High Performance Computing / Data Mining / Pattern Recognition

Elective IV: Advanced Operating Systems / Mobile Computing / Digital Signal Processing / Machine Learning

Elective V: Neural Networks and Deep Learning / Image Processing / Optical and Sensor Networks / Cryptography and Network Security

Elective VI: Speech and Natural Language Processing / Web and Internet Technology / Internet of Things

Open Elective Courses

Elective I: Scientific Computing / Human Resource Development / Professional Ethics

Elective II: Operations Research / Multimedia Systems / Introduction to Philosophical Thoughts

Elective III: Big Data Analytics / Cyber Laws and Ethics / Remote Sensing and GIS

Elective IV: E-Commerce and ERP / Research Methodology / VLSI Design / Economic Policies in India

Total Credit: 166

Detailed Syllabus

1st Semester

Subject : PHYSICS (PH 101)

Paper Code : PH101 Subject Category: Theoretical
Full Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L + 1T Credits: 4

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 40

Electronic materials

Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Density of states, Occupation probability, Fermi level, Effective mass, Phonons. $8L + 2T$

Semiconductors

Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction, Metal-semiconductor junction (Ohmic and Schottky), Semiconductor materials of interest for optoelectronic devices.10L+ 2T.

Light-semiconductor interaction

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Joint density of states, Density of states for photons, Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect, Exciton, Drude model. 6L+ 1T

Measurements

Four-point probe and van der Pauw measurements for carrier density, resistivity, and hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission. 6L+ 1

Engineered semiconductor materials

Density of states in 2D, 1d and 0D (qualitatively). Practical examples of low-dimensional systems such as quantum wells, wires, and dots: design, fabrication, and characterization techniques. Heterojunctions and associated band-diagrams. $6L+ 2T$

Recommended Books:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., (2007).
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford University Press, New York (2007).
5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).

Subject: MATHEMATICS-I(MA 101)

Paper Code: MA101 Subject Category: Theoretical Full Marks:100 [End Semester Examination: 70 Marks+InternalAssessment:30 Marks] *Contact Hours per week=3L+1T*
Credits:4
Duration of the semester:12 weeks Assumed total contact hours in a semester: 48

Calculus:
Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima. 5*L*+2*T*

Sequences and series:
Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; 3*L*+1*T*

Calculus:
Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. 6*L*+1*T*

Multivariable Calculus (Differentiation):
Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence. 6*L*+2*T*

Matrices:
Determinants, Matrices, vectors: addition and scalar multiplication, matrix multiplication; Inverse and rank of a matrix, rank-nullitytheorem; Eigenvalues, eigenvectors,- symmetric, skew-symmetric, and orthogonal Matrices, eigenbases; Diagonalization.
System of linear equations, Cramer's Rule; Gauss elimination and Gauss-Jordan elimination. 10*L*+4*T*

Vectorspaces:
Vector Space, linear dependence of vectors, basis, dimension; Linear transformations(maps), range and kernel of a linear map, Inverse of a linear transformation, comsudo apt-get install abi word position of linear maps, Matrix associated with a linear map.
Inner product spaces, Cayley-Hamilton Theorem, and Orthogonal transformation, Gram-Schmidt orthogonalization. 6*L*+2*T*

Recommended Books:

1.*G.B.Thomas and R. L. Finney, "Calculus and Analytic geometry", 9*thEdition, Pearson, Reprint, 2002.
2.Erwin Kreyszig, "Advanced Engineering Mathematics",9th Edition, John Wiley & Sons, 2006.
3.D. Poole, "Linear Algebra: A Modern Introduction",2nd Edition, Brooks/Cole, 2005.
4.T. Veerarajan, "Engineering Mathematics for first year",TataMcGraw-Hill, NewDelhi, *2008.*
5.B.V.Ramana,"Higher Engineering Mathematics",Tata McGraw Hill NewDelhi,11th Reprint,2010.
6.N.P.Baliand Manish Goyal,"A text book of Engineering Mathematics", Laxmi Publications, Reprint,2010.
7.B.S.Grewal,"Higher Engineering Mathematics",Khanna Publishers,35th Edition, 2000.

8.V.Krishnamurthy, V.P.Mainraand J.L. Arora, "An introduction to Linear Algebra",Affiliated East–West press, Reprint2005.

Subject :BASIC ELECTRICAL ENGINEERING(EE 101)

PaperCode:EE101Subject Category: Theoretical FullMarks:100 [End Semester Examination:70 Marks+InternalAssessment:30 Marks] *Contact Hours per week=3L+1T Credits:4*

Duration of the semester:12weeks Assumed total contact hours in a semester:40

DC Circuits:

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff currentand voltage laws, analysis of simple circuits with dcexcitation. Superposition, Thevenin and Norton Theorems, Maximum Power Transfer Theorem, Miller Theorem & Millman's Theorem. Time-domainan alysis of first-order RL and RC circuits. 8*L*+3*T*

AC Circuits:

Representation of sinusoidal wave forms ,peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R,L,C, RL, RC, RLC combinations (seriesandparallel), resonance. Three-phase balanced circuits, voltage and current relations in starand delta connections. 8*L*+3*T*

Transformers:

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections. 6L+2T

ElectricalMachines:

Generation of rotating magnetic fields, Construction and working of a three-phaseInduction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators. 8L+2T

ElectricalInstallations:

Components of LTS witch gear: Switch Fuse Unit (SFU),MCB,ELCB,MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup. 6L+2T

RecommendedBooks

1.B.L.Thereja,A.K.Thereja;ATextbookofElectricalTechnology-VolumeI&II,SChand;Twenty Thirdedition(1January1959)
2.D.P.KothariandI.J.Nagrath,"BasicElectricalEngineering",TataMcGrawHill,2010.
3.L.S.Bobrow,"FundamentalsofElectricalEngineering",OxfordUniversityPress,2011.
4.E.Hughes,"ElectricalandElectronicsTechnology",Pearson,2010.
5.V.D.Toro,"ElectricalEngineeringFundamentals",PrenticeHallIndia,1989.

Subject: PHYSICS LABORATORY(PH191)

Code:PH191Subject Category:Sessional
FullMarks:100
Contact Hours per week=3 P Credits:1.5

Duration of thes emester:12 weeks Assumed total contact hours in a semester:36

1. To Study the characteristics of different PN junction Diode-Ge and Si
2. To analyze the suitability of a given Zener diode as a power regulator
3. To find out the intensity response of a solar cell/Photodiode/LED
4. To determine the band gap of a semiconductor
5. To determine the resistivity of a semiconductor by four probe method
6. To study voltage regulation and ripplef actor for a half-wave and a full-wave rectifier without and with different filters
7. To study the Hall effect for the determination of charge current densities
8. Distinguish between Diamagnetic material, Paramagnetic and ferromagnetic material.
9. To compare various capacitance and verify the law of addition of capacitance.

Subject: BASIC- ELECTRICAL ENGINEERING LABORATORY(EE191)

Code:EE191Subject Category:- Sessional
FullMarks:100
Contact Hours per week=2P Credits:1

Duration of thesemester:12 weeks Assumed total contact hours in a semester:24

1.Mesh and nodal analysis

2.Verification of superposition theorem

3.Verification of Thevevnins's theorem

4.Study of R-L series and R-C series circuit

5.R-L-C series resonance circuit

6.R-L-C parallel resonance circuit

7.Relationship between phase and line currents and voltages

8.Open Circuit and Short Circuit test on single phase transformer

Subject : ENGINEERING GRAPHICS & DESIGN(ME191)

Code:ME191 Subject Category: Sessional
FullMarks:100
Contact Hours per week=1L+4P Credits:3

Duration of the semester:12 weeks Assumed total contact hours in a semester:40

1. ***Introduction to Engineering Drawingcovering,***
   Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (Generalmethodonly); Cycloid, Epicycloid, Hypocycloid and Involute; Scales–Plain, Diagonal and Vernier Scales;
2. ***Orthographic Projections covering,***
   Principles of Orthographic Projections-Conventions-Projections of Points and lines inclined to both planes; Projections of planes inclined Planes-Auxiliary Planes;
3. ***Projections of Regular Solids covering,***
   Those inclined to botht hePlanes-AuxiliaryViews; Draws- implant notation, dimension in gand scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower,etc.
4. ***Sections and Sectional Views of Right Angular Solidsc overing,***
   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, objects from industry and dwellings(foundation tos labonly)
5. ***Isometric Projections covering,***
   Principles of Isometric projection–Isometric Scale, IsometricViews, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;
6. ***Overview of Computer Graphics***
   covering, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [suchas:The Menu System,Toolbars (Standard, Object Properties, Draw,Modify and Dimension), Drawing Area(Background,Crosshairs,CoordinateSystem), Dialog boxes and windows, Shortcutmenus (ButtonBars), The Command Line (whereapplicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.;Isometric Views of lines, Planes, Simple and compound Solids];
7. ***Customisation & CAD Drawing***
   Consisting of setup 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;
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, Computer-aided design(CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wire frame models. Part editing and two dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multi-view, auxiliary, and section views. Spatial visualization exercise. Dimensioning guidelines, to lerancing techniques; dimensioning and scale multi-views of dwelling.

9. ***Demonstration of a simple team design project that*** *illustrates*
   Geometry and topology of engineered components: creation of engineering models and the rpresentation in standard 2D blue print formand as 3 D wire-frame ; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and to lerancing; Use of solid-modelings of tware for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures suc ,bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).

Recommended Books

1. BhattN.D.,PanchalV.M.&IngleP.R.,(2014),EngineeringDrawing,CharotarPublishing House
2. Shah,M.B.&RanaB.C.(2008),EngineeringDrawingandComputerGraphics,Pearson Education
3. *Narayana,K.L.&PKannaiah(2008),TextbookonEngineeringDrawing,Scitech* Publishers
4. CADSoftwareTheoryandUserManuals

PART – I, 2ND SEMESTER (CSE)

NO. OF THEORETICAL SUBJECT : 04 **CREDITS ON THEORETICAL SUBJECTS : 13**
NO. OF SESSIONAL SUBJECT : 04 **CREDITS ON SESSIONAL : 7.5**
TOTAL SEMESTER CREDITS : 20.5

Subject : CHEMISTRY –I(CH 201)

Paper Code : CH 201 Subject Category: Theoretical
Full Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L+1T Credits: 4
Duration of the semester: 12 weeks Assumed total contact hours in a semester: 48

1. ***Atomic and molecular structure***
Schrodinger equation. Particle in a box solution and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots ofthese functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomics. Pi-molecular orbitals of butadiene and benzene and aromaticity.
Crystal field theory and the energy level diagrams for transition metal ions and their magnetic. Band structure of solids and the role of doping on band structures. *6L+2T*
2. ***Spectroscopic techniques and applications***
Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering. *5L+2T*
3. ***Intermolecular forces and potential energy surfaces***
Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces. *3L+1T*
4. ***Use of free energy in chemical equilibria***
Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of freeenergy considerations in metallurgy through Ellingham diagrams. *6L+2T*
5. ***Periodic properties***
Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries *8L+2T*
6. ***Some Important Chemical Processes***
Basic chemical processes in (1) petrochemical and polymer, (2) basic inorganic (sodium hydroxide, sulfuric and nitric acids, fertilizers, chlorine), (3) speciality chemicals (agricultural, dyes and pigments), (4) consumer chemicals (detergents, soaps, cosmetics, perfumes etc.) and (5) pharmaceuticals (some examples) *5L+2T*
7. ***Chemistry in the world***

Chemical evolution: how elements were formed; brief idea of chemical environment in ancient and modern world; chemistry and life 3*L+1T*

Recommended Books:

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", 9th Ed., Pearson, 2002.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
3. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
4. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
5. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
7. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-GrawHill, 2004.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Subject : PROGRAMMING FOR PROBLEM SOLVING(IT 201)

Paper Code : IT 201 Subject Category: Theoretical
Full Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L +0T Credits: 3

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 36

1. **Introduction**
Overview of basic components of computer system (primary memory, secondary memory, processor etc.) and basic computer organization, Basic idea of Operating System, Translator; Number System. 2*L*
2. **Introduction to Programming**
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudo code with examples. From algorithms to programs; Programming environments; source code, object and executable code; Variables (with data types), variables and memory locations; Syntax and Logical Errors in compilation, Debugging. 2*L*
3. **C Fundamentals**
The C character set, identifiers and keywords, data types & sizes, variable names, declaration statements, storage classes.C program structure, header files, built in libraries. 2*L*
4. **Operators & Expressions**
Arithmetic operator, relational and logical operators, Bit-Level Operators, type conversion, expression evaluation, precedence and associativity, Input and Output- standard input and output, formatted input and output. 2*L*
5. **Flow of control**
Statement and blocks, if-else, switch-case, loops- while, for, do while; break, continue, exit, return, go to and labels 3*L*
6. **Functions and Program Structures**
Basics of functions, function prototypes, function call, function definition, library
functions, user defined functions, system defined functions, functions returning values,
parameter passing: pass by value.
Command Line Argument; variable argument list;
Storage class: auto, external, static and register, scope rules.

Recursion, Tail recursion5*L*

7. **Arrays and Pointers**

One dimensional arrays, two dimensional arrays, Character Arrays, pointers. Passing arrays to functions, passing pointers to functions, idea of call by reference Functions returning structures, functions returning pointers 4*L*

9. **Structures, Union, Enumerator** 3*L*

10. **Advanced arrays and Pointers**

Memory allocation– static and dynamic; Multidimensional arrays, pointer to pointer, array of pointers, pointer to array, pointer to a function, Array of structures, pointer to structures; Near Pointer, Far Pointer, Huge Pointer; Character Arrays and Strings; Arrays of structures, Pointer to structures; Structure containing pointer, self-referential structures 5L

11. **Preprocessor Directives**

Types of Preprocessors, Macro substitution directives, File inclusion directives, Compiler control directives 2L

12. **Files & Error Handling:**

Concepts of File Management, FILE Type; Bit fields, formatted and unformatted files; Error Handling 6*L*

Recommended Books:

1. B.W. Kernighan and P. J. Plauger, "The Elements of Programming Style", McGraw-Hill, New York
2. E. Yourdon, "Techniques of Program Structures and Design", Prentice Hall
3. F.S. Scheid, "Theory and Problems of Computers and Programming", McGraw-Hill
4. Gottfried, "Programming with C", Tata McGraw-Hill
5. B.W. Kernighan and D.M. Ritchie, "The C Programming Language", Prentice Hall India
6. V. Rajaraman, "Fundamentals of Computers", Prentice Hall India
7. E. Balaguruswamy, "Programming in ANSI C", Tata McGraw-Hill
8. Y. Kanetkar, "Let us C", BPB
9. Y. Kanetkar, "Pointers in C", BPB
10. M.M. Oka, "Computer Fundamentals", EPH

Subject : ENGLISH (HU 201)

Paper Code : HU201 Subject Category: Theoretical

Full Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]

Contact Hours per week = 2L Credits: 2

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 24

1. ***Vocabulary Building***

The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations. *5L*

2. ***Basic Writing Skills***

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents,Techniques for writing precisely *5L*

3. ***Identifying Common Errors in Writing***

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés *5L*

4. ***Nature and Style of sensible Writing***

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion *5L*

5. ***Writing Practices***

Comprehension, Précis Writing, Essay Writing *4L*

Recommended Books:

1. Michael Swan, "Practical English Usage". OUP. 1995.
2. F.T. Wood, "Remedial English Grammar". Macmillan.2007
3. William Zinsser, "On Writing Well". Harper Resource Book. 2001
4. Liz Hamp-Lyons and Ben Heasly, "Study Writing". Cambridge University Press. 2006.
5. Sanjay Kumar and Pushp Lata, "Communication Skills". Oxford University Press. 2011.
6. "Exercises in Spoken English. Parts. I-III". CIEFL, Hyderabad. Oxford University Press

Subject : CHEMISTRY LABORATORY(CH 291)

Code : CH 291 Subject Category: Sessional
Full Marks : 100
Contact Hours per week = 3S Credits: 3

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 36

1. Determination of viscosity coefficient by Ostwald viscometer
2. Determination of surface tension by stalagmometer
3. Determination of pH by pH meter and by colour-matching
4. Determination of part of phase boundary of phenol-water system
5. Determination of equilibrium constant of KI + I 2 = KI 3
6. Determination of UV-Vis spectrum of a chromophore

Subject : WORKSHOP/MANUFACTURING PRACTICES LABORATORY(ME 291)

Code : ME 291 Subject Category: Sessional
Full Marks : 100
Contact Hours per week = 1L + 4S Credits: 3

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 60

1. Machine shop
2. Fitting shop
3. Carpentry
4. Welding shop
5. Casting
6. Smithy
7. Plastic moulding & Glass Cutting

Subject : PROGRAMMING FOR PROBLEM SOLVING LABORATORY(IT 291)

Paper Code : IT- 291 Subject Category: Sessional

Full Marks : 100
Contact Hours per week = 4P Credits: 2

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 48

1. Problem solving using computers: Familiarization with programming environment
2. Variable types and type conversions: Simple computational problems using arithmetic expressions
Experiments using bit level operator and other operators
3. Branching and logical expressions
4. Loops: Iterative problems
5. 1D and 2D Array declaration and manipulation
6. Functions, call by value, call by reference
7. Pointers, structures, dynamic memory
8. Experiments on Preprocessor Directives
9. Library function implementation, experiments with command line argument and variable argument list
10. Experiments on file handling and error handling

Subject : LINGUISTIC LABORATORY(HU 291)

Code : HU 291 Subject Category: Sessional
Full Marks : 100
Contact Hours per week = 2P(2S) Credits: 1

Duration of the semester: 12 weeks Assumed total contact hours in a semester: 24

1. Listening Comprehension
2. Pronunciation, Intonation, Stress and Rhythm
3. Common Everyday Situations: Conversations and Dialogues
4. Communication at Workplace
5. Interviews
6. Group Discussions
7. Formal Presentations

PART – II, 1st SEMESTER (CSE)

Semester III

Course Title: Basic Electronic Circuits & Devices

Paper Code: EC 301 **Subject Category: Theoretical**
Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L ***Credits: 3***

Introduction to Electronics: Signals, Frequency Spectrum of Signals, Analog and Digital Signals, Linear Wave Shaping Circuits: RC LPF, Integrator, RC HPF, Differentiator.

Diode circuits: P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits.

BJT circuits: Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits

MOSFET circuits: MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Differential, multi-stage and operational amplifiers: Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

Linear applications of op-amp: Idealized analysis of op-amp circuits. Inverting and non-inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion.

Nonlinear applications of op-amp: Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector. Monoshot.

Recommended Books

1. A. S. Sedra and K. C. Smith, ―Microelectronic Circuits‖, New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, ―Introduction to Operational Amplifier theory and applications‖, McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, ―Microelectronics‖, McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, ―The Art of Electronics‖, Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, ―Analysis and Design of Analog Integrated Circuits‖, John Wiley & Sons, 2001.

Course Title: Data Structure and Algorithms

Paper Code: CS 301 **Subject Category: Theoretical**
Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L ***Credits: 3***

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off.

Searching: Linear Search and Binary Search Techniques and their complexity analysis.

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Recommended Books

1. Ellis Horowitz, S. Sahni, D. Mehta Fundamentals of Data Structures in C++, Galgotia Book Source, New Delhi.
2. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms (2nd ed.), Prentice-Hall of India, 2006
3. Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education Asia, 2nd Edition, 2002.
4. Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., “Data Structures and Algorithms”, Addison Wesley

Course Title: Digital Logic & Circuits

Paper Code: CS 302 **Subject Category: Theoretical**
Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L ***Credits: 3***

Fundamentals of Digital Systems and logic families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, one‘s and two‘s complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Combinational Digital Circuits: Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don‘t care conditions, Multiplexer, De- Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.

Sequential circuits and systems: A 1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K-T and D types flip-flops, applications of flipflops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flipflops, special counter IC‘s, asynchronous sequential counters, applications of counters.

A/D and D/A Converters: Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using Voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D Converter ICs

Semiconductor memories and Programmable logic devices: Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Recommended Books

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

Course Title: Mathematics-III

Paper Code : MA 301 **Subject Category: Theoretical**
Full Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks] ***Contact Hours per week = 2L*** ***Credits: 2***

Probability, Basic terminology, Types of Probability, concept of random variables, Probability rules, Bayes Theorem, Probability distribution, Discrete and Continuous distributions, Binomial, Poisson, Negative-Binomial, Geometric, Hypergeometric, Uniform, Exponential, Normal distribution, log-normal, beta and gamma distributions, central limit theorem. Random Variables and Probability Functions: Expected value and variance, Moment generating functions; Joint, marginal, and conditional distributions.

