CURRICULUM & SYLLABUS

OF

COMPUTER ENGINEERING

DEPARTMENT

Sikkim Institute of Science and Technology

(Affiliated to Sikkim University)

Curriculum

for

Undergraduate Degree Courses in Computer Engineering

(Bachelor of Technology)

Syllabus

[Session 2020 Onwards]

A Central University established by an Act of Parliament of India,2007

Curriculum for Undergraduate Degree Courses in Technology

(B. Tech in Computer Engineering)

Chapter -1

General, Course structure & Theme & Semester-wise credit distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	**1 credit**
1 Hr. Tutorial (T) per week	**1 credit**
1Hr. Practical (P) per week	**0.5 credits**
2Hours Practical (Lab) per week	**1 credit**

B. Range of credits -A range of credits from 150 to 175 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

Criteria to pass a Semester

A student in order to pass a semester must **secure in each paper a minimum of 40% of the total marks in internal examinations and 40% of total marks in the end semester examination.**

With respect to the movement of student in subsequent semesters, as per section **B. h.** of the **Revised regulations on the Conduct of Examinations,** approved by the **Executive Council on 9th June 2017**, "**...a student shall not be detained in any semester even if the student attends less than 75% of the classes held in that particular semester and/or fails in the end semester examination subject to the condition that the student has to clear all papers within the stipulated number of semesters as is fixed by the university, failing which the student would be declared 'failed' and has to restart from the first semester of the course in case still willing to pursue study."**

A student has **12 (twelve) semesters** as the **maximum number** of **permissible semesters** for the Bachelor of Technology Programme, i.e. **04 (four) semesters in addition to the regular 08 (eight) semesters.**

Notation

1. **BTEG: Bachelor of Technology General (Common Across all Disciplines of Engg.)**
2. **BTCO: Bachelor of Technology in Computer Engineering**
3. **UG: Under Graduate**
4. **C: Core Subject**
5. **L: Laboratory Subject**
6. **M: Mandatory Subject**
7. **O: Open Elective**
8. **P: Programme Elective**
9. **I: Internship**
10. **D: Dissertation**

SEMESTER I					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTEG-UG-C101	ENGINEERING MATHEMATICS I	4	3	1	0
BTEG-UG-C102	ELEMENTS OF MECHANICAL ENGINEERING	3	2	1	0
BTEG-UG-C103	COMMUNICATION ENGLISH	3	2	0	0
BTEG-UG-C104	ENGINEERING PHYSICS	3	2	0	0
BTEG-UG-C105	ELEMENTS OF ELECTRICAL ENGINEERING	2	2	0	0
BTEG-UG-L106	ENGINEERING PHYSICS LABORATORY	1.5	0	0	3
BTEG-UG-L107	ELECTRICAL ENGINEERING LABORATORY	1.5	0	0	3
BTEG-UG-L108	WORKSHOP PRACTICES	1.5	0	0	3
BTEG-UG-M109	ENVIRONMENTAL STUDIES	-	3	1	0
		19.5	14	3	9

SEMESTER II					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTEG-UG-C201	ENGINEERING MATHEMATICS II	4	3	1	0
BTEG-UG-C202	ENGINEERING CHEMISTRY	2	2	0	0
BTEG-UG-C203	BASIC ELECTRONICS	2	2	0	0
BTEG-UG-C204	MECHANICS OF SOLIDS	2	2	0	0
BTEG-UG-C205	PROBLEM SOLVING USING COMPUTERS	2	2	0	0
BTEG-UG-C206	UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS	3	2	1	0
BTEG-UG-L207	ENGINEERING CHEMISTRY LABORATORY	1.5	0	0	3
BTEG-UG-L208	PROGRAMMING LABORATORY	1.5	0	0	3
BTEG-UG-L209	ENGINEERING GRAPHICS AND DESIGN	2.5	1	0	4
		21.5	14	2	9