Introduction, Measures of Central Tendency and Dispersion in Frequency Distributions, Arithmetic Mean, Weighted Mean, Geometric Mean, Median, Mode, Dispersion, Ranges, Coefficient of Variation; Graphical representation of data, descriptive and inferential statistics, Data summarization and exploratory data analysis.

Sampling and Sampling Distribution, Random sampling, Design of Experiments, Sampling distribution, Relationship between sample size and standard error, estimation theory.

Testing Hypotheses: Null and alternative hypotheses, Type I and Type II errors, critical regions and p-values, One-sample and two-sample tests for population mean, median, proportion and variance, Chi-square test, Analysis of Variance (ANOVA): One-way ANOVA and Two-way ANOVA, Nonparametric Methods: Wilcoxon signed-rank test, Mann-Whitney U test, Kruskal-Wallis test, Applications of hypothesis testing.

Simple Regression and Correlation: Estimation using the regression line, Least-square regression, Correlation analysis, making inferences about population parameters. Multiple Regression: Multiple regression and correlation analysis, Finding multiple regression equation, Inferences about population parameters.

Recommended Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. Johnson, R. A., Miller & Freund's Probability and statistics for engineers, Pearson Education, 2000.
4. Hogg R. V., Craig A., Probability and Statistical Inference, 6th edition, Pearson Education.
5. Ross S. M., First Course in Probability, Pearson Education.

Course Title: Economics for Engineers

Paper Code : HU 301 **Subject Category: Theoretical**
Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L ***Credits: 3***

An Introduction of Economics— Definition of Economics; Nature of Economic Problem and Production Possibility Curve; Production— Interaction between Economic Theory and Production; Concepts of Firm, Industry and Economy. Demand and Supply Analysis— Demand and its determinants, Demand Function, Law of demand, Demand curve, Factors influencing demand curve, Elasticity of demand; Different concepts of Revenue; Supply and its determinants, Law of supply, Supply Function, Supply curve.

Theory of Costs— Classification of cost; Concepts of Total Cost, Average Cost and Marginal Cost. Concepts of Competition and Markets— Introduction to Perfect Competition; Short run and Long run equilibrium under perfect competition; Classification of Market—Monopoly and Oligopoly Markets; Equilibrium under monopoly and oligopoly; Price and output determination under monopoly. Theory of Production— Factors of production; Production Function; Laws of Returns; Returns to Scale; Cobb-Douglas production function and its properties. Product Pricing— Price Leadership model; Average Cost Pricing; Cost-plus or Mark-up Pricing; Marginal Cost Pricing and Variable Cost Pricing.

Nature of Indian Economy— Introduction to Indian Economy; Concepts of Public Sector, Privatization and Globalization — Their merits and demerits; Basic concepts of GATT, WTO and TRIPS.

Financial Management: Basic Concept— Meaning and definition of Financial Management; Financial Planning and Capitalization. Financial Statement— Meaning of Financial Analysis— Ratio Analysis. Capital Budgeting— Concept, importance and Process of Capital Budgeting; Nature of Investment Decision— Investment Criterion; Payback period; Accounting and Discounting; Different methods used— Rate of Return method, Fund Flow method, Net Present Value method, Internal Rate of Return method, Cost-Ratio method. Management of Working Capital— Concepts of Working Capital and its management; Importance of Working Capital; Financing and Investment Analysis; Cost of Capital. Budgeting Control Techniques— Concepts of budget, budgeting and budgeting control— its objectives, functions, merits and demerits; Master Budget and Report. Financial Control— Posting of Ledgers and Preparation of Trial Balance; Preparation of Balance Sheet; Preparation of Profit and Loss Accounts; Controlling other departments by Financial Accounting

Recommended Books

1. "Macroeconomics", Paul Samuelson, William Nordhaus, Sudip Chaudhuri, Tata McGraw Hill
2. "Economics for Engineers", T.R. Jain, M.L. Grover, V.K. Ohri and O.P. Khanna, V.K. Enterprise
3. "Engineering Economy", W.G.Sullivan, Pearson Education
4. "Engineering Economics and Costing", S. Mishra, Prentice Hall India
5. "Microeconomics", D. N. Dwivedi, 2011, Pearson Education
6. "Financial Management Theory and Practice"< Prasanna Chandra, Tata McGraw Hill
7. "Financial Management Text and Problems", Khan and Jain, Tata McGraw Hill

Course Title: Constitution of India

Paper Code : MC 301 **Subject Category: Theoretical**
Marks : 100 [End Semester Examination: 70 Marks + Internal Assessment: 30 Marks]
Contact Hours per week = 3L ***Credits: 3***

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution – Sources and constitutional history, Features – Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions; Learning outcomes:-After completion of this unit student will

State Government and its Administration Governor – Role and Position – CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

Local Administration – District's Administration Head – Role and Importance, Municipalities – Mayor and role of Elected Representative – CEO of Municipal Corporation PachayatiRaj: Functions, ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level Organizational Hierarchy – (Different departments), Village level – Role of Elected and Appointed officials – Importance of grass root democracy

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

Recommended Books

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Title: Basic Electronic Circuits & Devices Lab

Paper Code : EC 391 **Subject Category: Sessional**
Marks : 100

Contact Hours per week = 4P ***Credits: 2***

Familiarization with Electronic components such as Resistors, Capacitors, Diodes, Transistors etc., Familiarization with electrical devices and measuring equipment like DC power supply, Multimeter, Trainer kit etc., Familiarization with measuring and testing equipment like CRO, Signal generator, Study of characteristics of diodes, transistors and op-amp circuits taught in EC 301.

Course Title: Data structure & Algorithms Lab	
Paper Code : CS 391 **Marks : 100**	**Subject Category: Sessional**
Contact Hours per week = 4P	***Credits: 2***
Implementation of data structures and algorithms taught in CS 301 in C language	

Course Title: Digital Logic & Circuits Lab	
Paper Code : CS 392 **Marks : 100**	**Subject Category: Sessional**
Contact Hours per week = 4P	***Credits: 2***
Implementation and realization of logic circuits taught in CS 302	

Course Title: IT Workshop (Python/R/Matlab)	
Paper Code : CS 393 **Marks : 100**	**Subject Category: Sessional**
Contact Hours per week = 4P	***Credits: 2***
Lab on Python/R/Matlab programming	

PART – II, 2nd SEMESTER (CSE)

Semester IV

Course Name:	**Discrete Mathematics**		
Course Code:	CS 401	**Category:**	Basic Science Course
Semester:	IV (Second Year)	**Credit:**	4
L-T-P:	3-1-0	**Pre-Requisites:**	Some concepts from basic math – algebra, geometry, pre-calculus
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance: -

Course Objectives:	
1	To use mathematical logics and Boolean algebra in the field of computer applications.
2	To know about Set-Relation-Function and Group theory.
3	To learn counting techniques and number theory.
4	To use the concept of graph theory in engineering problems.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Module-1: **Sets-Relation-Function** • Operations and Laws of Sets • Cartesian Products, Binary Relation, Equivalence Relation, Partial Ordering Relation, Lattice **Number Theory** • Proofs by Mathematical Induction • The Division Algorithm, Prime Numbers, The Greatest Common Divisor, Euclidean Algorithm, The Fundamental Theorem of Arithmetic	10

2	**Module-2:** **Combinatorics** • Basic Counting Techniques, Inclusion and Exclusion Theorem • Permutation and Combination • Pigeon-Hole Principle	6
3	**Module-3:** **Propositional Logic and Proofs** • Basic Connectives and Truth Tables of propositional logics, Disjuntive and Conjuntive Normal Form using truth table, Argument • Quantifiers and their uses • Proofs; Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof by Mathematical Induction • The Laws of Logic, Logical Implication, Rules of Inference	8
4	**Module-4:** **Algebraic Structures and Boolean Algebra** • Algebraic Structures with one Binary Operator • Group, Subgroup, Cyclic group, Permutation group, Symmetric group. • Coset, Lagrange's Theorem, Normal Subgroup, Quotient group • Homomorphism and Isomorphism of groups **Algebraic Structures with two Binary Operators** • Rings, Integral Domain and Fields **Boolean Algebra** • Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjuntive and Conjuntive Normal Form • Switching network from Boolean expression using Logic Gates • Karnaugh Map	10
5	**Module-5:** **Advanced Graph Theory** • Planar and Dual graph: Kuratowski's graphs, Euler's formulae for connected and disconnected planar graphs, Detection of planarity • Graph Coloring: Vertex coloring, Chromatic number of complete graphs, circuit and bipartite graph, Chromatic polynomial • Connectivity and matching	6
Total	**40**	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Express a logic sentence in terms of predicates, quantifiers, and logical connectives
2	Derive the solution for a given problem using deductive logic and prove the solution based on logical inference
3	Classify its algebraic structure for a given a mathematical problem,
4	Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra
5	Develop the given problem as graph networks and solve with techniques of graph theory

Learning Resources:	
1	Russell Merris, Combinatorics, Wiley-Interscience series in Discrete Mathematics and Optimisation
2	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
3	Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning
4	Gary Chartrand and Ping Zhang – Introduction to Graph Theory, TMH
5	J.K. Sharma, Discrete Mathematics, Macmillan
6	Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PRSEAON.
7	S. K. Chakraborty and B. K. Sarkar, Discrete Mathematics, OXFORD University Press.
8	Douglas B. West, Introduction to graph Theory, PHI
9	C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.
10	R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.
11	R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.
12	N. Deo, Graph Theory, Prentice Hall of India, 1974.
13	S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999.
14	J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer

	Science, Tata McGraw-Hill, 1997.
15	Higher Algebra- S.K. Mapa
16	N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI
17	S.B. Singh, Discrete Structures – Khanna Publishing House (AICTE Recommended Textbook – 2018)
18	S.B. Singh, Combinatorics and Graph Theory, Khanna Publishing House (AICTE Recommended Textbook – 2018)

Course Name:	**Computer Organization and Architecture**		
Course Code:	CS 402	**Category:**	Professional Core Course
Semester:	IV (Second Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Digital Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance: -

Course Objectives:	
1	To introduce students how Computer Systems work & basics involved in data representation.
2	This course will also expose students to the basic organization of Processor and Memory System.
3	The students will be able to know how I/O devices are being accessed.
4	To learn the principles of pipelining
5	To distinguish between the concepts of serial, parallel, pipeline architecture.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**

1	**Basic Computer Organization and Data Representation** Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Commonly used number systems. Fixed- and floating-point representation of numbers Floating point - IEEE 754 standard, Overflow, Underflow	3
2	**Microoperation and Computer Arithmetic:** Arithmetic Microoperations, Logic Microoperations, S Design of adders - Ripple carry adder, Serial Adder and Carry Look Ahead Adder, Arithmetic Circuit Fixed point multiplication -Booth's algorithm.	4
3	**Central Processing Unit** General Register Organization, Stack Organization Instruction Formats, Addressing Modes, Instruction Set, C Design of control unit - hardwired and microprogrammed control.	3
4	**Memory Organization** Static and dynamic memory, Memory hierarchy, Associative memory. Cache memory, Associative Mapping, Direct Mapping, Set Associative Mapping, Virtual memory, Paging, Segmentation, Page Replacement Algorithm, Memory unit design with special emphasis on implementation of CPU-memory interfacing. Data path design for read/write access.	8
5	**Input-Output Organization** Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Mode of Transfer, Priority Interrupt, Direct Memory Access	3
6	**Pipelining** Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques; Compiler techniques for improving performance.	6

7	**Instruction-level parallelism** Basic concepts, techniques for increasing ILP, superscalar, super pipelined and VLIW processor architectures. Array and vector processors.	4
8	**Multiprocessor architecture** Taxonomy of parallel architectures; Centralized shared- memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.	5
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe Computer hardware, System, Instruction sets and Addressing Mode.
2	Design memory organization that uses banks for different word size operations.
3	Learn pipelining concepts with a prior knowledge of stored program methods
4	Study of parallel architecture and interconnection network

Learning Resources:	
1	Mano, M.M., "Computer System Architecture", PHI.
2	Hayes J. P., "Computer Architecture & Organisation", McGraw Hill,
3	Hamacher, "Computer Organisation", McGraw Hill,
4	William Stallings "Computer Organization and Architecture Designing for Performance", Pearson
5	J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
6	Hwang & Briggs—Computer Architecture & Parallel Processing, TMH
7	B.Ram – "Computer Organization & Architecture", Newage Publications
8	Rajaraman – "Computer Organization & Architecture", PHI
9	Hwang, K. "Advanced Computer architecture with parallel programming", McGraw

	Hill, 1993

Course Name:	**Microprocessor & its Applications**		
Course Code:	CS 403	**Category:**	Professional core Courses
Semester:	IV (Second Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electrical & Electronics Engineering ES-EE101
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance: -

Course Objectives:	
1	To introduce architecture and operation of microprocessor and microcontroller
2	To learn assembly language programming for microprocessor and microcontroller
3	To understand and design microprocessor and microcontroller based real world applications.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Intel 8085: pin description, architecture, addressing modes, interrupts, timing diagrams. Intel 8086: Pin description, architecture, memory segmentation, pipelining, min/max mode, addressing modes, data structure / access, interrupts.	8
2	Instruction Set and Assembly Language Programming of 8085 and 8086 microprocessors. Instruction formats, addressing modes, instruction set, simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations.	8

3	8255 PPI various modes of operation and interfacing to 8085. Intel 8279: Keyboard & display controller, D/A and A/D converter and other applications.	6
4	Overview of Intel 8051 microcontroller. Architecture. I/O Ports. Memory organization, addressing modes and instruction set of 8051, simple program.	8
5	Serial communication standards, Serial data transfer schemes. 8251 USART architecture and interfacing. Introduction to Advanced Processors (Intel 80286, Intel 80486) and PIC Microcontroller	6
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply a basic concept of digital fundamentals to Microprocessor based personal computer system
2	Identify the detailed s/w & h/w structure of the Microprocessor.
3	Illustrate the operation, interface and instructions of microprocessor and microcontroller

Learning Resources:	
1	Microprocessor Architecture, Programming and Applications with the 8085, Ramesh Gaonkar, 2013, Penram International Publishing.
2	Fundamentals of Microprocessor and Microcomputer, B Ram, 2017, Dhanpat Rai Publications.
3	Advanced Microprocessor and Peripherals, K M Bhurchandi, A K Ray, 2017, McGraw Hill Education.
4	The 8051 Microcontroller, Kenneth J. Ayala, 1996, Penram International Publishing
5	The 8051 Microcontroller and Embedded Systems: Using Assembly and C, M. A. Mazidi, J. G. Mazidi and R D McKinlay, 2007, Pearson.

6	Microprocessors & Interfacing, Douglas V. Hall and SSSP Rao, 2017, McGraw Hill Education.
7	Computer Organization and Design: The Hardware/Software Interface, David A. Patterson, John L. Hennessy, 2016, Morgan Kaufmann Publishing

Course Name:	**Object Oriented Programming**		
Course Code:	CS 404	**Category:**	Professional Core Courses
Semester:	IV (Second Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming for Problem Solving),IT Workshop (Using Python) Lab
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance: -

Course Objectives:	
1	Gain knowledge about basic Java language syntax and semantics to write Java programs and use concepts such as variables, conditional and iterative execution methods etc.
2	Understand the fundamentals of object-oriented programming in Java, including defining classes, objects, invoking methods etc and exception handling mechanisms.
3	Understand the principles of inheritance, packages and interfaces.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Object-oriented design Concepts of object-oriented programming language, Major and minor elements, Object, Class, relationships among objects, aggregation, links, relationships among classes-association, aggregation, using, instantiation, meta-class, grouping constructs.	10

2	Object-oriented concepts Difference between OOP and another conventional programming– advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism	06
3	Class & Object proprieties Basic concepts of java programming – advantages of java, byte-code & JVM, data types, access specifiers, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, garbage collection, nested & inner classes, basic string handling concepts. command line arguments, basics of I/O operations – keyboard input using BufferedReader & Scanner classes.	06
4	Reusability Properties Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, use of abstract classes & methods, interfaces. Creation of packages, importing packages, member access for packages.	06
5	Exception handling & Multithreading Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter-thread communication, deadlocks for threads, suspending & resuming threads.	06
6	Applet Programming (using swing) Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applets, concept of delegation event model and listener, I/O in applets, use of repaint(), getDocumentBase(), getCodeBase() methods, layout manager (basic concept), creation of buttons (JButton class only) & text fields.	06
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify classes, objects, members of a class and relationships among them, needed for a specific problem.
2	Demonstrate the concepts of polymorphism and inheritance.
3	Implement Java collection API as well as the java standard class library.
4	Implement error handling techniques using exception handling.
5	Implement the concept of Multithreading and Applet programing.

Learning Resources:	
1	Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2	E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH
3	Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4	Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson
5	Ivor Horton's Beginning Java 2 SDK – Wrox

Course Name:	Organizational Behaviour Management		
Course Code:	HU 401	**Category:**	Humanities & Social Sciences including Management Courses
Semester:	IV (Second Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	To know the existence of an organization as a place for human livelihood
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance: -

Course Objectives:

1	To help the students to develop cognizance of the importance of human behavior and how to align it with basic organizational theories.
2	To enable students to describe how people behave under different conditions and understand why people behave as they do.
3	To provide the students to analyze specific strategic human resources demands for future action.
4	To enable students to synthesize related information and evaluate options for the most logical and optimal solution such that they would be able to predict and control human behaviour and improve results.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1.	**Introduction of Human Resource Development:** Human aspect of management, Human Relations; Human Resource Management- Concept, Scope and Importance; Competencies of HR Manager, Human Resource Planning, Job Analysis, and Job Design: Job analysis; Job description and specifications; Job design; Job characteristic approach to job design.	5
2.	**Recruitment, Selection, Training, and Development:** Factors affecting recruitment; Sources of recruitment (internal and external); Basic selection model; Psychological tests for selection; Interviewing; Placement and Induction; Job Changes- Transfers, Promotions, and Separations; An overview of Training and Development; Emerging trends in Recruitment, Selection, and development.	5
3.	Concept, Objectives and Methods; Traditional and Modern Methods- MBO, 360 Degree Appraisal, Behaviourally Anchored Rating Scale, Potential Appraisal, Human Resource Audit.	5

4.	**Introduction of Organizational Behavior** : Introduction, definition, historical development, An OB model; contributing disciplines, challenges and opportunities. Personality: Meaning, formation, determinants, traits of personality, big five and MBTI, personality attributes influencing OB. Attitude: Formation, components of attitudes, relation between attitude and behavior. Learning; Perception: Process of perception, factors influencing perception, link between perception and individual decision- making; Transactional Analysis: An Introduction to Transactional Analysis; Johari window.	6
5	**Group Dynamics and Team Development**: Group dynamics -definition and importance, types of groups, group formation, group development, group composition, group performance factors; Principle-centered-approach to team development	5
6.	**Motivation**: Meaning, theories of motivation-needs theory, two factor theory, Theory X and Y, application of motivational theories. Job satisfaction. Case Study analysis. **Leadership**: Meaning, styles of leadership, leadership theories, trait theory, behavioral theories, managerial grid, situational theories.	6
7.	**Power and Authority**: Definition of Power –Types of Power; Power and Politics in Organization; Organizational Stress; Conflict: Nature of Conflict & Conflict Resolution; Case Study Analysis	4
8.	**Organizational Change and Development**: Planned Change & OB Techniques; Organizational Development; Organizational Culture: Meaning & Definition, Contemporary Models of Culture and Organizational Effectiveness; Cross Cultural Management	4
		40L

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate the applicability of the concept of organizational behavior to understand the behavior of people in the organization
2	Demonstrate the applicability of analyzing the complexities associated with management of individual behavior in the organization.
3	Analyze the complexities associated with management of the group behavior in the organization
4	Demonstrate how the organizational behavior can integrate in understanding the motivation (why) behind behavior of people in the organization.

Learning Resources:	
1.	D'Cenzo, David A., Stephen P. Robbins, and Susan L. Verhulst, Human Resource Management, John Wiley and Sons, New Delhi
2.	Saiyadain, Mirza S., Human Resource Management, Tata McGraw-Hill Pub. Co. Ltd., New Delhi.
3.	Robbins, S.P. Judge, T.A. & Sanghi, S.: Organizational Behaviour, Pearson
4.	Luthans, Fred: Organizational Behaviour, McGraw Hill
5.	Newstrom J.W. &Devis K.: Organizational Behavior, McGraw Hill
6.	Aswathappa, K : Organisational Behaviour ,Himalaya Publishing House
7.	Shukla, Madhukar : Understanding Organizations – Organizational Theory & Practice in India, Prentice Hall
8.	Sekharan, Uma: Organisational Behaviour , The McGraw –Hill Companies

Course Name:	**Environmental Science**		
Course Code:	MC 401	**Category:**	Mandatory Course
Semester:	IV (Second Year)	**Credit:**	0
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Environmental

			Science
Full Marks:	100		
Examination Scheme:	Semester Examination of 100 marks		

Course Objectives:	
1	Purpose: We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times.
2	Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two type of activities.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Concept of Environment and Environmental Science, Environmental Problems and Global Environmental Issues, Concept of conservation of environment, Green Environment, Sustainability of ecosystem of Environment, Policies on environmental conservations. Waste Management .	
2	**(a) Awareness Activities:** i) Small group meetings about any of the topic. ii) Slogan making event iii) Poster making event iv) Seminar on any of the topic. v) Preparation of a report on any of the topic regarding current scenario.	
3	**(b) Actual Activities:** i) Plantation ii) Gifting a tree to see its full growth iii) Cleanliness drive iv) Drive for segregation of waste v)Shutting down the fans and ACs of the campus for an hour or so	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain basic concepts, man, society & environment, their interrelationship, mathematics of population growth and associated problems, steady state conservation system.
2	Demonstrate natural environmental hazards like flood, earthquake, landslide-causes, effects and control/management.
3	Classify air pollution, water pollution, land pollution, noise pollution and their controls.
4	Study Elements of ecology and environmental management.

Learning Resources:	
1	M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House, New Delhi, 2019
2	Environmental science by Gillbert G. Master

Course Name:	Computer Organization and Architecture Lab		
Course Code:	CS 491	**Category:**	Professional Core Course
Semester:	IV (Second Year)	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Digital Electronics, Basic Programming Concept
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To Familiar with different type of IC-chips
2	To Design different arithmetic and Logic Circuits
3	To know the working principle of RAM IC.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1.	Familiarity with IC-chips: a) Multiplexer, b) Decoder, c) Encoder d) Comparator Truth Table verification and clarification from Data-book.	6
2	Design an Adder/Subtractor composite unit.	3
3	Use a multiplexer unit to design a composite ALU	3
4	Use ALU chip for multibit arithmetic operation	3
5	Implement read write operation using RAM IC	3
6	Cascade two RAM ICs for vertical and horizontal expansion.	3
7	HDL introduction. Basic digital logic base programming with HDL	3
8	8-bit Addition, Multiplication, Division	3
9	8-bit Register design, Memory unit design and perform memory operations.	3
10	8-bit simple ALU design, 8-bit simple CPU design	3
11	Interfacing of CPU and Memory- Simulation only	3
Total		**36P**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Familiar with different ICs and their Application
2	Design different circuits with RAM ICs and perform read-write operation.
3	Design various hardware circuits using VHDL software.
4	Integrate components to present independent circuitry.

Microprocessor & Its Applications Lab (CS 492)

Module / Sl.No.	Module Name and Topics	No. of Lectures
1	Familiarisation I (H/w) 8 bit / 16 bit INTEL microprocessor with SDK (Functional blocks, Major ICs used, Memory Map, Decoding circuit, special h/w facilities etc.) + Data and Command keys, Commands, etc.	3
2	Familiarisation II (S/w) Hand assembly and loading and execution ofsimple programs.	3
3	I/O : Programming, Memory and I/O mapped I/O; PPI and using PPIs	3
4	Procedures/Functions and use of stack	3
5	Programming/Debugging: H/W and S/W facilities: Implementation of complex algorithms and use of debugging methods, Recursive routine, Stack based parameter passing	9
6	Serial I/O: Downloader (loading the object file from computer to SDK)	3
7	Interrupt: Test a keyboard Interrupt and a Timer/Counter interrupt	3
8	Familiarization followed by Design and Development of a small systemusing Raspberry PI/ Arduino/ 8051 Microcontroller family,	9

Object oriented programming Using C++ Lab (CS 493)

Unit 1:

C++ Language Basics, Control Statements : Introduction to C++, basic loop control, executing programs, writing functions, selection statements. Function & Recursion Review of functions and parameters, command line arguments, recursion.

Unit 2:

IO, Pointer & String I/O streams, arrays and string manipulation, pointers, structures & unions.

Unit 3

Basics of OOPs and Constructors & Destructors Object-Oriented Programming in C++, fundamentals of classes, constructors-destructors. Dealing with member functions. Polymorphism & Inheritance Function & operator overloading and polymorphism (both static & dynamic), Dealing with inheritance, derived class handling, abstract class, virtual class, overriding.

Unit 4:

Template & Dynamic Memory Allocation: Template class, name-space & exception handling, Dynamic memory allocation, implementation of Linked Lists, using C++.

PART – III, 1st SEMESTER (CSE)

Semester V

Course Name:	**Operating System**		
Course Code:	CS 501	**Category:**	Professional Core Course
Semester:	V (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Organization
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To Learn Operating System concepts and algorithms
2	To gain the knowledge about the application and analysis of algorithms

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine.	4
2	Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR	6
3	Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, RAG, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.	6
4	Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, The Producer Consumer Problem, Semaphores, Event Counters, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.	6
5	Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation– Fixed and variabl partition– Internal and External fragmentation and Compaction; Paging, Protection and sharing, Disadvantages of paging, segmentation	6
6	Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Not recently used (NRU) and Least Recently used (LRU).	4
7	Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C- SCAN, Boot-block, Bad blocks	4

8	File Management: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous,linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table).	4
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Recall and understand introductory concepts of operating system
2	Apply and analyze process scheduling methods and deadlock handling schemes
3	Understand inter process communication
4	Understand, apply and analyze memory management and disk management procedures

Learning Resources:	
1	Operating System Concepts, Silberschatz, Galvin and Gagne, Wiley
2	Principles of Operating System, Naresh Chauhan, Oxford
3	Operating System, Deitel, Deitel, Pearson

Course Name:	**Database Management Systems**		
Course Code:	CS 502	**Category:**	Professional Core Courses
Semester:	V (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic programming Knowledge, Concept of Set theory, Tree Data structure
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To understand the different issues involved in the design and implementation of a database system.
2	To study the physical and logical database designs, database modeling, relational, hierarchical, and network models
3	To understand and use data manipulation language to query, update, and manage a database
4	To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.
5	To understand the different issues involved in the design and implementation of a database system.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to database management, data abstraction and system structure, Database users, Database Administrator	4
2	Entity relational model, entity set, relationship sets, mapping cardinalities, keys, E-R diagrams.	6
3	Relational model, database schema, relational algebra, outer join and manipulation of databases. Tuple relational calculus: Example queries, formal definitions and safety of expressions; SQL: Query processing and optimization, set operations, aggregate functions, data definition language and views, comparison of queries in relational algebra, SQL, tuple relation calculus and domain relation calculus.	8
4	Introduction to Schema Refinement - Problems Caused by redundancy, Decompositions - Problem related to decomposition, Functional Dependencies - Reasoning about FDS, Normal Forms - FIRST, SECOND, THIRD Normal forms - BCNF - Properties of Decompositions - Loss less join Decomposition, Dependency preserving Decomposition, Schema Refinement in Data base Design - Multi valued Dependencies - FOURTH Normal Form, Join Dependencies, FIFTH Normal form, Inclusion Dependencies.	8

5	Transaction Management, ACID property, Transaction state, Serializability and testing for serializability, concurrency control schemes, lock-based protocols, two-phase locking protocols, graph, time stamp-based protocols,,deadlocks.	8
6	Recovery systems, log-based recovery, deferred and immediate database modification, object oriented database design.	2
7	Overview of Storage and Indexing: Data on External Storage, File Organization and Indexing - Clustered Indexes, Primary and Secondary Indexes, Index data Structures - Hash Based Indexing, Tree based Indexing, Comparison of File Organizations.	4
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe the fundamental concept of File System and DBMS Architecture.
2	Understand the concepts of different types of attribute, keys and Entity Relationship model.
3	Apply concepts of relational algebra, calculus and Structured Query language.
4	Apply concepts of functional dependency and normalization process to construct normalized database.

Learning Resources:	
1	Data base System Concepts, A.Silberschatz, H.F. Korth, S.Sudarshan, McGraw Hill, VI edition, 2006.
2	Elmasi, R. and Navathe, S.B., "Fundamentals of Database Systems", 4th Ed., Pearson Education
3	Date, C. J., "Introduction to Database Systems", Pearson Education.
4	Ramakrishnan, R. and Gekhre, J., "Database Management Systems", 3rd Ed., McGraw-Hill.

Course Name:	**Design and Analysis of Algorithm**		
Course Code:	CS 503	**Category:**	Professional core Courses
Semester:	V (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Data Structure, Discrete Mathematics, Basic Programming

			Ability
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	The aim of this course is to learn how to develop efficient algorithms for simple computational tasks and reasoning about the correctness of them
2	Through the complexity measures, different range of behaviors of algorithms and the notion of tractable and intractable problems will be understood.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst- case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Method of Iteration, Recursion Tree method and Masters' theorem (Examples: Analysis of Binary Search, Merge Sort and Quick Sort using Recurrence)	8
2	**Fundamental Algorithmic Strategies:** **Divide and Conquer Method:** Basic method, use, Example – Max- Min Problems and its complexity analysis. **Greedy Method:** Basic method, use, Examples – Fractional Knapsack Problem, Job sequencing with deadlines, Activity Scheduling Problem, Travelling Salesperson Problem and their complexity analysis **Dynamic Programming:** Basic method, use, Examples – Matrix Chain Manipulation, 0/1 Knapsack Problem and their complexity	12

	analysis **Branch and Bound and Backtracking:** Basic method, use, Examples – 15 Puzzles Problem, N queens' problem, Graph Coloring problem, Hamiltonian Cycle Problem	
3	**Graph and Tree Algorithms:** Traversal algorithms: Recapitulation of Depth First Search (DFS) and Breadth First Search (BFS); Shortest path Algorithms (Single Source and All Pairs with their Complexity Analysis), Transitive Closure, Minimum Spanning Tree (Prim's and Kruskal's Algorithms with their Complexity Analysis), Topological Sorting, Ford Fulkerson algorithm, Max-Flow Min-Cut theorem (Statement and Illustration).	10
4	**Tractable and Intractable Problems:** Computability of Algorithms, Computability classes – P, NP, NP- complete and NP-hard. Satisfiability Problem, Cook's theorem, Clique decision problem	6
5	**Advanced Topics:** Approximation Algorithms: Introduction and Example - Vertex Cover Problem, Randomized Algorithms: Introduction and Example - Quick Sort	4
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Recall the fundamental concepts of Asymptotic Notations and identify their mathematical significance and analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms. Derive and solve recurrence relation.
2	Describe different algorithm design techniques like D&C, Greedy Method, DP, Backtracking, Branch and Bound, Graph Algorithms, NP etc and their implementations.
3	Apply appropriate algorithms and required Data Structure to construct the solution of a given problem.
4	Explain Randomized algorithms (expected running time, probability of error), and Approximation algorithm to compute approximation factors.

5	Analyze algorithms and determine the correctness.

Learning Resources:	
1	Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2	Fundamentals of Algorithms – E. Horowitz et al.
3	Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson.
4	Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley.
5	Algorithms -- A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA
6	Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House (AICTE Recommended Textbook – 2018)
7	Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai

Course Name:	**Formal Language and Automata Theory**		
Course Code:	CS 504	**Category:**	Professional Core Courses
Semester:	V (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Mathematics , Digital Electronics , Discrete Mathematics.
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To give an overview of the theoretical foundations of computer science from the perspective of formal languages
2	To acquire insights into the relationship among formal languages, formal grammars, and automata
3	To illustrate finite state machines to solve problems in computing
4	To develop the ability to design of PDA and Turing Machine

Course Contents:		
Module No.	Description of Topic	**Contact Hrs.**
1	**Fundamentals:** Introduction: Basic Mathematical Notation and techniques, Strings, Alphabet, Language, Grammar, Productions and Derivation, Chomsky hierarchy of languages. Basic definition of sequential circuit, block diagram, concept of transition table and transition diagram (Relating of Automata concept to sequential circuit concept), Design of sequence detector, Finite state machine: Definitions, capability & state equivalent, kth- equivalent concept	5L
2	**Finite Automata:** Finite automaton model, acceptance of strings, and languages, Deterministic finite automaton and non deterministic finite automaton. Transition diagrams and Language recognizers. NFA with λ transitions - Significance, acceptance of languages. Conversions and Equivalence: Equivalence between NFA with and without λ transitions, NFA to DFA conversion, minimisation of Finite Automata, Finite Automata with output- Moore and Mealy machines	8L
3	**Regular Languages and Regular Grammar:** Regular sets, Regular expressions, identity rules. Arden's theorem state and proof, Constructing finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Regular grammars-right linear and left linear grammars, quivalence between regular linear grammar and FA Closure properties of regular languages, pumping lemma for regular languages	8L
4	**Context-free languages and Pushdown Automata:** Context Free Grammars, Parse three, Ambiguity in context free grammars, Minimization of Context Free Grammars. Chomsky and Greibach normal forms. Pumping Lemma for Context Free Languages, Closure property of CFL Push down automata: Definition, Acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence, equivalence of CFL and PDA, interconversion. (Proofs not required), introduction to DCFL and DPDA	10L

5	**Context Sensitive Languages:** Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	3L
6	**Turing Machine:** Turing Machine, definition, model, Design of TM, Computable functions, Recursively Enumerable Languages, Unrestricted Grammar, Church- Turing thesis, Variants of Turing machines, Universal Turing Machine, Halting problem	6L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the concept of abstract machines and their power to recognize the languages
2	Construct automata for any given pattern and find its equivalent regular expressions
3	Design context free grammars for formal languages.
4	Design PDA and Turing Machine.

Learning Resources:	
1	Peter Linz, "An Introduction to Formal Language and Automata", Third Edition, Narosa Publishers, New Delhi, 2002.
2	Mishra K L P and Chandrasekaran N, "Theory of Computer Science – Automata, Languages and Computation", Third Edition, Prentice Hall of India, 2004.
3	Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", Second Edition, Prentice Hall of India, Pearson Education, New Delhi, 2003.
4	Hopcroft H.E. and Ullman J. D., "Introduction to Automata Theory Language and Computation", Pearson Education.
5	John C Martin, "Introduction to languages and the Theory of Computation", TMH
6	C.K.Nagpal, "Formal Languages and Automata Theory", Oxford
7	ZVI Kohavi, "Switching & Finite Automata", Tata McGraw Hill

SIGNALS AND SYSTEMS (SS 501) Credit - 3

UNIT I

SIGNALS AND SYSTEMS: Continuous and Discrete-Time Signals; Transformations of the Independent Variable; Exponential and Sinusoidal Signals; Unit Impulse and Unit Step Functions; Continuous and Discrete -Time Systems; Basic System Properties.

LINEAR-TIME INVARIANT SYSTEMS: Discrete-Time LTI Systems: The Convolution Sum; Continuous-Time LTI Systems: The Convolution Integral; Properties of Linear Time-Invariant Systems; Causal LTI Systems Described by Differential and Difference Equations.

UNIT II

FOURIER SERIES REPRESENTATION OF PERIODIC SIGNALS: Response of LTI Systems to Complex Exponentials; Fourier Series Representation of Continuous-Time Periodic Signals; Convergence of the Fourier Series; Properties of Continuous- Time Fourier Series; Fourier Series Representation of Discrete-Time Periodic Signals; Properties of Discrete-Time Fourier Series; Fourier Series and LTI Systems; Filtering; Examples of Continuous-Time Filters Described by Differential Equations; Examples of Discrete-Time Filters Described by Difference Equations.

UNIT III

THE CONTINUOUS-TIME FOURIER TRANSFORM: Representation of Aperiodic Signals; The Continuous-Time Fourier Transform; The Fourier Transform for Periodic Signals; Properties of Continuous-Time Fourier Transform; The Convolution and Multiplication Properties; Fourier Transform Properties and Fourier Transform Pairs; Systems Characterized by Linear Constant-Coefficient Differential Equations.

UNIT IV

THE DISCRETE-TIME FOURIER TRANSFORM: Representation of Aperiodic Signals: The Discrete-Time Fourier Transform; The Fourier Transform for Periodic Signals; Properties of Discrete-Time Fourier Transform; The Convolution and Multiplication Properties; Fourier Transform Properties and Fourier Transform Pairs; Duality; Systems Characterized by Linear Constant-Coefficient Difference Equations.

UNIT V

TIME AND FREQUENCY CHARACTERIZATION OF SIGNALS AND SYSTEMS: The Magnitude-Phase Representation of The Fourier Transform; The Magnitude-Phase Representation of The Frequency Response of LTI Systems; Time-Domain Properties of Ideal Frequency-Selective Filters; Time-Domain and Frequency-Domain Aspects of Non Ideal Filters; First-Order and Second-Order Discrete-Time Systems.

SAMPLING: Representation of a Continuous-Time Signal by its Samples; The Sampling Theorem; Reconstruction of a Signal From its Samples Using Interpolation; The Effect of Under Sampling; Aliasing; Discrete-Time Processing of Continuous-Time Signals; Sampling of Discrete-Time Signals.

UNIT VI

THE LAPLACE TRANSFORMS: The Laplace transform; The Region of Convergence for Laplace Transforms; The Inverse Laplace Transform; Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot; Properties of the Laplace Transform; Laplace Transform Pairs; Analysis and Characterization of LTI Systems Using the Laplace Transform.

UNIT VII

THE Z-TRANSFORM: The Z-Transform; The Region of Convergence for the Z-Transform; The Inverse Z-Transform; Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot; Properties of the Z-Transform; Z-Transform Pairs; Analysis and Characterization of LTI Systems using Z-Transforms.

UNIT VIII

RANDOM PROCESSES: Introduction; Mathematical Definition of a Random Process; Stationary Processes; Mean, Correlation and Covariance Functions; Ergodic Processes; Transmission of a Random Process Through a Linear Time-Invariant Filter; Power Spectral Density; Gaussian Process; Noise; Narrowband Noise; Summary and Discussion.

Text Books:

I. Signals and Systems, A.V. Oppenheim and A.S. Willsky with S. H. Nawab, Second Edition,PHI Private limited, 2006.
II. Communication Systems, Simon Haykin, 4th Edition, Wiley Student Edition, 7th Reprint 2007.

Reference Books:
1. Signals and Systems, Second Edition, S. Haykin and B. Van Veen, John Wiley & Sons.
2. Schaum's Outline of Theory and Problems of Signals and Systems, McGraw-Hill PublishingCompany Ltd.
3. Signals and Systems, M.J. Roberts, Tata McGraw-Hill Publishing Co. Ltd.

Probabilistic Methods of Signal and System Analysis, Third Edition, G.R. Cooper and C.D.McGillem, Oxford University Press

Elective I

Graph Theory (PEC 501)

Module / Sl No	Module Name and topics	No. of Lectures
1	**Introduction:** Definition and Application of Graphs, Finite and Infinitegraphs, Incidence and degree, Isolated and pendant vertex, Null graphs.	2
2	**Paths and Circuites:** Concept of Graph Isomorphism and Subgraphs; Definition of walks, paths and circuits; Connected and disconnected graphs; Components; Euler graphs, Hamiltonian Paths and Circuits. The travelling salesman problem	4
3	**Trees and fundamental circuits:** Trees; Properties of a tree; Distance and centre in a tree; rooted and binary trees; Counting trees; Spanning trees;Finding spanning trees in weighted graphs	4
4	**Special classes of graphs:** Bipartite graphs, line graphs, chordal graphs	2
5	**Cut set and verticess:** Cut sets and their properties; finding all cut sets in a graph; fundamental circuits and cut sets; connectivity and seperability;Network flows.	6
6	**Planner and Dual Graphs:** Combinatorial vs geometric graphs; Planner graphs; Kuratowsk's two graphs; Detection of planarity; geometric and combinatorial dual; Different representation of planner graphs.	2
7	**Representation Graph:** Incidence matrix; Adjacency matrix and list; Path matrix; cut set matrix.	2
8	**Graph Coloring:** Chromatic number; Chromatic partitioning; Chromatic polynomial; matching; covering; The four color problem.	4
9	**Independent sets, coverings, matchings:** Basic equations, matchings in bipartite graphs, perfect matchings,	4

10	**Directed graph**: Definition and types; Digraphs and binary relations; directed paths and connectedness; Euler digraph; trees with directed edges;fundamental circuits and Digraphs.	4
11	**Graph theoretic Algorithms and computer program:** traversal algorithms; connectedness and components; spanning trees; a set of fundamental circuits; cut vertex and reparability; Shortest path algorithms; Planarity testing algorithms etc(home assignmemts to be given)	A4

Course Name:	**Software Engineering**		
Course Code:	PEC 501	**Category:**	Professional Elective Courses
Semester:	V (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Programming for Problem Solving
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	Exposer of the challenges of large scale software development and the ideas of how to overcome those.
2	To provide the idea of decomposing the given problem into Analysis, Desing, Implementation, Testing and Maintenance phases.
3	To provide an idea of using various process models in the software industry according to given circumstances.
4	To gain the knowledge of how Analysis, Design, Implementation, Testing and Maintenance processes are conducted in a software project.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
	Module I: Overview of System, System Development Life Cycle, Waterfall Model, Iterative Waterfall Model, V Model, Spiral Model, Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis,	

1	COCOMO model, SRS.	10
2	**Module II:** System Design – DFD, Top-Down And Bottom-Up design; Decision tree, Decision table and structured English; Functional vs. Object- Oriented approach.	10
3	**Module III:** Coding & Documentation guidelines, Errors, Faults and Failures. Testing – Levels of Testing, Unit Testing, Integration Testing, System Testing, Validation & Verification in Testing, Black Box Testing, White Box Testing Strategies. Introduction to Agile	10
4	**Module IV:** UML diagrams: Class diagram, interaction diagram, collaboration diagram, sequence diagram, state chart diagram, activity diagram.	10
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Compare and apply the software development models.
2	Apply the data flow model, relational model and unified model to visualize the design of a system.
3	Know the degree of functionality and the relationship of modules of a software system.
4	Illustrate the validation and verification types of testing techniques and the steps of project management and scheduling.