SEMESTER III					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTCO-UG-C301	ENGINEERING MATHEMATICS III	3	2	1	0
BTCO-UG-C302	COMPUTER ORGANIZATION AND ARCHITECTURE	3	2	1	0
BTCO-UG-C303	DATA STRUCTURE	4	3	1	0
BTCO-UG-C304	DIGITAL ELECTRONICS & LOGIC DESIGN	3	2	1	0
BTCO-UG-C305	OBJECT ORIENTED CONCEPTS & PROGRAMMING USING C++	3	2	1	0
BTCO-UG-C306	INTELLECTUAL PROPERTY RIGHTS	3	2	1	0
BTCO-UG-L307	DATA STRUCTURE LABORATORY	1.5	0	0	3
BTCO-UG-L308	DIGITAL ELECTRONICS & LOGIC DESIGN LABORATORY	1.5	0	0	3
BTCO-UG-L309	PROGRAMMING USING C++ LABORATORY	1.5	0	0	3
BTCO-UG-M310	CONSTITUTION OF INDIA/ ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	-	2	0	-
		23.5	15	6	9

SEMESTER IV					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTCO-UG-C401	ENGINEERING MATHEMATICS IV	3	2	1	0
BTCO-UG-C402	DATABASE MANAGEMENT SYSTEMS	3	2	1	0
BTCO-UG-C403	DESIGN AND ANALYSIS OF ALGORITHMS	4	3	1	0
BTCO-UG-C404	MICROPROCESSORS AND PERIPHERAL DEVICES	3	2	1	0
BTCO-UG-C405	OPERATING SYSTEMS	3	2	1	0
BTCO-UG-O406	OPEN ELECTIVE I	3	2	1	0
BTCO-UG-L407	DATABASE MANAGEMENT SYSTEMS LABORATORY	1.5	0	0	3
BTCO-UG-L408	OPERATING SYSTEMS LABORATORY	1.5	0	0	3
BTCO-UG-L409	ALGORITHMS LABORATORY	1.5	0	0	3
		23.5	13	6	9

SEMESTER V					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTCO-UG-C501	COMPUTER NETWORKS	4	3	1	0
BTCO-UG-C502	FORMAL LANGUAGES AND AUTOMATA THEORY	3	2	1	0
BTCO-UG-P503	PROGRAMME ELECTIVE I	3	2	1	0
BTCO-UG-P504	PROGRAMME ELECTIVE II	3	2	1	0
BTCO-UG-C505	PROGRAMMING IN JAVA	3	2	1	0
BTCO-UG-C506	SOFTWARE ENGINEERING	3	2	1	0
BTCO-UG-L507	COMPUTER NETWORKS LABORATORY	1.5	0	0	3
BTCO-UG-L508	PROGRAMMING IN JAVA LABORATORY	1.5	0	0	3
		22	13	6	6

SEMESTER VI					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTCO-UG-C601	COMPILER DESIGN	3	2	1	0
BTCO-UG-C602	PARALLEL COMPUTER ARCHITECTURE AND PROGRAMMING	3	2	1	0
BTCO-UG-P603	PROGRAMME ELECTIVE III	3	2	1	0
BTCO-UG-P604	PROGRAMME ELECTIVE IV	3	2	1	0
BTCO-UG-P605	PROGRAMME ELECTIVE V	3	2	1	0
BTCO-UG-L606	COMPILER DESIGN LABORATORY	1.5	0	0	3
BTCO-UG-L607	PARALLEL PROGRAMMING LABORATORY	1.5	0	0	3
BTCO-UG-I608	INDUSTRIAL TRAINING/ SEMINAR	1	-	-	-
		19	10	5	6

SEMESTER VII					
CODE	SUBJECTS	Credit	Lecture	Tutorial	Practical
BTCO-UG-C701	DISTRIBUTED AND CLOUD COMPUTING	3	2	1	0
BTCO-UG-C702	ESSENTIALS OF MANAGEMENT	3	2	1	0
BTCO-UG-P703	PROGRAMME ELECTIVE VI	3	2	1	0
BTCO-UG-P704	PROGRAMME ELECTIVE VII	3	2	1	0
BTCO-UG-O705	OPEN ELECTIVE II	3	2	1	0
BTCO-UG-L706	INTELLIGENT SYSTEM LABORATORY	1.5	0	0	3
BTCO-UG-L707	INTERNET TECHNOLOGIES LABORATORY	1.5	0	0	3
BTCO-UG-D708	MINI PROJECT	2	0	0	3
		20	10	5	9

SEMESTER VIII					
CODE	**SUBJECTS**	**Credit**	**Lecture**	**Tutorial**	**Practical**
BTCO-UG-D801	**MAJOR PROJECT**	**12**	**-**	**-**	**-**