Learning Resources:	
1	Rajib Mall, Fundamental of Software Engineering, PHI Learning Pvt. Ltd.
2	Roger S. Pressman, Bruce R. Maxim, Software Engineering : A practitioner's approach– Pressman, McGraw Hill Education
3	Pankaj Jalote , Software Engineering: A Precise Approach, Wiley

Advanced Computer Architecture:(PEC 501)

Module / Sl. No.	Module Name and topics	No. of Lectures
1	**Introduction** Development of computer systems, von Neumann machine, performancemeasure, CISC and RISC processors	3
2	**Memory** Virtual memory system; cache – properties, mapping, performance;CAM; mass storage - RAID	3
3	**Processor design** Pipelining – instruction and arithmetic pipeline; linear pipeline processors – asynchronous and synchronous models; non-linear pipeline processors -reservation table, latency analysis, collision free scheduling, scheduling optimization; superpipelined design Pipeline hazards - structural, data and control hazards, role of reservation table, minimizing data hazard stalls, data forwarding, dynamic scheduling, reducing pipeline branch penalties - branch-delay slot,prediction schemes, branch predictors; exceptions handling - in-order/out-of-order issues	12
4	**Cache design** Cache updates – write-back and write-through caches; reducing compulsory, capacity and conflict misses, miss penalty and hit time reduction; cache coherence - data consistency, enforcing cache coherence, directory based protocol, snooping, MESI and other cache models	10
5	**Instruction-level parallelism** Multiple issue processors; superscalar processor – structure, pipeline scheduling; VLIW; compiler support for exploiting ILP	4
6	**Parallel computers** Flynn's taxonomy - SISD, SIMD – shared memory, interconnectionnetwork; MISD and MIMD machines Parallel and scalable architectures; multiprocessor system interconnects – shared bus, multi-port, crossbar, multistage networks; vector processors; distributed shared-memory architectures; Cluster Computer Architecture Program flow mechanisms; dataflow processors; threaded dataflow; hybrid structures	8

References:

1. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of SuperscalarProcessors, Tata McGraw-Hill.
2. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach,Morgan Kaufmann.
3. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa PublishingHouse.
4. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability,McGraw-Hill.
5. Parallel Computation: Models and Methods by Selim G. Akl; Pearson

Course Name:	**Computer Graphics**		
Course Code:	PEC 501	**Category:**	Professional Elective Courses
Semester:	V (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To familiarize the students with the basic concepts of computer graphics and scan conversion algorithms.
2	To acquaint the students with transformation, clipping algorithms and their application areas.
3	To develop the ability to compare shading models and hidden surface removal algorithms.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**

1	**Introduction to computer graphics & graphics systems:** Overview of computer graphics, Visualization & image processing; RGB color model, direct coding, lookup table; display devices, Plotters, printers, digitizers, light pens etc.; Computer graphics software. Scan conversion algorithms: Points & lines; DDA & Bresenham's line algorithm, Circle generation algorithm; Ellipse generating algorithm; scan line polygon, boundary fill & flood fill algorithm.	10
2	**2D & 3D Transformation**: Basic transformations: Translation, Rotation, Scaling; Matrix representations & homogeneous coordinates, transformations between coordinate systems, Composite Matrix Transform; Reflection, Shear; Transformation of points, lines and related problems , 3D transformations: Translation, Rotation, Scaling.	10
3	**2D & 3D Clipping**: Viewing pipeline, Window to view port co-ordinate transformation, clipping operations, point clipping, line clipping algorithms:. Cohen and Sutherland, Liang Bersky, Cyrus-Beck line clipping algorithms; Polygon Clipping: Sutherland-Hodgeman Polygon clipping algorithm, 3D viewing & Projection: Parallel & Perspective projection, vanishing point	10
4	**Curves, Hidden surface removal algorithm & Shading models** Curves: Curve representation, surfaces, Bezier curves, B-spline curves, conditions for joining two Bezier Curve segments and related problems. Hidden surface removal algorithms: Depth comparison, Z-buffer algorithm, Backface detection, BSP tree method, the Painter's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods , Fractal - geometry. Color & shading models: Lighting conditions: Ambient, diffuse etc.; Shading models: Flat, Gouraud & Phong shading models, comparison.	10
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand contemporary graphics hardware componemts.
2	Implement different algorithms for drawing basic graphics structures like straight line, circle & ellipse.
3	Demonstrate working of clipping algorithms and distinguish between different clipping methods.
4	Analyze methods of transformations and solve problems on them.
5	Use spline properties, shading models and hidden surface removal algorithms for

	creating real world object.

Learning Resources:	
1	Hearn, Baker – "Computer Graphics (C version 2nd Ed.)" – Pearson education
2	Z. Xiang, R. Plastock – " Schaum's outlines Computer Graphics (2nd Ed.)" – TMH
3	D. F. Rogers, J. A. Adams – "Mathematical Elements for Computer Graphics (2nd Ed.)" – TMH
4	Anirban Mukhopadhyay, Arup Chattopadhyay, "Introduction to Computer Graphics & Multimedia"

Artificial Intelligence: (PEC 501)

Module / Sl. No.	**Module Name and Topics**	**No. of Lectures**
	Introduction	
1	Overview of Artificial Intelligence (AI).	1
	Problem Solving and Game Playing	
2	Problem Representations: Problem Representation in State Space, Production System – Components, Advantages, Applications.	2
3	Uninformed Searches: BFS, DFS, Iterative Deepening (ID) Search with Space and Time Complexities.	3
4	Informed Searches: Heuristic Functions, Hill Climbing Search, Best First Search, A* Algorithm, Admissibility of A* Algorithm, IDA* Algorithm, Problem Reduction and AO* Algorithm, Means-Ends Analysis.	5
5	Adversarial Search: Games, Evaluation Function, The Min-Max	1

	Algorithm, Alpha-Beta Pruning.	
	Logic and Reasoning	
6	Introduction: Formal Logic, Entailment, Proofs, Soundness and Completeness, History of Logic and Knowledge – The Last Millennium, Logic in Ancient Greece, Logic in Ancient India.	1
7	Proposition and Predicate Logic: Automated Reasoning using Resolution-Refutation in Propositional Logic (PL), Resolution Algorithm, Skolem Standard Form in First Order Predicate Logic (FOPL), Clausal Form, Unification and Substitution, Unification Algorithm, Theorem Proving with Resolution-Refutation in FOPL, Answer Extraction, Various Resolution Strategies.	5
8	Introduction to Modal Logic: Syntax and Semantics, Kripke Structures, Truth of Modal Formulas, Truth of Modal Formulas, Inference Rules, Axioms and their Corresponding Properties, Selected Applications like Modal Logic and Game Trees.	3
9	Introduction to Temporal Logic: Linear Time Temporal Logic, Brunch Time Temporal Logic, Concurrency.	3
10	Nonmonotonic Reasoning: The Closed-World Assumption, Predicate Completion, Taxonomic Hierarchies and Default Reasoning, Circumscription, Default Theories.	3
11	Reasoning with Uncertainty: Review of Probability Theory, Using Bayes' Rule in Uncertain Reasoning, Propagating Probabilistic Inferences, Belief Networks, Combining Evidences to form Beliefs,The Dempster-Shafer Theory.	3
	Logic Programming	
12	Horn Clause and Basic Inferencing with them, PROLOG as a RestrictedResolution-Based Theorem Prover, Control Strategy of PROLOG, List Manipulations, Accumulators, The System Predicate 'CUT', Negation as Failure, Implementations of Sorting Algorithms in PROLOG, Tree Representations and Operations in PROLOG, Representation of Graphs and Problems on Graphs in PROLOG, Solving AI Problems in PROLOG.	8
	Expert Systems	
13	Rule Based Expert System: Rules as Knowledge Representation Technique, Architecture of Rule Based Expert System, Example, Forward Chaining and Backward Chaining, Advantages and Disadvantages, Uncertainty Management in Rule Based Expert Systems, Certainty Factors Theory, Comparisons of Baysian Reasoning- and Certainty Factors.	2

14	Frame Based Expert System: Frames as Knowledge Representation Technique, Inheritance in Frame Based System, Methods and Demons, Interaction of Frames and Rules.	2
	Planning	
15	Planning with Certainty: Representing States, Actions and Goals – Explicit State-Space Representation, The STRIPS Representation, Feature-Based Representation of Actions; Forward Planning, Regression Planning, Planning as a Constraint Satisfaction Problem, Partial-Order Planning.	4
16	Planning with Uncertainty: Preferences and Utility – Axioms for Rationality, Factored Utility, Prospect Theory; Single Stage Decision Network, Sequential Decisions – Decision Networks, Policies, VariableElimination for Decision Networks; The value of Information and Control, Decision Processes – Policies, Value Iteration, Policy Iteration, Dynamic Decision Network, Partially Observable Decision Processes.	6

Books (Text and References – Includes Books for Associated Laboratory Course):

1) Artificial Intelligence-A Modern Approach, Stuart Russel and Peter Norvig, 3rd Ed., Pearson,2014.
2) Artificial Intelligence - Foundations of Computational Agents, David L. Poole and AlanMackworth, 2nd Edition, Cambridge University Press, 2017.
3) A First Course in Artificial Intelligence, Deepak Khemani, McGraw Hill Education, 2013.
4) Artificial Intelligence, Elaine Rich, Kevin Night and Shivshankar B. NairMcGraw Hill Education, 2017.
5) Artificial Intelligence - A Guide to Intelligent Systems, Michael Negenvitsky, 2nd Edition,Pearson, 2008.
6) Artificial Intelligence, Structure, Strategies for Complex Problem Solving, George F. Luger, 5thEdition, Pearson, 2008.
7) Prolog Programming for Artificial Intelligence, Ivan Bratko, 3rd Edition, Pearson, 2002.
8) Techniques of Prolog Programming, with Implementation of Logical Negation and QuantifiedGoal, T. Van Lee, Wiley, 1992.
9) Programming in Prolog, William F. Clocksin and Christopher S. Melish5th Edition, Springer, 2003.
10) Prolog Programming in Depth, Michael A. Covington, Donald Nute and Andre Vellino, PrenticeHall, 1997.

Course Name:	**Operating System Lab**		
Course Code:	CS 591	**Category:**	PC
Semester:	V (Third Year)	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Computer organization
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance :

Course Objectives:	
1	To learn UNIX commands and shell script
2	To gain the knowledge about process, thread, signal, semaphore and IPC

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	UNIX Commands and Permissions	
2	Creating a bash shell script, making a script executable, shell syntax (variables, conditions, control structures, functions, CLA, String)	
3	C programs for parent process, child process, orphan process, sleeping process, running process, zombie process.	
4	Multithreaded C program using PThread API and Win32 API	
5	C programs for signal handling, sending signals and signal interface.	
6	C programs regarding Semaphore	
7	Inter-process communication through shared memory segment, message queues, pipes and named pipes	
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Recall and understand UNIX commands and applications of shell script

2	Apply and Analyze Process and Thread execution
3	Apply and Analyze Signal and Semaphore
4	Apply and Analyze IPC related concepts

Learning Resources:	
1	UNIX Concepts and Applications, Sumitabha Das, McGrawhill
2	Vijay Mukhi's The C Odyssey UNIX – The Open Boundless C, BPB Publications

Course Name:	**Database Management System Lab**		
Course Code:	CS 592	**Category:**	Professional Core Courses
Semester:	V (Third Year)	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Basic understanding in database management
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	Learn to create and use a database.
2	Be familiarized with a query language.
3	Have a good understanding of DDL, DML and DCL commands.
4	Familiarize advanced SQL queries.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Structured Query Language** Creating Database, Creating a Table, Specifying Relational, Data Types Specifying Constraints, Creating Indexes.	

2	**Table and Record Handling** INSERT statement, Using SELECT and INSERT together, DELETE, UPDATE, TRUNCATE statements, DROP, ALTER statements.	
3	**Retrieving Data from a Database** The SELECT statement, Using the WHERE clause, Using Logical Operators in the WHERE clause, Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING Clause *Using Aggregate Functions *Combining Tables Using JOINS * Subqueries	
4	**Database Management** Creating Views, Creating Column Aliases, Creating Database ,Users, Using GRANT and REVOKE commands – Commit, Rollback, Save point.	
5	**PL/SQL Concepts** Introduction, Cursors, Stored Procedures, Stored Functions, Database Triggers.	
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply the basic concepts of Database Systems and Applications.
2	Use the basics of SQL and construct queries using SQL in database creation and interaction.
3	Design a commercial relational database system (Oracle, MySQL) by writing SQL using the system.
4	Analyze and Select storage and recovery techniques of database system.

Learning Resources:	
1	Beginning SQL Programming,Kauffman, SPD/WROX
2	Ivan Bayross, “SQL, PL/SQL the Programming Language of Oracle”

Course Name:	**Design and Analysis of Algorithm lab**		
Course Code:	CS 593	**Category:**	Professional Core Courses
Semester:	V (Third Year)	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Data Structure, Basic Programming

			Ability
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	The aim of this course is to study about various designing paradigms of algorithms for solving real world problems.
2	Through this course one can apply appropriate algorithms and methods of analysis.
3	To pick an appropriate data structure for a design situation is also under consideration.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
The contents should include about 10 assignments with the focus given as outlined below:		
UNIT - I Divide and Conquer, Greedy Method, Dynamic Programming		
1	Implement Binary Search, Merge Sort, Implement Quick Sort, Find Maximum and Minimum Element from an Array of Elements Implement Knapsack Problem, Job sequencing with deadlines, Traveling Salesman Problem Find the minimum number of scalar multiplication needed for Chain of Matrix	
UNIT - II Graph Traversal Algorithm, Minimum Cost Spanning Tree Generation Algorithms, Shortest Path Algorithms		
2	Implement Breadth First Search (BFS), Depth First Search (DFS) Implement Minimum Cost Spanning Tree by Prim's and Kruskal's Algorithm Implement Single Source shortest Path for a graph (Dijkstra, Bellman Ford Algorithm) and All pair of Shortest path for a graph (Floyd- Warshall Algorithm)	
UNIT - III Backtracking and Branch and Bound		
	Implement N Queen problem , Implement Graph Coloring Problem Implement Hamiltonian Problem Implement 15-Puzzle Problem	

3		
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate and implement Binary Search, Merge Sort, Quick Sort, and Max-min Problem using D&C Algorithm Design Techniques.
2	Implement Fractional Knapsack, Job Sequencing with Deadline, TSP, Matrix Chain, Graph Traversals, MST problems, Shortest Path, N- Queens, Graph Coloring, Hamiltonian Cycle, and 15 Puzzles using proper Algorithm Design Techniques.
3	Apply suitable algorithm for solving a particular problem.
4	Analyze the complexities and memory usages of different algorithms.

Learning Resources:	
1	Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill.
2	Fundamentals of Algorithms – E. Horowitz et al.
3	Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai
4	Design and Analysis of Algorithm, Biswas and Dey, JBBL

PART – III, 1st SEMESTER (CSE)

Semester VI

Course Name:	**Compiler Design**		
Course Code:	CS 601	**Category:**	Professional Core Courses
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic programming Knowledge, Automata

			Theory
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To understand and list the different stages in the process of compilation.
2	Identify different methods of lexical analysis
3	Design top-down and bottom-up parsers
4	Identify synthesized and inherited attributes
5	Develop syntax directed translation schemes
6	Develop algorithms to generate code for a target machine

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction: Programs, interpreters, and translators; Analysis-Synthesis model of translation; Examples of translators; Structure of a compiler; Issues in compiler design.	2L
2	Lexical Analysis: Role of a lexical analyzer; Input buffering, Specification of tokens, Recognition of tokens; Languages, Regular expressions, Regular definitions; Finite automata, Nondeterministic and deterministic finite automata, Transitions tables, Acceptance of input strings by automata, Conversion of an NFA to DFA; State-machine-driven lexical analyzers and their implementations	8L
3	Syntax Analysis: Role of a parser, Representative grammars, Context-free grammars, Parse trees, derivations and sentential forms, Ambiguity; Top down parsing, Predictive and Recursive descent parsing, Elimination of left recursions, Left factoring, FIRST and FOLLOW sets and their computations, LL(1) grammars, Error recovery techniques; Bottom up parsing, Reductions, Handle pruning, Shift reduce parsing; LR parsing, Implementing the parser as a state machine, viable prefixes, Items and the LR(0) automaton; Constructing SLR parsing tables: LR(0) grammars, SLR(1) grammars; Canonical LR(1) items and constructing canonical LR(1) parsing tables; Constructing LALR parsing tables.	10L

4	Semantics and Semantic Analysis: Syntax-directed translation, Attribute grammars, Inherited and synthesized attributes, Dependency graphs, Evaluation orders of attributes, S-Attributed definitions, L-attributed definitions, Syntax-directed translation schemes.	5L
5	Intermediate Code Generation & Runtime Environment: Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples). Intermediate languages – Declarations – Assignment Statements – Boolean Expressions – Case Statements – Back patching – Procedure calls. Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Storage organization (Subdivision of run-time memory, Activation records), Storage allocation strategies, Parameter passing (call by value, call by reference, copy restore, call by name), Symbol tables, dynamic storage allocation techniques	6L
6	Code Optimization: Overview of optimization; Data Flow Analysis; Peephole Optimizations; Constant Folding, Common Subexpression Elimination, Copy Propagation, Strength Reduction. Global Optimization: Loop optimizations; Induction Variable elimination, Optimizing procedure calls – inline and closed procedures. Machine-Dependent Optimization: Pipelining and Scheduling	6L
7	Code Generation: Issues in the design of code generator – The target machine, Construction of executable code and libraries.	3L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Summarize the basic concept of compiler and underlying finite state automata, regular expression, grammars and regular languages.
2	Describe the functional phases of a compiler such as lexical analyzer, parser, code optimizer and code generator
3	Compare LL, LR(0), LR(1) and LALR parser.
4	Construct of semantic rule, quadruple, triples, indirect triple and optimized code.

Learning Resources:	
1	Aho, Sethi, Ullman - “Compiler Principles, Techniques and Tools” - Pearson Education

2	Holub - “Compiler Design in C” - PHI.
3	“Crafting a compiler with C”, C. N. Fischer and R. J. LeBlanc, Pearson Education
4	“Compiler Construction: Principles and Practice”, Kenneth C. Louden, , Thomson Learning

Course Name:	**Data Communication & Computer Networks**		
Course Code:	CS 602	**Category:**	Professional Core Courses
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Communication Engineering and Operating Systems
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To develop an understanding of modern network design and performance.
2	To introduce the student to the major concepts involved in variety of networks.
3	To provide a foundation to apply in network programming

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Data communication Components, Data Representation and its flow, Networks, Topology, Protocols and Standards, OSI model, TCP/IP, Transmission Media, Switching, Connecting Devices.	6
2	**Physical Layer:** Brief of Data and Signals- Basics, SNR, Bandwidth-Delay, Nyquist theorem, Shannon’s Capacity, Baud, Signal Impairments, Data to Signal conversion Techniques- Digital to Analog, Digital to Digital, Scrambling, Multiplexing.	6

3	**Data Link Layer and Medium Access Sub Layer:** Framing, Byte/ Character stuffing, Bit stuffing; Error Detection and Error Correction - Fundamentals, Hamming Distance, Parity, CRC, Checksum; Flow Control and Error control protocols – ARQ- Stop and Wait, Sliding Window- Go- Back- N, Selective Repeat, Piggybacking, HDLC, Multiple access- Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA, Token Passing, Poll, TDMA, FDMA, CDMA, LAN: Wired LAN, Wireless LAN, VLAN.	10
4	**Network Layer:** Logical addressing and Protocols– IPV4, IPV6; ICMP, Address mapping – ARP, RARP, BOOTP and DHCP– Delivery, Forwarding and Unicast Routing protocols.	8
5	**Transport Layer:** Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Congestion Control, Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.	6
6	**Application Layer:** DNS, Telnet, Email, FTP, HTTP, Firewalls, Basics of Cryptography.	4
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	classify the role of the components of computer networks using addressing mechanisms and layer models.
2	compare different signal conversion techniques, transmission media, switching methodologies.
3	evaluate different error, flow and access control protocols over variety of networks.
4	analyze different network and transport layer protocols.
5	explain variety of protocols and security techniques at application layer.

Learning Resources:	
1	"Data Communications and Networking (4th Ed.)" – B. A. Forouzan, TMH
2	"Computer Networks (4th Ed.)" – A. S. Tanenbaum, Pearson Education/PHI
3	"Data and Computer Communications (5th Ed.)"- W. Stallings, PHI/ Pearson Education

Course Name:	**Advanced Algorithms**

Course Code:	PEC 601	**Category:**	**Professional Elective Courses**
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Design and Analysis of Algorithm, Data Structure, Discrete Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	Introduce students to the advanced methods of designing and analyzing algorithms.
2	The student should be able to choose appropriate algorithms and use it for a specific problem.
3	To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
4	Students should be able to understand different classes of problems concerning their computation difficulties.
5	To introduce the students to recent developments in the area of algorithmic design.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Sorting:** Review of various sorting algorithms, Topological sorting **Lower Bound Theory:** O(n log n) bound for a comparison sort. **Graph:** Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.	6

2	***Matroids:*** *Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST.* ***Disjoint Set Manipulation:*** *Set manipulation algorithm like union-find, union by rank, path compression.* ***Graph Matching:*** *Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's, Blossom algorithm to compute augmenting path.*	6
3	**String matching problem:** Different techniques – Naive algorithm, string matching using finite automata, and Knuth, Morris, Pratt (KMP) algorithm with their complexities **Matrix Computations:** Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.	6
4	**Modulo Representation of integers/polynomials:** Chinese Remainder Theorem, Conversion between base-representation and modulo- representation. Extension to polynomials. Application: Interpolation problem. **Discrete Fourier Transform (DFT):** In the complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm.	6
5	**Computational Geometry:** Robust geometric primitives, Convex Hull, Triangulation, Voronoi diagrams, Nearest neighbor search, Range search, Point location, Intersection detection, Bin Packing, Medial-axis transform, Polygon partitioning, Simplifying Polygons, Shape Similarity, Motion Planning, Maintaining line arrangements, Minkowski sum.	5
6	**Linear Programming:** Geometry of the feasibility region and Simplex algorithm **NP-completeness:** Examples, proof of NP-hardness and NP- completeness.	6
7	Recent trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.	5
Total		**40**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain lower bound theorem, various graph algorithms along with analysis of different sorting algorithms.
2	Understand matroids, disjoint set manipulation, graph matching algorithm, different string-matching algorithms, and operations on Strassen's matrix manipulation etc.
3	Understand different DFT algorithms and Modulo representation of Integer/ Polynomial.
4	Explain Convex hull, Voronoi diagram, Range search, Bin packing and other methods under computational geometry.
5	Understand Linear programming, NP-completeness and recent activities in the field of advanced data structure.

Learning Resources:	
1	"Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2	"The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
3	"Algorithm Design" by Kleinberg and Tardos.
4	Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House, New Delhi.

Course Name:	**Soft Computing**		
Course Code:	PEC 601	**Category:**	Professional Elective Courses
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic knowledge of Set theory
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To familiarize the students with the basic concepts of soft computing and its techniques.
2	To acquaint the students with fuzzy logic and Genetic Algorithm.
3	To develop the ability to perform different types of learning with the help of Artificial Neural networks.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to Soft Computing:** Introduction to soft computing; introduction to fuzzy sets and fuzzy logic systems; introduction to biological and artificial neural network; introduction to Genetic Algorithm.	6
2	**Fuzzy Logic:** Introduction, Operations on Classical sets, properties of classical sets, Properties of fuzzy sets, Linguistic Hedges, Fuzzy set operations. Features of membership functions, standard forms and boundaries, different fuzzification methods, Lambda Cuts for fuzzy sets, Defuzzification methods. Crisp Logic, Fuzzy Logic, Fuzzy Rule based Inference System – Mamdani FIS, Sugeno FIS. Applications of Fuzzy Inference System	10
3	Artificial Neural Network: Introduction to Artificial Neural Networks, Biological Neurons and Artificial Neural Network, Resemblance of Biological neuron and ANN, Basic Idea of learning. Basic terminology of ANN, Topology of ANN, Different Activation Function, MP Neural Network. Neural Network for Supervised Learning: Perceptron and Delta learning Rule, ADALINE, Single layer Perceptron, MADALINE, Multilayer Perceptron with Back propagation Algorithm Neural Network for Unsupervised Learning: Hebbian Learning Rule, Competitive ANN like Kohonen's Self Organizing Feature Map. Associative Memory using ANN: Associative memory, Bi-directional Associative Memory, Binary Hopfield Networks. Neuro-Fuzzy modelling: Applications of Neural Networks: Pattern Recognition and classification	14
4	**Genetic Algorithms:** Basic Idea of Optimization, Introduction to Simple GA, brief introduction to other optimization techniques with Pros and Cons, Simple GA Algorithm, GA operator: Different selection techniques, Different non-constrained and constrained Crossover and Mutation techniques Introduction to Multi-objective Genetic Algorithm (MOGA), pareto Optimal Solutions Genetic algorithms in search and optimization, GA based clustering Algorithm, Image processing, and Pattern Recognition	8
5	**Other Soft Computing techniques:** Simulated Annealing, Ant colony optimization (ACO), Particle Swarm Optimization (PSO).	2
Total		**40L**

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

1	Identify the difference between Hard Computing and Soft Computing
2	Practice fuzzy set theory and fuzzy logic to illustrate Fuzzy Inference System
3	Identify and implement appropriate Artificial Neural Network for solving a given problem
4	Describe the Simple Genetic Algorithm and its operators
5	Recall the other Soft Computing Techniques such as Simulated Annealing, ACO, Swarm Optimization, MOGA

Learning Resources:	
1	Principles of Soft Computing, S N Sivanandam, S.N. Deepa, Wiley India
2	S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI
3	Neural Networks: A Classroom Approach,1/e by Kumar Satish, TMH,
4	Soft Computing and Intelligent System Design, Theory, Tools and Applications, F.O. Karray, C. De Silva, Pearson
5	Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg
6	Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, PHI
7	Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley and Sons.
8	Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg, Pearson/PHI
9	A beginner's approach to Soft Computing, Samir Roy & Udit Chakraborty, Pearson
10	Fuzzy Sets and Fuzzy Logic: Theory and Applications, George J. Klir and Bo Yuan, Prentice Hall
11	Neural Networks: A Comprehensive Foundation (2nd Edition), Simon Haykin, Prentice- Hall.

Course Name:	**Cloud Computing**		
Course Code:	PEC 601	**Category:**	Professional Elective Courses

Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Architecture, Operating System
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	This course gives students an insight into the basics of cloud computing along with virtualization.
2	It will provide the students basic understanding of cloud security and privacy issues.
3	Students will be able to use different cloud services for different purposes.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**<u>Definition of Cloud Computing and its Basics:</u>** Defining a Cloud, Cloud Types – NIST model, Cloud Cube model, Deployment models (Public, Private, Hybrid and Community Clouds), Service model: - Infrastructure as a Service, Platform as a Service, Software as a Service with examples of services/ service providers. Cloud Reference model, Characteristics of Cloud Computing, Benefits and advantages of Cloud Computing, A brief introduction on Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Connecting to the Cloud by Clients, IaaS –concept, Workload, partitioning of virtual private server instances, Pods, aggregations. SaaS - Basic concept and characteristics, Open SaaS and SOA, examples of SaaS platform Identity as a Service (IDaaS) Compliance as a Service (CaaS)	10

2	**Use of Platforms in Cloud Computing:** Concepts of Abstraction and Virtualization technologies: Types of virtualization (access, application, CPU, storage), Load Balancing and Virtualization: Basic Concepts, Network resources for load balancing, Advanced load balancing (including Application Delivery Controller and Application Delivery Network), Mention of The Google Cloud as an example of use of load balancing. Hypervisors: Virtual machine technology and types, VMware vSphere Machine Imaging. Porting of applications in the Cloud: The simple Cloud API and AppZero Virtual Application appliance, Concepts of Platform as a Service, Definition of services, Distinction between SaaS and PaaS (knowledge of Salesforce.com and Force.com), Application development Use of PaaS Application frameworks. Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, Adwords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service. Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery Network, SQL Azure, and Windows Live services.	12
3	**Cloud Infrastructure:** Cloud Management: An overview of the features of network management systems and a brief introduction of related products from large cloud vendors, Monitoring of an entire cloud computing deployment stack – an overview with mention of some products, Lifecycle management of cloud services (six stages of lifecycle). Concepts of Cloud Security: Cloud security concerns, Security boundary, Security service boundary Overview of security mapping Security of data: Brokered cloud storage access, Storage location and tenancy, encryption, and auditing and compliance Identity management (awareness of Identity protocol standards).	8
4	**Concepts of Services and Applications** : Service Oriented Architecture: Basic concepts of message-based transactions, Protocol stack for an SOA architecture, Event-driven SOA, Enterprise Service Bus, Service catalogs, Applications in the Cloud: Concepts of cloud transactions, functionality mapping, Application attributes, Cloud service attributes, System abstraction and Cloud Bursting, Applications and Cloud APIs Cloud-based Storage: Cloud storage definition – Manned and Unmanned Webmail Services: Cloud mail services including Google Gmail, Mail2Web, Windows Live Hotmail, Yahoo mail, concepts of Syndication services.	10

Total	**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe the fundamental concept of cloud computing and its characteristics, benefits and limitations.
2	Explain different types of cloud models, architecture and infrastructure of cloud computing and its examples.
3	Explain abstraction and different types of virtualization, load balancing technology and their role in the cloud computing model.
4	Explain the security, privacy and cloud management of cloud computing.
5	Use various cloud services in different applications.

Learning Resources:	
1	Cloud Computing Bible by Barrie Sosinsky, Wiley India Pvt. Ltd, 2013
2	Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education (India) Private Limited, 2013
3	Cloud computing: A practical approach, Anthony T. Velte, Tata Mcgraw-Hill
4	Cloud Computing, Miller, Pearson
5	Building applications in cloud: Concept, Patterns and Projects, Moyer, Pearson
6	Cloud Computing – Second Edition by Dr. Kumar Saurabh, Wiley India
7	Cloud Computing – Second Edition by Dr. Kumar Saurabh, Wiley India

5G Communication (PEC 601)

Course outcomes: At the end of the course the student will be able to

CO1	Learn 5G Technology advances and their benefits
CO2	Learn the key RF, PHY, MAC and air interface changes required to support 5G
CO3	Learn Device to device communication and millimeter wave communication
CO4	Implementation options for 5G

Detailed Syllabus

Overview of 5G Broadband Wireless Communications:

Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro) , An Overview of 5G requirements, Regulations for 5G,Spectrum Analysis and Sharing for 5G.

The 5G wireless Propagation Channels:

Channel modeling requirements, propagation scenarios and challenges in the 5G modeling, Channel Models for mmWave MIMO Systems.

Transmission and Design Techniques for 5G:

Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques – orthogonal frequency division multiple accesses (OFDMA), generalized frequency division multiple accesses (GFDMA), non- orthogonal multiple accesses (NOMA).

Device-to-device (D2D) and machine-to-machine (M2M) type communications

Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi- hop and multi-operator D2D communications.

Millimeter-wave Communications

Spectrum regulations, deployment scenarios, beam- forming, physical layer techniques, interference and mobility management, Massive MIMO propagation channel models, Channel Estimation in Massive MIMO, Massive MIMO with Imperfect CSI, Multi-Cell Massive MIMO, Pilot Contamination, Spatial Modulation (SM),

Textbooks:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G MobileNetworks" , Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directionsin Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.

References

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.
2. Amitabha Ghosh and Rapeepat Ratasuk "Essentials of LTE and LTE-A", Cambridge University Press.

Professional Elective Course (PEC 602) Elective III

Course Name:	**High Performance Computing**		
Course Code:	PEC 602	**Category:**	Professional Elective Courses
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Organization and Architecture
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 30	Attendance:

Course Objectives:	
1	To know how modern high-performance processors are organized their strengths and weaknesses.
2	To study about the architecture of parallel systems.
3	To gain knowledge about the analytical parallel algorithms.

Course Contents:		
Module	**Description of**	**Contact**

No.	Topic	Hrs.
1	Introduction: Review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance.	4
2	Parallel Processing Concepts; Levels and model of parallelism: instruction, transaction, task, thread, memory, function, data flow models, demand- driven computation; Parallel architectures: superscalar architectures, multi- core, multi-threaded, server and cloud.	4
3	Fundamental design issues in HPC: Load balancing, scheduling, synchronization, and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; OpenMP, Pthread, MPI, java, Cilk; Performance analysis of parallel algorithms.	10
4	Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques; Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi, Cell BE; Power-aware HPC Design: computing and communication, processing, memory design, interconnect design, power management; Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.	8
5	HPC programming assignments: Hands on experiment and programming on parallel machine and HPC cluster using Pthread, OpenMP, MPI, Nvidia Cuda and Cilk. Standard multiprocessor simulator or cloud simulator at an introductory level only.	10
6.	Distributed shared-memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.	4
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able:	
1	Investigate modern design structures of pipelined and multiprocessors systems.
2	Design the architecture of parallel systems
3	Understand the API for parallel programming in shared-memory environments

4	Understand the implementation of MPI

Learning Resources:	
1	Hennessey and Patterson, "Computer Architecture: A quantitative Approach", Morgan Kaufman.
2	Ananth Grama and George Karypis, “Introduction to parallel computing”, Addison -Wesley, 2009.
3	John Levesque and Gene Wagenbreth, “High Performance Computing: Programming and Applications”, Chapman & Hall, 2010.
4	John L. Hennessy and David Patterson, “Computer Architecture- A Quantitative Approach”, Elsevier, 2012.
5	Michael Quinn, “Parallel Programming in C with MPI and OpenMP”, Indian edition, McGraw Hill Education, 2017.

Course Name:	**Data Mining**		
Course Code:	PEC 602	**Category:**	Professional Elective Courses
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic concepts of Database, Concept of Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To identify the scope and essentiality of Data Mining and Warehousing
2	To analyze data, choose relevant models and algorithms for respective applications.
3	To develop research interest towards advances in data mining.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**

1	Data Mining overview, Data Warehouse and OLAP technology, Data Warehouse Architecture, Steps for the Design and Construction of Data Warehouses, A Three – tier Data Warehouse Architecture, OLAP, OLAP queries, metadata repository, Data Preprocessing, Data – Integration and Transformation, Data Reduction, Data Mining Primitives: What defines a Data Mining Task? Task Relevant Data, The Kind of Knowledge to be mined, KDD.	10
2	Mining Association rules in Large Databases, Association Rule Mining, Market Basket Analysis: Mining a Road Map, The Apriori Algorithm: Finding Frequent Itemsets using Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, Mining Frequent Itemsets without Candidate Generation, Multilevel Association Rules, Approaches to Mining Multilevel Association Rules, Mining Multidimensional Association Rules for Relational Databases and Data Warehouses, Multidimensional Association Rules, Mining Quantitative Association Rules, Mining Distance Based Association Rules, From Association Mining to Correlation Analysis.	10
3	Classification and Prediction, Issues regarding Classification and Prediction, Classification by Decision Tree Induction, Bayesian Classification, Bayes Theorem, Naïve Bayesian Classification. Classification based on Concepts from Association Rule Mining and Other Classification methods like k-Nearest Neighbor Classifiers, Prediction, Linear and Multiple Regression, Non Linear Regression, Other Regression Models, Classifier Accuracy.	10
4	Cluster Analysis, Data types in Cluster Analysis, Categorization of Major Clustering Methods, Classical Partitioning Methods: k-Means and k-Medoids, Partitioning Methods in Large Databases i.e k-Medoids to CLARANS, Hierarchical Methods, Agglomerative and Divisive Hierarchical Clustering, Density-Based Methods, CLIQUE: Clustering High-Dimensional Space, Model Based Clustering Methods.	10
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Identify the key processes of data mining, data warehousing and knowledge discovery process.
2	Identify appropriate data mining algorithms to solve real world problems
3	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining

4	Describe complex data types with respect to spatial and web mining.

Learning Resources:	
1	Jiawei Han and M Kamber, Data Mining Concepts and Techniques,, Second Edition, Elsevier Publication, 2011
2	Vipin Kumar, Pang-Ning Tan, Michael Steinbach, Introduction to Data Mining - Addison Wesley,2006.
3	Arun K. Pujari, Data Mining Techniques, Universities Press, 2001
4	Alex Berson and Stephen J. Smith, Data Warehousing, Data Mining, & OLAP, Second Edition Tata McGraw Hill Education
5	Pang-Ning Tan, "Introduction to Data Mining", Addison Wesley, 2006.

Course Name:	**Pattern Recognition**		
Course Code:	PEC 602	**Category:**	Professional Elective Courses
Semester:	VI (Third Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Discrete Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To introduce students to the application of the Bayesian Decision theorem for pattern classification
2	To make the students realize the need for dimensionality reduction and choosing a proper dimensionality reduction model depending on the problem statement
3	To introduce students to different classification and clustering methods depending on the nature of the pattern

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**

1	**Introduction:** Pattern; Feature; Feature Selection; Dimensionality; Types of Learning	
2	**Basics of Probability:** Probability; Independence of events, conditional and joint probability, Bayes' theorem; Distribution Functions; Bayes Decision Theory	4
3	**Bayes Decision Theory:** Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, discrete features, Naïve Bayesian Classifier	6
4	**Parameter Estimation Methods:** Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case **Nonparametric techniques for density estimation:** Histogram Based Method, Windows Based Methods, Parzen-window method; K-Nearest Neighbour method	6
5	**Dimensionality reduction:** Introduction, Problems of High dimensionality, Principal component analysis; Linear Discriminant Analysis	5
6	**Sequential Pattern Recognition:** Hidden Markov Models (HMMs); Discrete HMMs	5
7	**Linear discriminant functions:** Gradient descent procedures; Perceptron; Support vector machines (brief introduction) **Non-linear discriminant functions:** Introduction to Multilayer Perceptron; Brief introduction to Back Propagation Algorithm	8
8	**Non-metric methods for pattern classification**: Non-numeric data or nominal data; Decision trees: ID3	4
9	**Unsupervised learning and clustering:** Criterion functions for clustering; Algorithms for clustering: K-Means, Hierarchical clustering, Self- Organizing Map	4
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate the concept of Bayesian Decision Theory for classification of data having parametric and non-parametric PDF
2	Compare different dimensionality reduction methods
3	Solve problems related to sequential data using Discrete Hidden Markov Model
4	Differentiate problems related to linear classifiers and non-linear classifier
5	Solve problems related to non-metric methods of pattern classifications

6	Demonstrate the concept of clustering

	Learning Resources:
1	R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
2	S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3	C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Open Elective Courses (OEC 601): Elective I

Scientific Computing (OEC 601)

Objectives:

This course serves two goals:

1. To make students familiar with the concepts of programming and the get them accustomed with high-level languages like Matlab, Mathematica, etc.
2. To provide an overview of some of the issues and problems that arise in scientific computation, such as (non-)linear systems, numerical and symbolic integration, differential equations and simulation.

Outcome of this course:

After this course the student should be able to understand simple mathematical models and scientific problems (such as finite capacity growth models, plotting a line through data points, etc.) and implement a solution in an adequate scientific programming language (such as matlab, mathematica).

Syllabus:

Module 1:

Introduction to scientific computing. Representing numbers in a computer: scalar data types; Variables and constants: guidelines for variable names. Assignment statements: mathematical and logical operators; Keyboard input and screen output;

Module 2:

Writing a simple, linear program. Conditional statements; arrays and subscripts; loops.; plotting; Functions and subroutines. Program design; writing well structured programs; debugging techniques. Scientific applications of computer programs; Introduction to Matlab. Solving nonlinear equations;

Module 3:

Numerical integration; Data analysis, plotting and smoothing; simulating simple physical, chemical and/or mathematical systems. Simulation: the simple programming approach to difference equations. Differential Equations.

Human Resource Development(OEC 601)

Course Objective:

- To enable the students to gain knowledge on the human resource management
- To enable the students to effectively plan and manage the human resource in the handloom and textile industry.

Course Outcome:

Upon completion of this course, the students will be able to effectively plan and manage the Human resource in the handloom and textile industry

Syllabus

Unit I

For complete syllabus and results, class timetable and more pls download iStudy. Its a light weight, easy to use, no images, no pdfs platform to make students life easier.