FORTH SEMESTER OPEN ELECTIVE (BTCO-UG-O406)		
CODE	**SUBJECTS**	**SUBJECTS**
BTCO-UG-O406	**E1:INTERNET TECHNOLOGY**	**E5:COMPUTER GRAPHICS**
	E2:COMPUTER HARDWARE MAINTENANCE	**E6:SOFT SKILLS AND INTERPERSONAL COMMUNICATION**
	E3: PYTHON PROGRAMMING	**E7:COMPUTATIONAL AND QUANTITATIVE BIOLOGY**
	E4: SOCIAL NETWORK ANALYSIS	

FIFTH SEMESTER (BTCO-UG-P503 & BTCO-UG-P504)		
CODE	**SUBJECTS**	**SUBJECTS**
BTCO-UG-P503 BTCO-UG-P504	E1: SYSTEM PROGRAMMING	E9: ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS
	E2: SYSTEM MODELING AND SIMULATION	E10: BIG DATAANALYTICS
	E3: BIOINFORMATICS	E11: GRAPH THEORY AND APPLICATIONS
	E4: DIGITAL IMAGE PROCESSING	E12: UNIX AND SHELL PROGRAMMING
	E5: LOW POWER CIRCUITS AND SYSTEMS	E13: MACHINE LEARNING
	E6: SPEECH AND NATURAL LANGUAGE PROCESSING	E14: ADVANCED WEB TECHNOLOGY
	E7: SIGNALS AND NETWORKS	E15: USER INTERFACE/USER EXPERIENCE (UI/UX) DESIGN
	E8: ADVANCED ALGORITHMS	

SIXTH SEMESTER (BTCO-UG-P603 & BTCO-UG-P604 & BTCO-UG-P605)		
CODE	**SUBJECTS**	**SUBJECTS**
BTCO-UG-P603 BTCO-UG-P604 BTCO-UG-P605	E1: ADVANCED JAVA PROGRAMMING	E13: COMPUTER VISION
	E2: INFORMATION RETRIEVAL	E14: HIGH PERFORMANCE COMPUTING
	E3: INFORMATION THEORY AND CODING	E15: AGILE SOFTWARE DEVELOPMENT
	E4: DATA MINING AND WAREHOUSING	E16: AUGMENTED AND VIRTUAL REALITY
	E5: SOFTWARE TESTING AND QUALITY ASSURANCE	E17:MOBILE ROBOTICS
	E6: REMOTE SENSING	E18: BLOCKCHAIN TECHNOLOGY AND APPLICATIONS
	E7: GEOGRAPHIC INFORMATION SYSTEM	E19: DATA ANALYTICS
	E8: COMPUTATIONAL NUMBER THEORY	E20: HUMAN COMPUTER INTERACTION
	E9: ADVANCED OPERATING SYSTEMS	E21: ADVANCED LINUX PROGRAMMING
	E10: COMPUTATIONAL GEOMETRY	E22: ARTIFICIAL NEURAL NETWORKS
	E11: QUEUING THEORY WITH APPLICATIONS TO COMPUTER SCIENCE	E23: WIRELESS NETWORKS
	E12: REAL TIME SYSTEMS	E24: CRYPTOGRAPHY AND NETWORK SECURITY

SEVENTH SEMESTER (BTCO-UG-P703 & BTCO-UG-P704)		
CODE	**SUBJECTS**	**SUBJECTS**
BTCO-UG-P703 BTCO-UG-P704	E1: SOFT COMPUTING	E9: DEEP LEARNING AND APPLICATIONS
	E2: WIRELESS ADHOC AND SENSOR NETWORKS	E10: CYBER SECURITY
	E3: MOBILE COMPUTINGAND APPLICATION	E11: R PROGRAMMING
	E4: FAULT TOLERANT COMPUTING SYSTEMS	E12: INTERNET OF THINGS
	E5: MULTI-AGENT SYSTEMS	E13: PARALLEL AND DISTRIBUTED DATABASE SYSTEM
	E6: UBIQUITOUS COMPUTING	E14: MULTIMEDIA APPLICATIONS
	E7: PARALLEL AND DISTRIBUTED ALGORITHMS	E15: GAME THEORY WITH ENGINEERING APPLICATIONS
	E8: FUTURE INTERNET ARCHITECTURE	