Unit II

Human Resource Planning: Need and Importance of Human Resource Planning- Process of Human Resource Planning-Factors affecting Human Resource Planning Process- Forecasting Techniques-Demand and Supply Forecasting in Planning- Job Analysis Process and Methods-Job Design- Job Description- Job Specification- Job Evaluation

Unit III

Recruitment: Definition, Importance and Process of Recruitment-Current Trends in RecruitmentRecruitment Source-Internal and External Sources of Selection-Selection Process Methods of Selection-Types of Tests-Types of Interview-Induction Types of Induction and Importance of Induction- Training and Development-Needs of Training- Type of Training and Types of Training Methods-Process of Training- TNA (Training Need analysis) Need and Benefits.

Unit IV

For complete syllabus and results, class timetable and more pls download iStudy. Its a light weight, easy to use, no images, no pdfs platform to make students life easier.

Unit V

Motivation: Nature and Types of Motivation -Employee Motivation Need-Process of Motivation - Theories of Motivation-Goal Setting and Career Planning Need and Importance- Role of Human Resource in Textile Industry- Human Resource Skill Requirements in Textile Industry-Human Resource Planning in Textile Industry.

Text Books:

1. K Aswathappa- Human Resource and Personnel Management -Publisher Mc Graw Hill Education 8th Edition
2. P. Subba Rao -Human Resource Management – Himalayan Publication – Revised Edition
3. Neo, Hollenbeck, Gerhart& Wright – Fundamentals of Human Resource ManagementPublisher Mc Graw Hill Education 3rd Edition

References:

4. Jawad Syed and Robin Karmar-Human Resource Management (Global and Critical Perspective)- 2nd Edition
5. Max Muller -The Managers Guide to HR- 2nd Edition
6. Editors -Sanjeev Bansal, Jaya Yadav &Hara Govind Kakaa-Case Studies in Human Resource

7. Armstrong Handbook – Human Resource Management Practice- 13th Edition.

Course Name:	**Professional Ethics**		
Course Code:	OEC 601	**Category:**	Open Elective Courses
Semester:	VI (Third Year)	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Must have the knowledge on basic statistics and other decision-making tools
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1.	To understand the core values that shape the ethical behaviour of a professional.
2.	To understand the concepts of project planning and organization, budgeting and control, and project life cycles.
3.	To learn concepts related to organizational workflow including the staffing process, project planning elements, and the project plan contents and project communications.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1.	Morals, values and Ethics. Engineering Ethics & Professionalism. Code of Ethics. Profession and Professionalism- Models of professional roles- Theories about right action.	
2.	Managing conflict. Whistle Blowing. Global Ethical Issues. Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics - Role in Technological Development- Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.	

3.	Project Management: Definitions of Project and Project Management, Issues and Problems in Project Management, Project Life Cycle - Initiation / Conceptualization Phase, Planning Phase, Implementation / Execution Phase, Closure / Termination Phase	
4.	Project Feasibility Studies – Pre-Feasibility and Feasibility Studies, Preparation of Detailed Project Report, Technical Appraisal, Economic/Commercial/Financial Appraisal including Capital Budgeting Process, Social Cost Benefit Analysis Project Planning – Importance of Project Planning, Steps of Project Planning, Project Scope, Work Breakdown Structure (WBS) and Organization Breakdown Structure(OBS), Phased Project Planning	
5.	Project Scheduling and Costing – Gantt chart, CPM and PERT Analysis, Identification of the Critical Path and its Significance, Calculation of Floats and Slacks, Crashing, Time Cost Trade-off Analysis, Project Cost Reduction Methods.	
6.	Project Monitoring and Control – Role of Project Manager, MIS in Project Monitoring, Project Audit. Case Studies with Hands-on Training on MS- Project.	

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Apply the knowledge of human values and social values to contemporary ethical values and global issues.
2.	Make a framework for analyzing a project and apply their knowledge systematically to value a business
3.	Applying the principles and practices while maintaining high standards of practice, making ethical judgments and decisions in a respectful, and sustaining professional standing through a commitment to life-long learning.
4.	Implements the generally recognized framework and good practices of project management, organizational influences; operations; strategic planning; programs; project life cycles; and project management cycles

Learning Resources:	
1.	*Project Management - David I Cleland - Mcgraw Hill International Edition.*
2.	*Project Management – Gopalakrishnan – Mcmillan India Ltd*
3.	*Project Management – K Nagarajan*
4.	*Project Management- Erik Larson and Clifford Gray- SEI*

Course Name:	**Data Communication & Computer Networks Lab**		
Course Code:	CS 691	**Category:**	Professional Core Courses
Semester:	VI (Third Year)	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Operating System, Programming knowledge
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To develop an understanding of modern network design and configuration methodologies.
2	To introduce the student to the major concepts involved in network communication.
3	To apply the communication concepts in network programming

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Familiarization with network cables (CAT5/5e/6 UTP), connectors (RJ45, T- connector), Ethernet driver, connecting devices (Hubs, Switches, Routers) etc. and preparation of crossover and/or straight-through patch cable using color code.	
2	System Configuration (Windows and/or Linux) with implementation of subnetting. Familiarization of network related commands like ping, netstat, ifconfig/ ipconfig, netconfig, traceroute, telnet, finger, iptables, ipchains etc.	
3	Familiarization of network simulator and/or packet tracer, configuration of router and configuration of DNS, FTP, HTTP, Mail server etc.	
4	Implementation of IPC using Pipe.	
5	Implementation of IPC using connection-oriented (TCP) and connection-less (UDP) socket in both iterative and concurrent (multi-process and/or multi- threaded approach) modalities.	
6	Implementation of Data Link Layer Flow Control Mechanism (Sliding Window).	

Course Outcomes:	
After completion of the course, students will be able to:	
1	prepare network cable to connect devices for network design.
2	apply configuration knowledge and skill to setup Ethernet Card in Windows and Linux.
3	implement of Inter-Process Communication using Pipe.
4	design variety of iterative and concurrent servers to implement client-server communication using TCP and UDP socket.

Learning Resources:	
1	"Unix Network Programming: The Sockets Networking API Vol 1" – W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, Third Edition, Addison Wesley
2	"UNIX Network Programming: Interprocess Communications, Volume 2" – W. Richard Stevens, 2nd Edition, Prentice Hall
3	"Hands-On Network Programming with C: Learn socket programming in C and write secure and optimized network code"- Lewis Van Winkle, Packt Publishing Limited

Course Name:	**Java Programming Lab**		
Course Code:	CS 694	**Category:**	Professional Core
Semester:	VI (Third Year)	**Credit:**	2
L-T-P:	0-0-4	**Pre-Requisites:**	Basic understanding of object-oriented paradigm
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To build software development skills using java programming for real-world applications.
2	To understand and apply the concepts of classes, packages, interfaces, array list, exception handling and file processing.
3	To develop applications using generic programming and event handling.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Assignments on class, constructor, overloading, inheritance, overriding	
2	Assignments on wrapper class, arrays	
3	Assignments on developing interfaces- multiple inheritance, extending interfaces	
4	Assignments on creating and accessing packages	
5	Assignments on multithreaded programming	
6	Assignments on generic class and arraylist	
7	Assignments on applet programming	
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Implement Java programs for simple applications that make use of classes, packages and interfaces.
2	Implement Java programs with arraylist, exception handling and multithreading.
3	Design applications using generic programming, applet and event handling.

Learning Resources:	
1	P. J. Deitel, H. M. Deitel, "Java for Programmers", Pearson Education, PHI, 4th Edition, 2007.
2	P. Radha Krishna, "Object Oriented Programming through Java", Universities Press, 2nd Edition, 2007
3.	Bruce Eckel, "Thinking in Java", Pearson Education, 4th Edition, 2006.
4.	Sachin Malhotra, Saurabh Chaudhary, "Programming in Java", Oxford University Press, 5th Edition, 2010.

PART – IV, 1st SEMESTER (CSE)

Semester VII

Professional Elective Courses (PEC 701) Elective IV

Advanced Operating Systems (PEC 701)

1 Review of introductory operating systems concepts, process management, inter-process communication, memory management, I/O systems, file systems, and the like (6 Hours)

2 Use of the UNIX operating system interface and study of the architecture, design and implementation aspect of Unix/Linux Operating System (10 Hours)

3 Gaining experience in implementing and debugging operating system components, including the kernel module, system call, synchronization primitives, and the file system (6 Hours)

4 Distributed Operating system concepts: Goals, Distributed Computing Models, Hardware Concepts, Software Concepts, Architecture of DOS.

1. Design Issues: Transparency, Flexibility, Scalability, Reliability, Performance, fault tolerance (6 Hours)

5 Mobile OS: Architecture, Android OS, iOS, Virtual OS, Cloud OS and their design issues (6 Hours)

6 Real Time Operating Systems: Characteristics of Real Time operating Systems, Classification of Real Time Operating Systems, Scheduling in RTOS. (4 Hours)

References:

7 Silberschatz, Galvin, and Gagne, Operating System Concepts Essentials, 9th Edition.

8 The Design of the UNIX Operating System. Maurice J. Bach

9 Unix Internal. Uresh Vahalia

10 Linux Kernel Development. Robert Love

Mobile Computing (PEC 701)

Syllabus:

Sl. No.	Module Name and Topics	No. of Classes
1.	Introduction to mobile computing	
2.	Wireless and Cellular network, channel allocation, multiple access	
3.	1G, 2G, systems, GSM standards, architecture	
4.	Location management, Handoffs, Authentication	
5.	2G CDMA, 3G CDMA, 4G standards and advances	
6.	IEEE 802.11 WLAN	
7.	Bluetooth, HiperLAN architecture, comparison of wireless technologies	
8.	Mobility adaptation, process migration, mobile IP	
9.	Mobile Ad-hoc networking. MAC protocols, Routing	
10.	Energy efficient computing, Impact of mobility on algorithms	
11.	Mobile Computing Architecture	
12	Mobile Computing through Telephony	
13	Security Issues in Mobile Computing	

Books:

1. Fundamentals of Mobile Computing by Pattnaik Mall, PHI.
2. Mobile Computing, by TalukderAsoke K. Hasan Ahmed and Roopa Yavagal, Mcgraw Hill.
3. Mobile Computing Third Edition, by RAJ KAMAL, Oxford University Press.
4. Mobile Communications, by Jochen Schiller, Second Edition, Pearson Education, 2003.

Digital Signal Processing (PEC 701)

Module / Sl. No.	Module Name and topics	No. of Lectures
1	**Introduction:** Review of discrete-time signal and system analysis; Advantages and typical applications of DSP	
2	**Sampling and Quantization:** Sampling and discrete-time processing of continuous time signals, Sampling of low-pass and band-pass signals; Uniform and non-uniform quantization, Lloyd-Max algorithm, Log-companding, A-law, μ-law; Adaptive quantization and prediction	
3	**Orthogonal transforms:** Properties and applications of DFT, implementing linear time invariant systems using DFT, circular convolution, linear convolution using DFT; Fast Fourier Transform, FFT algorithms: Decimation in time, decimation in frequency; Goertzel algorithm; Application of transform in speech, audio, image and video coding, Karhunen-Loeve Transform, DCT, JPEG and MPEG coding standards	
4	**Digital Filter design techniques:** IIR and FIR filters, filter design specifications; Design of digital IIR filters: Impulse invariant, and bilinear transformation techniques for Butterworthand Chebyshev filters; **Design of FIR filters:** Windowing, frequency sampling filter design, optimum approximations ofFIR filters	
5	**Multi-rate Signal Processing:** Fundamentals of multirate systems, Decimation and interpolation, application of Multirate DSP in sampling rate conversion; Filter banks; Polyphase structures; Quadrature-mirror filter bank; Wavelet transform and its relation to multi-ratefilter banks; applications to speech and audio coding.	

6	**Basic concept of Adaptive Digital Signal Processing:** Adaptive Wiener filter and LMS algorithm; Applications of adaptive filtering to echo cancellation and equalization	

References:

2. Proakis, J.G. and Manolakis, D.G., "Digital Signal Processing: Principles, Algorithm andApplications", 4th Ed., Pearson Education.
3. Ifeachor, E.C. and Jervis, B.W., "Digital Signal Processing: A Practical Approach", 2nd Ed.,Pearson Education.
4. Mitra, S.K., "Digital Signal Processing-A Computer Based Appraoach", 3rd Ed., Tata McGraw-Hil
5. Oppenheim, A.V. and Schafer, R.W. with Buck, J.R., "Discrete TimeSignal Processing", 2nd Ed.,Prentice-Hall of India.

Machine Learning(PEC 701)

Course Name:	**Machine Learning**		
Course Code:	PEC 701	**Category:**	Professional Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	BSM 301, BSM 404
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To learn the concepts of data and patterns
2	To design and analyze various machine learning algorithms.
3	Explore supervised and unsupervised machine learning
4.	Explore Deep Learning Techniques and various feature extraction.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**

1	Supervised Learning: - Distance based methods, Nearest Neighbor. Learning Techniques with Decision Tree and Naïve Bayes Classifier.	
2	Supervised Learning (Regression/Classification):- Linear Regression, Logistic Regression, Linear Models optimization SVM, Dealing with Non Linearity and Kernel Methods. Multi class classification, Ranking	
3	Introduction to Unsupervised Learning:- K-Means Clustering, Kernel K- Means, Dimensionality Reduction with PCA and Kernel PCA. Preliminary idea of Factorization and generative models (Mixture model and Latent factor model).	
4	Evaluating Machine Learning Algorithms model selection, Introduction to statistical learning theory and Ensemble Methods (Bagging, Boosting and Random Forests).	
5	Model Estimation, Modeling Time Series Data, Deep Learning and Feature Extraction Techniques. Shallow Neural Network and Deep Neural Network.	
6.	Case Study: - Selection from a Technique and implementation with Model Selection.	

Course Outcomes:	
1.	Explain different supervised Learning Techniques
2.	Identify the difference between Linear and Non Linear Models
3.	Understand different unsupervised learning techniques.
4.	Understand the concept of model estimation and deep learning techniques.

Learning Resources:	
1	Machine Learning, Tom Mitchell, McGraw Hill, 1997.
2	Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
3	Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4	Hastie, Tibshirani, Friedman The Elements of Statistical Learning Springer 2007

Professional Elective Courses(PEC 702) Elective V

Neural Networks and Deep Learning (PEC 702)

Course Name:	**Neural Networks and Deep Learning**		
Course Code:	PEC 702	**Category:**	Professional Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	BS-M101, BS-M301
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:2	Attendance:

Course Objectives:	
	To explore the evolution of ANN starting from its initial phase
	To learn the structure and function of ANN
	To analyse ANN learning
	To explore different deep neural networks
	To learn tools, applications, limitations and future scopes

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction: McCulloch-Pitts Neuron, Perceptron, Perceptron Learning Algorithm and Pattern classification using perceprton, Perceptron function vs Sigmoid or Logistic function, Sigmoid Neuron.	
2	Structural and Functional framework of ANN: Feedforward Neural Networks: Activation Functions-Hidden Layer, Activation Functions- Output Layer, Multilayer feedforward neural networks with example.	
3	Learning: Approximation of any arbitrary function, Error or Loss Function- Mean Square and Cross Entropy, Learning Algorithm-Minimization of Loss, Gradient Descent, Backpropagation of error with example, Optimizers, Learning Rate, Overfitting and Underfitting, L1 and L2 Regularization, Dropout, Early Stopping, Augmentation.	

4	Deep Neural Netwoks: Convolutional Neural Network (CNN), Pre-Trained Networks, Recurrent Neural Network (RNN) - LSTM, Restricted Boltzmann Machine (RBM), Deep Belief Network (DBN), Autoencoders, Diffusion Model.	
5	Generative Adversarial Net (GAN) - Introduction, Applications of GANs, GAN Discriminator, GAN Generator, GAN Training - Upsampling, Transposed Convolutions, Binary Cross Entropy (BCE) Loss for GANs.	
6	Deep Learning Tools, Research Applications, Limitations of Deep Learning and Potential Future Directions.	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Comprehend the concepts of McCulloch-Pitts neuron and perceptron
2	Describe structural and functional framework of ANN
3	Comprehend ANN learning procedure
4	Classify different deep neural networks
5	Know deep learning tools, research applications, limitations and future directions

Learning Resources:	
1	Neural Networks and Learning Machines, Simon Haykin, Pearson; 3rd edition, 2009.
2	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
3	Deep Learning:A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly, 2017
4	Fundamentals of Deep Learning, Nithin Buduma, Nikhil Buduma, Joe PapaO'Reilly Media; 2nd edition, 2022.
	Online Books:
3	https://www.deeplearningbook.org/
4	https://d2l.ai/
5	YouTube: https://www.youtube.com/playlist?list=PLEAYkSg4uSQ1r-2XrJ_GBzzS6I- f8yfRU
6	Modeling Tools: https://www.tensorflow.org/, https://pytorch.org/, http://caffe.berkeleyvision.org/ , https://theano-pymc.readthedocs.io/en/latest/

Image Processing (PEC 702)

Course Name:	**Image Processing**		
Course Code:	PEC 702	**Category:**	Professional Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Mathematics I (BS-M-101) Mathematics II (BS-M-201) Computer Graphics (PE- CS501C)
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To understand the fundamentals of digital image processing.
2	To familiarize with the basic image model suitable for computer processing
3	To familiarize with mathematical preliminaries of digital image processing.
4	To understand different image enhancement methods.
5	To understand different image restoration procedures.
6	To understand applications of different image processing techniques in image segmentation

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Digital Images, Fundamental steps in Digital Image Processing, Components of Digital Image Processing system. Elements of Digital Image Processing - Image Acquisition, Storage, Processing, Communication, Display.	
2	**Image Model:** Image model suitable for computer processing, Sampling & Quantization - Uniform & Non uniform.	

3	**Mathematical Preliminaries:** Neighborhood, Connectivity, boundaries, Relations, Distance Measures, Arithmetic/Logic Operations. Complex Numbers, Fourier Transformation and its properties. Two Dimensional Fourier Transform and Discrete Fourier Transform basic and applications.	
4	**Image Enhancement:** Spatial Domain Method, Frequency Domain Method, Basic Intensity Transformation: Image negative, Log transform, Gamma transform, Piecewise linear transform, Histogram Processing: Histogram equalization, Histogram specification, Global and local histogram processing, Histogram statistics Spatial Filtering: Correlation and Convolution, Spatial filter mask, Smoothing spatial filters-Linear and Non-linear, sharpening Spatial filters-Gradient, Laplacian, Unsharp masking, Highboost filtering.	
5	**Image Restoration:** Degradation Model, Discrete Formulation, Differences in noise removal and restoration, noise models, Different spatial and frequency domain filters, Estimation of degradation function, Inverse filters; Wiener Filtering, Geometric Transformation - Spatial Transformation, Gray Level Interpolation.	
6	**Image Segmentation:** Point, Line and Edge detection, Gradient operator, Combined detection, Edge Linking & Boundary Detection - Local Processing, Global Processing via Hough Transform; Thresholding – Otsu method, Single and multiple threshold, Variable thresholding, Region Oriented Segmentation - Region Growing, Region Splitting & Merging.	
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the basic concepts of digital image fundamentals and computer processing of image models.
2	Comprehend different image enhancement techniques.
3	Develop Fourier transform for image processing in frequency domain.
4	Learn to apply the knowledge of different image processing techniques for image restoration and segmentation.

Learning Resources:

1	Digital Image Processing by Richard E. Woods and Rafael C.Gonzalez, Pearson
2	Digital Image Processing and Analysis by Chanda Bhabatosh, Majumder Dutta Dwijesh, PHI.
3	Digital Image Processing, Castleman, Pearson
4	Fundamentals of Digital Image Processing, A. K. Jain, PHI

Optical and Sensor Networks (PEC 702)

Module 1:

Optical fiber Communications: Historical development, The general system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, Photonic crystal fibers.

Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber.

Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices: Fusion Splices, Mechanical splices, Fiber connectors: Cylindrical ferrule connectors, Duplex and Multiple fiber connectors, Fiber couplers: three and four port couplers, star couplers, Optical Isolators and Circulators.

Module 2:

Optical sources: Light Emitting diodes: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and Threshold conditions, Rate equation, External Quantum Efficiency, Resonant Frequencies.

Photodetectors: Physical principles of Photodiodes, Photo detector noise, Detector response time.

Optical Receiver: Optical Receiver Operation: Error sources. Front End Amplifiers, Receiver sensitivity, Quantum Limit.

Module 3:

WDM Concepts and Components: Overview of WDM: Operational Principles of- WDM, WDM standards, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings. Optical amplifiers: Basic application and Types. Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Ampli: fiers, Wideband Optical Amplifiers.

Optical Networks: Optical network evolution and concepts: Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, Public telecommunication network overview. Optical network transmission modes, layers and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching, Optical burst switching networks.

Module 4:

Introduction and Overview of Wireless Sensor Networks: Introduction, Brief Historical Survey of Sensor Networks, and Background of Sensor Network Technology, Ah-Hoc Networks, Applications of Wireless Sensor Networks: Sensor and Robots, Reconfigurable Sensor Networks, Highway Monitoring, Military Applications, Civil and Environmental Engineering Applications, Wildfire Instrumentation, Habitat Monitoring, Nanoscopic Sensor Applications, Another Taxonomy of WSN Technology, Basic Sensor Network Architectural Elements, Home Control, Medical Applications, Basic Wireless Sensor Technology : Introduction, Sensor Node Technology, Sensor Taxonomy, WN Operating Environment, WN Trends, Wireless Network Standards: IEEE 802.15.4, ZigBee, IEE 1451

Module 5:

Medium Access Control Protocols for Wireless Sensor Networks: Introduction, Background, Fundamentals of MAC Protocols, MAC Protocols for WSNs: Schedule-Based Protocols, Random Access-Based Protocols, Coordination, Schedule Synchronization, Adaptive Listening, Access Control and Data Exchange (B-MAC, Box-MAC, Bit-MAC, H-MAC, I-MAC, O-MAC, S-MAC. RiMAC, T-MAC, Q-MAC (Querry MAC), Q-MAC (QoS MAC), X-MAC).

Module 6:

Routing Protocols for Wireless Sensor Networks: Introduction, Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks Network Scale and TimeVarying Characteristics, Resource Constraints, Sensor Applications Data Models, Routing Strategies in Wireless Sensor Networks: WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing .

Module 7:

Transport Control Protocols and Middle wares for Wireless Sensor Networks: Traditional Transport Control Protocols: TCP (RFC 793), UDP (RFC 768), MobileIP, Introduction, WSN Middleware Principles, Middleware Architecture: Existing Middleware: MiLAN (Middleware Linking Applications and Networks), IrisNet (Internet-Scale Resource-Intensive Sensor Networks Services), Operating Systems for Wireless Sensor Networks: Introduction, Examples of Operating Systems: TinyOS, Mate, Magnet OS.

Text Books:

1 Gerd Keiser, Optical Fiber Communication, 5th Edition, Mc Graw Hill Education (India) Private Limited, 2015.ISBN:l-25-900687-5.

2 John M Senior, Optical Fiber Communications, Principles and Practice, 3td Edition, Pearson Education, 2010,ISBN:978-81-317-3266-3

3 Joseph CPalais, Fiber Optic Communication, Pearson Education, 2005, ISBN:0130085103.

4 Wireless Sensor Network by Kazem Sohraby, Daniel Minoli, Taieb Znati Pub: Wiley.

6. Wireless Sensor Networks Signal Processing and Communications by Ananthram Swami, Qing Zhao, Yao-Win Hong, Lang Tong, John Wiley & Sons.

2. Ad Hoc Wireless Networks: Architectures And Protocols By Murthy Pub: Pearson Education

3. Wireless sensor networks Edited by C. S. Raghavendra Pub: Springer

4. Fundamentals of Sensor Network Programming: Applications and Technology By Sridhar S. Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley.

Cryptography & Network Security (PEC 702)

Course Name:	**Cryptography & Network Security**		
Course Code:	PEC 702	**Category:**	Professional Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Discrete Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: -	Continuous Assessment: -	Attendance: -

Course Objectives:	
1	To understand basics of Cryptography and Network Security
2	To be able to secure a message over insecure channel by various means.
3	To learn about how to maintain the Confidentiality, Integrity and Availability of a Data.
4.	To understand various protocols for network security to protect against the threats in the networks.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Cryptography** Introduction to security attacks - services and mechanism - introduction to cryptography -Conventional Encryption: Conventional encryption model - classical encryption techniques - substitution ciphers and transposition ciphers – cryptanalysis – steganography - stream and block ciphers introduction only.	
2	**Confidentiality and Modular Arithmetic** Confidentiality using conventional encryption – traffic confidentiality - key distribution – random number generation - Introduction to graph - ring and field - prime and relative prime numbers - modular arithmetic - Fermat's and Euler's theorem - primality testing - Euclid's Algorithm - Chinese Remainder theorem - discrete algorithms.	

3	**Public key cryptography and Authentication requirements** Principles of public key crypto systems - RSA algorithm - security of RSA - key management – Diffle-Hellman key exchange algorithm - introductory idea of Elliptic curve cryptography – Elgamel encryption - Message Authentication and Hash Function: Authentication requirements-authentication functions - message authentication code - hash functions - birthday attacks –security of hash functions and MACS.	
4	**Integrity checks and Authentication algorithms:** MD5 message digest algorithm - Secure hash algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - digital signature standards (DSS)	
5.	**Web and System Security** Web Security: Secure socket layer and transport layer security - secure electronic transaction (SET) - System Security: Intruders - Viruses and related threads - firewall design principals –trusted systems.	
6.	Introduction to Blockchain and Cryptocurrency, Concept of Consensus, Ethereum and application of Blockchain and Cryptocurrency in different domains considering the security aspects.	

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Explain the principle of cryptography
2.	Differentiate between symmetric and asymmetric key cryptography
3.	Explain the web security features and different security threats.
4.	Explain Blockchain and Cryptocurrency and its role in different domains.

Learning Resources:	
1.	William Stallings, “Crpyptography and Network security Principles and Practices”, Pearson/PHI.
2.	Wade Trappe, Lawrence C Washington, “Introduction to Cryptography with coding theory”, Pearson.
3.	Ferouzen “Cryptography & Network Security”, TMH Publication.

Biology for Engineers (BIO 701)

Course Objectives:

1. Understand the core principles of biology, including cell theory, cellular structures, and
1. biomolecules, as well as their significance in living organisms.
2. Explore human nutrition, digestive, respiratory, excretory, nervous, endocrine, immune,
3. and reproductive systems, comprehending their functions and interactions.
4. Learn the basics of computational biology, bioinformatics tools, sequence analysis,
5. genome sequencing, structural biology, and data analysis techniques for biological data.
6. 4. Gain skills in analyzing biomedical signals, medical imaging, and applying AI and
7. machine learning in biomedical data analysis.
8. 5. Understand healthcare information systems, electronic health records, telemedicine,
9. health data security, data analytics, AI applications in healthcare, and the role of
10. computers in biomedical research and vaccine development.

Course Outcomes

CO1: By the end of the course, students will have a comprehensive understanding of fundamental biology concepts, including cell biology, biomolecules, and genetics, enabling them to appreciate the building blocks of life.

CO2: Students will be able to integrate computational skills and bioinformatics tools to analyze biological data, including DNA sequences, protein structures, and gene expression patterns, facilitating research and problem-solving in biology.

CO3: Graduates will gain competence in biomedical data analysis, covering the interpretation of biomedical signals, medical image analysis, and the application of artificial intelligence techniques in healthcare, preparing them for roles in healthcare technology.

CO4: Students will develop interdisciplinary knowledge, bridging computer science and biology, enabling them to explore the intersection of these fields and apply computational methods to biological and healthcare challenges.

CO5: Course participants will become aware of healthcare information systems, electronic health records, telemedicine, healthcare data security, and the potential of AI in improving patient care, equipping them with insights into the evolving healthcare landscape.

Introduction to Basic Biology and Molecular Biology (6 Lectures)

Cell: What is a Cell, Cell theory, Cell shapes, structure of a Cell, Cell cycle chromosomes The Plant Cell and animal Cell, protoplasm, prokaryotic and eukaryotic Cell, Plant Tissue and animal Tissue; Introduction to Bio-molecules, Carbohydrates, proteins, Amino acid, nucleic acid (DNA and RNA) and their types. Enzymes and their application in Industry. Large scale production of enzymes by Fermentation; Genes, Replication of DNA, Introduction to recombinant DNA Technology, Prokaryotic gene and Eukaryotic gene structure, gene replication, Central dogma, Transcription and Translation in Prokaryote and Eukaryote and synthesis of protein in Eukaryotes, structure and functions of Proteins.

Computational Biology and Bioinformatics (12 Lectures)

Introduction to Computational Biology and Bioinformatics, Bioinformatics Databases and Tools, Sequence Analysis and alignment, Genome sequencing and fragment assembly, Structural Biology and Protein Modeling, RNA-seq and gene expression analysis, Phylogenetic analysis, Systems Biology and Biological Network Analysis (Protein-protein interaction networks, gene- regulatory networks, metabolic pathway network)s, Data Mining and Machine Learning in Bioinformatics

Biomedical Data Analysis (12 Lectures)

Introduction to Biomedical Signals, Types of Biomedical Signals (e.g., EEG, ECG, EMG),

Signal Preprocessing and Filtering Techniques, Introduction to Medical Imaging, Types of Medical Imaging (e.g., X-ray, MRI, CT), Image Enhancement, Restoration and Analysis of Medical Images, AI and Machine Learning in Biomedical data analysis.

Computers in Healthcare Systems (10Lectures)

Overview of Healthcare Information Systems, Electronic Health Records (EHR) and Health Information Exchange, Telemedicine and Remote Patient Monitoring, Health Data Security and Privacy (HIPAA), Healthcare Data Analytics and Predictive Modeling, Artificial Intelligence in Healthcare (e.g., diagnostic algorithms), Basics of biosensors, biochips, computers in vaccine development, introduction to bioengineering and biotechnology.

Text Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular biology of the cell (6th ed.). Garland Science.
2. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry. W. H. Freeman.
3. Silverthorn, D. U. (2021). Human physiology: An integrated approach (8th ed.). Pearson.
4. Tortora, G. J., & Derrickson, B. (2017). Principles of anatomy and physiology (15th ed.).Wiley.
5. Setubal, J. C., & Meidanis, J. (1997). Introduction to Computational Molecular Biology. PWS Publishing Company.
6. Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). Biological sequence analysis: Probabilistic models of proteins and nucleic acids. Cambridge University Press.
7. Mount, D. W. (2004). Bioinformatics: Sequence and genome analysis. Cold Spring Harbor Laboratory Press.
8. Proakis, J. G., & Manolakis, D. G. (2013). Digital signal processing: Principles, algorithms, and applications (4th ed.). Pearson.
9. Cohen, A. (2000). Biomedical signal processing and signal modeling. John Wiley & Sons.
10. Enderle, J., Blanchard, S., & Bronzino, J. (2019). Introduction to biomedical engineering (4th ed.). Academic Press.
11. Salzer, R., & Siesler, H. W. (2014). Biomedical imaging: Principles and applications. John Wiley & Sons.
12. Theis, F. J., & Meyer-Baese, A. (2011). Biomedical signal analysis: Contemporary methods and applications. MIT Press.
13. Tan, J. (2018). Introduction to health informatics. CRC Press.
14. Wager, K. A., Lee, F. W., & Glaser, J. P. (2017). Healthcare Information Systems: A Practical Approach for Healthcare Management. Jossey-Bass.
15. Pape, L. A., & Mulhern, F. J. (2016). Healthcare Analytics: From Data to Knowledge to Healthcare Improvement. Wiley.
16. Abedin, B., Belle, A., & Villanustre, F. (2019). Artificial Intelligence in Healthcare: Anticipating Challenges. Springer.

Open Elective Course (OEC 701) Elective II

Course Name:	**Operations Research**		
Course Code:	OEC 701	**Category:**	Optional Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	School mathematics, BS- M101, BS-M201
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To impart knowledge in concepts and tools of Operations Research
2	To understand mathematical models used in Operations Research
3	To apply these techniques constructively to make effective business decisions

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Solving Linear Programming Problems:** Formulation, Solving LPP: Using Simultaneous Equations and Graphical Method; Simplex, Duality, Big-M method, Transportation& Assignment, Travelling Salesman problem	
2	**Game Theory** : Introduction ; 2- person Zero – sum Game; Saddle Point; Mini-Max and Maxi-Min Theorems (statement only); Games without saddle point ; Graphical Method ; Principle of Dominance	
3	**Queuing Theory :** Introduction ; Basic Definitions and Notations ; Axiomatic Derivation of the 7L Arrival & Departure (Poisson Queue). Pure Birth and Death Models; Poisson Queue Models : M/M/1 : ∞/FIFO and M/M/1: N/ FIFO.	
	Network Analysis : Shortest Path : Floyd Algorithm ; Maximal Flow Problem(Ford-Fulkerson); PERT-CPM (Cost Analysis, Crashing, Resource	

4	Allocation excluded).	
5	**Non-Linear Programming:** Integer Programming, Dynamic Programming.	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.
2	Determine optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products using various methods, Finding initial basic feasible and optimal solution of the Transportation problems
3	Optimize the allocation of resources to Demand points in the best possible way using various techniques and minimize the cost or time of completion of number of jobs by number of persons
4	Analyse competitive real-world phenomena using concepts from game theory. Analyse pure and mixed strategy games
5	Formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems

Learning Resources:	
1	H. A. Taha, "Operations Research", Pearson
2	P. M. Karak – "Linear Programming and Theory of Games", ABS Publishing House
3	Ghosh and Chakraborty, "Linear Programming and Theory of Games", Central Book Agency
4	Ravindran, Philips and Solberg - "Operations Research", WILEY INDIA
5	Kanti Swaroop — "Operations Research", Sultan Chand & Sons
6	Rathindra P. Sen—"Operations Research: Algorithms and Applications", PHI
7	R. Panneerselvam - "Operations Research", PHI
8	A.M. Natarajan, P. Balasubramani and A. Tamilarasi - "Operations Research", Pearson
9	M. V. Durga Prasad – "Operations Research", CENGAGE Learning
10	J. K. Sharma - "Operations Research", Macmillan Publishing Company

Multimedia Systems (OEC 701)

Course Name:	**Multimedia Systems**		
Course Code:	OEC 701	**Category:**	Open Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Fundamental knowledge of Computation, Networking and DBMS
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To give each student a firm grounding in the fundamentals of the underpinning technologies in graphics and multimedia.
2	To teach students the principled design of effective media for entertainment, communication, training and education.
3	To provide each student with experience in the generation of animations, virtual environments and multimedia applications, allowing the expression of creativity.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Multimedia today, Impact of Multimedia, Multimedia Systems, Components and Its Applications	
2	**Text and, Image:** Text: Types of Text, Ways to Present Text, Aspects of Text Design, Character, Character Set, Codes, Unicode, Encryption. Image: Formats, Image Color Scheme, Image Enhancement.	

3	**Audio and Video:** **Audio:** Basic Sound Concepts, Types of Sound, Digitizing Sound, Computer Representation of Sound (Sampling Rate, Sampling Size, And Quantization), Audio Formats, Audio tools, MIDI. **Video:** Analogue and Digital Video, Recording Formats and Standards (JPEG, MPEG, H.261) Transmission of Video Signals, Video Capture, and Computer based Animation.	
4	**Synchronization, Storage models and Access Techniques:** Temporal relationships, synchronization accuracy specification factors, quality of service, Magnetic media, optical media, file systems (traditional, multimedia) Multimedia devices – Output devices, CD-ROM, DVD, Scanner, CCD.	
5	**Image and Video Database, Document Architecture and Content Management:** Image representation, segmentation, similarity based retrieval, image retrieval by color, shape and texture; indexing- kd trees, R-trees, quad trees; Case studies- QBIC, Virage. Video Content, querying, video segmentation, indexing, Content Design and Development, General Design Principles Hypertext: Concept, Open Document Architecture (ODA), Multimedia and Hypermedia Coding Expert Group (MHEG), Standard Generalized Markup Language (SGML), Document Type Definition (DTD), Hypertext Markup Language (HTML) in Web Publishing. Case study of Applications.	
6	**Multimedia Applications:** Interactive television, Video-on-demand,Video Conferencing, Educational Applications, Industrial Applications, Multimedia archives and digital libraries, media editors	
Total		

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate knowledge and understanding of the concepts, principles and theories of Multimedia Applications and Virtual environments
2	Demonstrate knowledge and understanding of the current issues involved with development and deployment of multimedia system
3	Analyze and solve problems related to their expertise in Multimedia Applications and Virtual Environments.
4	Demonstrate their ability to extend their basic knowledge to encompass new principles and practice

5	Demonstrate their computing, technical and theoretical skills by developing a substantial Multimedia application.
6	Plan, conduct and report on the development of a Multimedia Application

Learning Resources:	
1	"Multimedia: Computing, Communications & Applications" by Ralf Steinmetz and Klara Nahrstedt, Pearson Ed.
2	"Multimedia and Animation" by V.K. Jain, Khanna Publishing House, 2019.
3	"Multimedia Information System" by Nalin K. Sharda , PHI.
4	"Multimedia Communications" by Fred Halsall, Pearson Ed.
5	"Multimedia Systems" by Koegel Buford, Pearson Ed.
6	"Multimedia Literacy" by Fred Hoffstetter, McGraw Hill.
7	"Multimedia Fundamentals: Vol. 1- Media Coding and Content Processing" by Ralf Steinmetz and Klara Nahrstedt, PHI.
8	"Multimedia in Practice: Technology and Application" by J. Jeffcoate , PHI.

Introduction to Philosophical Thoughts (OEC 701)

Course Name:	**Introduction to Philosophical Thoughts**		
Course Code:	OEC 701	**Category:**	Open Elective Courses
Semester:	VII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Human Values
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1.	To understand the Philosophical values and learn the various school of Philosophical thoughts.
2.	To apply concise explanations and arguments about basic philosophical problems

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1.	Nature of Indian Philosophy: Plurality as well as common concerns. Basic concepts of the Vedic and Upanisadic: Atman, Jagrata, Svapna, Susupti, Turiya, Brahman, Karma, Rta, Rna	
2.	Carvaka school: its epistemology, metaphysics and ethics. Mukti Jainism: Concepts of sat, dravya, guna, paryaya, jiva, ajiva, anekantavada, syadvada, and nayavada ; pramanas, ahimsa, bondage and liberation.	
3.	Buddhism: theory of pramanas, theory of dependent origination, the four noble truths; doctrine of momentaryness; theory of no soul. The interpretation of these theories in schools of Buddhism: Vaibhasika, Sautrantrika, Yogacara, Madhyamika.	
4.	Nyaya: theory of Pramanas; the individual self and its liberation ; the idea of God and proofs for His existence.	

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Describe and distinguish key philosophical concepts in the main subfields of philosophy, including concepts such as free will, mind, knowledge, belief, reality, faith, reason, good, etc.
2.	Discuss core philosophical problems, such as whether there is a god, what does it mean to be conscious, are we free to make choices, what is justice, etc.
3.	Explain and defend a position on basic philosophical problems.
4.	Read and comprehend philosophical texts, both classical and contemporary and concise explanations and arguments about basic philosophical problems

Learning Resources:	
1.	M. Hiriyanna : Outlines of Indian Philosophy.
2.	C.D.Sharma : A Critical Survey of Indian Philosophy.
3.	S.N.Das Gupta : A History of Indian Philosophy Vol – I to V.
4.	S.Radhakrishnan : Indian Philosophy Vol – I & II.
5.	T.R.V.Murti : Central Philosophy of Buddhism.

PART – IV, 2nd SEMESTER (CSE)

Semester VIII

Professional Elective Courses (PEC 801) Elective VI

Speech and Natural Language Processing(PEC 801)

Introduction
Brief Review of Regular Expressions and Automata; Finite State Transducers; Word level Morphology and Computational Phonology; Basic Text to Speech;
Introduction to HMMs and Speech Recognition.
Indian language case studies;
Part of Speech Tagging; Parsing with CFGs; Probabilistic Parsing. Representation of Meaning; Semantic Analysis; Lexical Semantics; Word Sense; Disambiguation; Discourse understanding;
Natural Language Generation;
Techniques of Machine Translation; Indian Language case studies.

Web and Internet Technology (PEC 801)

Course Name:	**Web and Internet Technology**		
Course Code:	PEC 801	**Category:**	Professional Elective Courses
Semester:	VIII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Networks, Internet
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To develop an understanding of modern network concepts.
2	To introduce different technologies for web development
3	To provide basic concepts of network security

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction (1L):** Overview, Network of Networks, Intranet, Extranet and Internet. World Wide Web (1L): Domain and Sub domain, Address Resolution, DNS, Telnet, FTP, **HTTP. Review of TCP/IP (1L):** Features, Segment, Three-Way Handshaking, Flow Control, Error Control, Congestion control, IP Datagram, IPv4 and IPv6. **IP Subnetting and addressing (1L):** Classful and Classless Addressing, Subnetting. NAT, IP masquerading, IP tables. **Internet Routing Protocol (1L):** Routing -Intra and Inter Domain Routing, Unicast and Multicast Routing, Broadcast. **Electronic Mail (1L):** POP3, SMTP.	
2	**HTML (3l):** Introduction, Editors, Elements, Attributes, Heading, Paragraph. Formatting, Link, Head, Table, List, Block, Layout, CSS. Form, Iframe, Colors, Color name, Color value. **Image Maps (1L):** Map, area, attributes of image area. Extensible **Markup Language (XML) (4L):** Introduction, Tree, Syntax, Elements, Attributes, Validation, Viewing. XHTML in brief. **CGI Scripts (1L):** Introduction, Environment Variable, GET and POST Methods.	
3	**PERL (3L):** Introduction, Variable, Condition, Loop, Array, Implementing data structure, Hash, String, Regular Expression, File handling, I/O handling. **JavaScript (4L):** Basics, Statements, comments, variable, comparison, condition, switch, loop, break. Object – string, array, Boolean, reg-ex. Function, Errors, Validation. **Cookies (1L):** Definition of cookies, Create and Store a cookie with example. **Java Applets (2L):** Container Class, Components, Applet Life Cycle, Update method; Parameter passing applet, Applications.	
	Client-Server programming In Java (2L): Java Socket, Java **RMI. Threats (1L):** Malicious code-viruses, Trojan horses, worms; eavesdropping, spoofing, modification, denial of service attacks. **Network security techniques (2L):**	

4	Password and Authentication; VPN, IP Security, security in electronic transaction, Secure Socket Layer (SSL), Secure Shell (SSH). **Firewall (1L):** Introduction, Packet filtering, Stateful, Application layer, Proxy.	
5	**Internet Telephony (1L):** Introduction, VoIP. Multimedia **Applications (2L):** Multimedia over IP: RSVP, RTP, RTCP and RTSP. Streaming media, Codec and Plugins, IPTV. **Search Engine and Web Crawler (2L):** Definition, Meta data, Web Crawler, Indexing, Page rank, overview of SEO.	

Course Outcomes:	
After completion of the course, students will be able to:	
1	recall the concepts of network and internet, technologies and protocols
2	apply different technologies such as HTML, CSS, JavaScript, Perl, applet and other Web technologies to develop static/ dynamic web pages for a given web application
3	apply JavaScript to implement cookie
4	design dynamic and interactive web pages by embedding JavaScript code in HTML to validate the user input
5	design security issues for devices like firewall

Learning Resources:	
1	Web Technology: A Developer's Perspective, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013. (Chapters 1-5,7,8,9).
2	Internetworking Technologies, An Engineering Perspective, Rahul Banerjee, PHI Learning, Delhi, 2011. (Chapters 5,6,12)
3	Web Technologies, Uttam K. Roy, Oxford University Press

Internet of Things (PEC 801)

Course Name:	**Internet of Things**		
Course Code:	PEC 801	**Category:**	Professional Elective Courses
Semester:	VIII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Fundamentals of computer network, Network Security
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	In this course, students will explore various components of Internet of things such as Sensors, internetworking, and cyber space.
2	In the end they will also be able to design and implement IoT circuits and solutions.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to IoT:** Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs. Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT	
2	**Sensors:** Working Principles: Different types; Selection of Sensors for Practical Applications Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc	
3	**M2M to IoT:** Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics. Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT,	

4	**IoT Reference Architecture-** Getting Familiar with IoT Architecture, Various architectural views of IoT such as Functional, Information, Operational and Deployment. Constraints affecting design in IoT world-Introduction, Technical design Constraints.	
5	**Domain specific applications of IoT:** Home automation, Industry applications, Surveillance applications, Other IoT application.	
6	**Developing IoT solutions:** Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi Implementation of IoT with Arduino and Raspberry, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT. Recent trends in smart sensor for day to day life, evolving sensors and their architecture.	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand general concepts of Internet of Things (IoT).
2	Recognize various devices, sensors and applications.
3	Understand M2M and IoT architectures.
4	Understand the application of IoT solutions.
5	Apply IoT solutions in various domain using sensors, actuators and Devices.

Learning Resources:	
1	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014
3	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
4	Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

Open Elective Courses (OEC 801): Elective III

Big Data Analytics (OEC 801)

Course Name:	**Big Data Analytics**		
Course Code:	OEC 801	**Category:**	Open Elective Courses
Semester:	VIII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	DBMS, JAVA, PYTHON
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To learn the concepts of Big Data and Hadoop
2	To understand and apply the concept of HDFS and MapReduce
3	To deal with Big Data using Hive, Pig, HBase, Impala, Sqoop

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to big data:** Variety of Big Data. Big Data and its Importance of 3 V's, 4 V's, 6 V's of Big Data, Characteristics' of Big Data. **Introduction of Hadoop:** Benefit of Hadoop, Core Components of Hadoop, Other Components of Hadoop, Hadoop Cluster, Hadoop Start-up Mode. Introduction to HDFS, Architecture of HDFS, Role and types of Name Node, HDFS Commands.	
2	**Introduction to MapReduce:** Flow of Map Reduce, Word Count Problem by Using Map Reduce etc.	

3	**Introduction to Hive:** Architecture of Hive, Data Types of Hive, Hive Query language, Handling Complex Data Types, Scripting in Hive, Different join operations on database tables. Introduction to PIG, Data Types in Pig, Pig Latin, Scripting in Pig.	
4	**Introduction to Sqoop:** import data from HDFS To MySQL, Import data From Hive to MySQL. Exporting Data from Hive to Mysql.	
5	**Introduction to NoSQL:** Types of NoSQL Databases. Introduction to HBase. Introduction to Impala. Introduction to Spark	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe the concept of Big Data, Hadoop and HDFS
2	Describe the concept of Map Reduce, Hive, HBase, Pig, Sqoop and Impala
3	Demonstrate the concept of data transfer between HDFS, MySQL and Hive.
4	Apply NoSQL for importing and exporting unstructured data

Learning Resources:	
1	Michael Minelli, Michehe Chambers, “Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today’s Business”, 1st Edition, Ambiga Dhiraj, Wiely CIO Series, 2013.
2	DT Editorial Services, “Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization”, Dreamtech Press India Pvt. Ltd., 2020
3	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
4	Rajkumar Buyya, “Big Data Principles and Paradigms”, MK
5	Tom White, “Hadoop: The Definitive Guide”, 3rd Edition, O’reilly, 2012.
6	Lars George, "HBase: The Definitive Guide", O'Reilley, 2011
7	Alan Gates, "Programming Pig", O'Reilley, 2011.
8	Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)”, John Wiley & Sons,2014

Cyber Laws and Ethics (OEC 801)

CO
CO-1 Understand Cyber laws
CO-2 Describe Information Technology act and Related Legislation.
CO-3 Demonstrate Electronic business and legal issues.
CO-4 Interpret Cyber Ethics.

Syllabus

Introduction to Cyber law:
Evolution of computer Technology, emergence of cyber space. Cyber Jurisprudence, Jurisprudence and law, Doctrinal approach, Consensual approach, Real Approach, Cyber Ethics, Cyber Jurisdiction, Hierarchy of courts, Civil and criminal jurisdictions, Cyberspace- Web space, Web hosting and web Development agreement, Legal and Technological Significance of domain Names, Internet as a tool for global access.

Information Technology Act:
Overview of IT Act, 2000, Amendments and Limitations of IT Act, Digital Signatures, Cryptographic Algorithm, Public Cryptography, Private Cryptography, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offences, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.

Cyber law and Related Legislation:
Patent Law, Trademark Law, Copyright, Software – Copyright or Patented, Domain Names and Copyright disputes, Electronic Data Base and its Protection, IT Act and Civil Procedure Code, IT Act and Criminal Procedural Code, Relevant Sections of Indian Evidence Act, Relevant Sections of Bankers Book Evidence Act, Relevant Sections of Indian Penal Code, Relevant Sections of Reserve Bank of India Act, Law Relating To Employees And Internet, Alternative Dispute Resolution , Online Dispute Resolution (ODR).

Electronic Business and legal issues:
Evolution and development in E-commerce, paper vs paper less contracts E-Commerce models- B2B, B2C, E security. Business, taxation, electronic payments, supply chain, EDI, E-markets, Emerging Trends.

Cyber Ethics:
The Importance of Cyber Law, Significance of cyber Ethics, Need for Cyber regulations and Ethics. Ethics in Information society, Introduction to Artificial Intelligence Ethics: Ethical Issues in AI and core Principles, Introduction to Block chain Ethics.

Reference Books:

1. Cyber Laws: Intellectual property & E Commerce, Security- Kumar K, dominant Publisher
2. Cyber Ethics 4.0, Christoph Stuckelberger, Pavan Duggal, by Globethic
3. Information Security policy & Implementation Issues, NIIT, PHI
4. Computers, Internet and New Technology Laws, Karnika Seth, Lexis Nexis

Butterworths WadhwaNagpur.
5. Legal Dimensions of Cyber Space, Verma S, K, Mittal Raman, Indian Law Institute, New Delhi,
6. Cyber Law, Jonthan Rosenoer, Springer, New York, (1997).
7. The Information Technology Act, 2005: A Handbook, OUP Sudhir Naib,, New York, (2011)
8. Information Technology Act, 2000, S. R. Bhansali,, University Book House Pvt. Ltd., Jaipur (2003).
9. Cyber Crimes and Law Enforcement, Vasu Deva, Commonwealth Publishers, New Delhi, (2003).

Remote Sensing & GIS (OEC 801)

Module 1

Fundamentals of remote sensing; Principles of electromagnetic radiation and EM spectrum. Sensors and platforms; remote sensing satellites, multispectral, hyper spectral and thermal sensors; RS data acquisition systems. Image processing; Image enhancement and visualization; Image interpretation and classification. Microwave thermal remote sensing; Radar & laser altimetry.

Module 2

Applications of Remote Sensing; Integration of remote sensing and GIS. Basic concepts of GIS; cartographic principles, map projections and coordinate systems. Geographic information and spatial data types; Hardware and software; Steps of spatial data handling; Database management systems; Spatial referencing.

Module 3

Data quality, measures of location errors on maps. Spatial data input, data preparation; Point data transformation, Analytical GIS capabilities, retrieval and classification, overlay functions, Neighbourhood operations, network analysis, error propagation; Data visualization.

Suggested Books:

1. Burrough PA:“Principles of Geographic Information System for Land Resources Assessment”, Oxford Univ. Press.
2. Curran PJ:“Principles of Remote Sensing”, Longman.
3. Jensen JR:“Introductory Digital Image Processing”, Prentice Hall.
4. Lillesand TM & Kiefer RW:“Remote Sensing and Image”, Wiley.

Open Elective Courses(OEC 802) Elective IV

E-Commerce and ERP(OEC 802)

Course Name:	**E-Commerce and ERP**		
Course Code:	OEC 802	**Category:**	Open Elective Courses
Semester:	VIII (Fourth Year)	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	DBMS, Computer Networks
Full Marks:	100		
Examination Scheme:	Semester Examination:	Continuous Assessment:	Attendance:

Course Objectives:	
1	To facilitate the students about the concept of E-commerce.
2	To develop the ability to distinguish different business models.
3	To impart the knowledge of electronic payment system.
4	To provide knowledge of different legal and security issues related with E-Commerce.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to E-Commerce:** Definition, Scope of E-Commerce, E-Commerce and Trade Cycle, Electronic Markets, Mobile Commerce, Electronic Data Interchange (EDI): Technology, Standards (UN/EDIFACT), Communications, EDI and Business, Relationship Between E – Commerce & Networking, Different Types of Networking: Internet, Intranet & Extranet, Wireless Application Protocol: Definition, Hand Held Devices, Infrastructure Requirement for E – Commerce, Rules & Regulations for Controlling E – Commerce	
2	**Business Model of E-Commerce:** Model Based on Transaction Type, Model Based on Transaction Party Business-to-Consumer (B2C) – Business-to-Business (B2B) – Consumer-to Consumer (C2C) – Consumer-to-Business (C2B). Brokerage Model – Value Chain Model – Advertising Model.	

3	**Supply Chain Management:** E – logistics, Supply Chain Portal, Supply Chain Planning Tools (SCP Tools), Supply Chain Execution (SCE), SCE - Framework, Internet's effect on Supply Chain Power.	
4	**Legal Issues** Legal issues**:** Risks, Paper Document vs. Electronic document, Authentication of Electronic document, Laws, Legal issues for Internet Commerce: Trademarks and Domain names, Copyright, Jurisdiction issues, Service provider liability, Enforceable online contract.	
5	**Security Issues:** Security Issues and solutions: Risk of E – Commerce: Overview, Security for E – Commerce, Security Standards, Firewall, Cryptography, Symmetric and Asymmetric Cryptosystems, Digital certificates, RSA, DES, and Digital Signature, Protocols for secure messaging, Internet Security, Cyber Laws.	
6	**Electronic Payment System:** Types of electronic payment systems; Digital token based electronic payment system: E-cash, properties of e-cash, electronic cash in action, business issues and electronic cash, operational risk and electronic cash, electronic cheques; smart cards and electronic payment system; credit card based electronic payment system; Risk and electronic payment system; designing electronic payment system.	
7	**E-business and E-Marketing:** Internet bookshops, Electronic Newspapers, Virtual Auctions, Online Share Dealing, Gambling on the net, Home –shopping, E-Marketing, Tele- marketing, E-Diversity, Case studies through internet.	

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the concept of E-Commerce and Business models.
2	Describe how procurement and supply chains relate to B2B E-commerce.
3	Discuss legal issues surrounding e-commerce.
4	Identify the key security threats and its solution in the E-commerce environment.

Learning Resources:
E-Commerce-Strategy, Technologies & Applications by David Whitley, TMH
E-Commerce- The cutting edge of business by Kamlesh K. Bajaj, TMH

E-Commerce through ASP by W Clarke- BPB
Bhaskar Bharat : Electronic Commerce - Technologies & Applications.TMH
Krishnamurthy, E-Commerce Mgmt, Vikas
Beginning E-Commerce, Reynolds, SPD
E – Commerce : Strategy Technologies & Applications, Tata McGraw Hill.
Global E-Commerce, J. Christopher & T.H.K. Clerk, University Press
Murthy : E – Commerce , Himalaya Publishing.

Research Methodology:(OEC 802)

OBJCTIVES OF THE COURSE

1. To learn the art of Literature Review and to focus on a research problem using scientific methods.
2. To learn the scientific practices and academic ethics.

COURSE OUTCOMES

On completion of this course, the students would be able:

CO1. To apply analytical thinking and data interpretation capability to solve a research problem.
CO2. To synthesize and communicate research findings to a wide range of audiences.
CO3. To effectively write scientific research proposals and reports.
CO4. To use research related tools.
CO5. To demonstrate a high level of research ethics.

Concepts of Research Design:

Research- Overview, types and basic steps. objectives and variables of a research problem, Literature review Importance and objective of Literature review, locating relevant literature, Writing a survey and identifying the research problem. Research Proposal- Planning and writing a research proposal, Structure and components of research proposal, Methodology for quality research , Report writing and quality publications.

Scientific Research and Statistical Analysis

Scientific Research: Introduction, objective and methods. Modelling-Introduction, types and stages of Model building, Data consideration and testing heuristics. Statistical Analysis:Reasoning, Error Analysis and Accuracy, Descriptive Statistics, Probability, Hypothesis Testing, Regression Analysis, SPSS/R/EViews/MATLAB/Octave. Numerical computation, plotting of functions, implementation of algorithms etc.

Research Tools

Advanced Searching Methods in online repositories/consortium, like in flibnet, Indest, Scopus, etc., Meta search engines and techniques. Tools for Editing, Presentation, Data visualization- Writing Research Paper-Hands-on with LaTeX. Syntax of Research Paper-Hands-on with Grammarly. Referencing Tools- Introduction, Importance and citation, Hands-on with Mendeley or Zotero and Scholarc. Plagiarism-Introduction and Hands-on with Turnitin tool.

Research Writing and Academic Ethics

Report writing and Publishing Research Findings. Structure of a thesis/research article/ review article, including title, introduction, literature review, methods and materials, referencing. Academic Ethics - Introduction, Intellectual Property Rights, Fraud and unscientific practices in science. Plagiarism, Citation counting and Impact factor, Types of Indexing SCI/SCIE/ESCI/SCOPUS/DBLP/Google Scholar/UGC-CARE etc. Significance of conferences and their ranking.

BOOKS:

1. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, New Delhi, 2004.
2. Justin Zobel, Writing for computer Science, Third Edition, Springer, 2014.
3. Kumar R. Research Methodology: A Step by Step Guide for Beginners, 3rd ed., Pearson Education, 2010.
4. Ranjit Kumar, ―Research Methodology: A Step by Step Guide for Beginners‖, 2/e, Pearson India, 2005.
5. Michael P. Marder, Research Methods for Science, Cambridge University Press, 2011.
6. P. Oliver, Writing Your Thesis, New Delhi: Vistaar Publications, 2004.
7. Gregory, Ethics in Research, Continuum, 2005.
8. C. Radhakrishna Rao, Statistics and Truth, CSIR, 1989.
9. Sheldon M Ross, Introduction to Probability and Statistics for Engineers and Scientists, Elsevier, 2010.
10. RA Day, How To Write and Publish a Scientific Paper, Cambridge University Press,London, 1992.
11. B. Latour, Woolgar, Laboratory Life: The Construction of Scientific Facts, 2nd Edition,Princeton: Princeton University Press, 1986.
12. S.K. Yadav, ―Elements of Research Writing‖, UDH Publishers & Distributors, Pvt. Ltd. New Delhi, 2015.
13. Douglas C. Montgomery and George C. Runger, ―Applied Statistics & Probability for Engineers‖, 3rd ed, Wiley India, 2007.

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VLSI Design(OEC 802)

Introduction

VLSI technology, MOS Transistor & Switches, Layout of basic devices- Inverter, NAND, NOR, Compound gates, Multiplexer, Memory-Latches & Register.

Overview of VLSI Design cycle

System specification; Design- Functional, Logic, Circuit, Physical; Fabrication, Design methodologies, Packaging; Design styles- Full custom, Standard cell, Gate arrays FPGA;

Partitioning

Problem formulation, Approximation of hyper graphs with graphs, Kerninghan-Lin & Fiduccia-Mattheyses heuristic algorithm, Ratio cut.

Placement

Cost function, Force directed methods, Partitioning placement, Resistive network, Regular & linear placement.

Floorplanning

Problem formulation, Hierarchical approach, Rectangular dualization, Floorplan sizing.

Routing

Global- Problem formulation; Fundamentals- Maze running, Line searching, Steiner trees; Lee & line probe algorithm, Hierarchical approach, Randomized routing; Detailed- Problem formulation, Channel routing & Switchbox routing, Hierarchical approach, Greedy algorithm; Single layer- General river routing algorithm; Two layer- Left edge algorithm (Basic & Dogleg); Constraint graph- Yoshimura & Kuh algorithm.

Testing

Need for testing- Functionality & Manufacturing test; Manufacturing test principles- Stuck At, short & open circuit, Observability, controllability, Fault coverage; Automatic test pattern generation, Design strategies for test- Scan based, Self test.

Suggested Books:

1. Naved A. Sherwani: "Algorithms ForVLSI Physical Design Automation", Kulwer Academic. 2. M Sarafzadeh&C.K.Wong: "An Introduction to VLSI Physical Design",TMH.
2. Sujata Pandey& Manoj Pandey:"VLSI Design", DhanpatiRai& Co.
3. Bhasker: "A VHDL Primer", P E.Publisher. 5. Douglas L. Pery: "VHDL Programming by Example", TMH.
4. B. Abrhamkhi: "Digital Testing"

Economic Policies in India (OEC 802)

Characteristics of Indian Economy on the eve of independence, Development Strategies in India: Planning in India: Objectives Strategies and Evaluation, 11th five year plan.

Trend and Structure of National Income since 1951, Economic Reforms in India since 1991, Critique of Indian Economic Policies-Pre and Post Reforms

Demographic Features and Indicators of Development, Poverty: Concept, Causes and Government policies, Unemployment in India: Concept, Causes and Government policies, Inflation: Nature and extent 4

Sectoral performance I: Agriculture:

Growth, Productivity Trends and Crop Patterns, Green Revolution, Recent Issues in Indian Agriculture

Growth ,Trends and patterns in Agriculture:

Rural Credit & Marketing, WTO & Agriculture

Industrial Sector in Pre-reform Period, Industrial Sector in Post-reform Period, Issues and Problems of Public Sector

Sectoral performance II:

Role of Infrastructure in economic development, Indian Financial System: Money Market and Monetary Policy, Capital Market in India and Working of SEBI

Sectoral performance III:

Foreign Trade and Balance of Payment, Role of Foreign Capital-FDI and Multinational Corporations

Fiscal Federalism in India, Government Finance :

Union and States, 12th and 13th Finance Commissions

Governance of the Economy:

Implementation of Economic Policies, Parallel Economy, Role of Bureaucracy and Delivery Mechanism in Implementation of Economic Policies, Implementation of Economic Policies: Role of Panchayat and Pressure Groups

Reference Book

1. India's Economic Policy, Bimal Jalan. , Penguin India