SEVENTH SEMESTER (BTCO-UG-O705)		
CODE	**SUBJECTS**	**SUBJECTS**
BTCO-UG-O705	**E1: DECISION SUPPORT SYSTEM**	**E6: PRINCIPLE OF PROGRAMMING LANGUAGES**
	E2: EMBEDDED SYSTEMS	**E7: ETHICAL HACKING AND DIGITAL FORENSICS**
	E3: VLSI DESIGN, VERIFICATION AND TEST	**E8: OPERATION RESEARCH**
	E4: HUMAN RESOURCE DEVELOPMENT AND ORGANIZATIONAL BEHAVIOR	**E9: ENGINEERING RESEARCH METHODOLOGY**
	E5: ENTERPRISE RESOURCE PLANNING	**E10: QUANTUM COMPUTING**

LIST OF HONOURS OR ADDITIONAL MINOR ENGINEERING

Minor Specialization

A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs. The institute may decide to offer subjects (from the ones Listed Below), Credited Seminar and Projects for the attainment of the proposed credit across different semesters of the course.
Minor specializations will be offered under following domain:

1. **Graphics And Image Processing**
2. **Intelligent Systems**
3. **Data Science**
4. **Cyber Security**

PROBABLE LIST OF SUBJECTS FOR MINOR SPECIALIZATION

GRAPHICS AND IMAGE PROCESSING	INTELLIGENT SYSTEMS	DATA SCIENCE	CYBER SECURITY
COMPUTER GRAPHICS	ARTIFICIAL INTELLIGENCE	BIG DATA	FUNDAMENTALS OF WEB TECHNOLOGIES
DIGITAL IMAGE PROCESSING	MACHINE LEARNING	DATA ANALYTICS	INFORMATION TRANSMISSION & CODING THEORY
REMOTE SENSING	ARTIFICIAL NEURAL NETWORKS	ARTIFICIAL INTELLIGENCE	ADVANCED WEB TECHNOLOGIES
GEOGRAPHICAL INFORMATION SYSTEM	DEEP LEARNING	MACHINE LEARNING	ADVANCED JAVA PROGRAMMING
COMPUTER VISION	SOFT COMPUTING	DATA WAREHOUSING & DATA MINING	AD-HOC WIRELESS NETWORKS
AUGMENTED REALITY	¤ PYTHON PROGRAMMING	SOCIAL NETWORK ANALYSIS	CLOUD COMPUTING
HUMAN COMPUTER INTERACTION	MULTI-AGENT INTELLIGENT SYSTEMS	SPEECH & NATURAL LANGUAGE PROCESSING	SOCIAL NETWORK ANALYSIS
	ADVANCED ALGORITHMS	ARTIFICIAL NEURAL NETWORKS	CRYPTOGRAPHY & NETWORK SECURITY
	SPEECH & NATURAL LANGUAGE PROCESSING	DEEP LEARNING	MOBILE COMPUTING
	SOCIAL NETWORK ANALYSIS	DATA ANALYTICS	CYBER SECURITY
		R PROGRAMMING	BIG DATA
		PYTHON PROGRAMMING	DATA WAREHOUSING & DATA MINING
			ETHICAL HACKING
			BLOCK CHAIN CODING
			DISTRIBUTED SYSTEMS
			INTELLECTUAL PROPERTY RIGHTS
			ARTIFICIAL INTELLIGENCE
			INFORMATION RETRIEVAL

Semester I

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTEG-UG-C101	ENGINEERING MATHEMATICS I	4	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C102	ELEMENTS OF MECHANICAL ENGINEERING	3	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C103	COMMUNICATION ENGLISH	3	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C104	ENGINEERING PHYSICS	3	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C105	ELEMENTS OF ELECTRICAL ENGINEERING	2	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-L106	ENGINEERING PHYSICS LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTEG-UG-L107	ELECTRICAL ENGINEERINGLABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTEG-UG-L108	WORKSHOP PRACTICES	1.5	50	-	-	-	50	50	2 hrs	100
BTEG-UG-M109	ENVIRONMENTAL STUDIES	-	-	25	25	1 hrs	50	50	2 hrs	100

Semester II

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTEG-UG-C201	ENGINEERING MATHEMATICS II	4	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C202	ENGINEERING CHEMISTRY	2	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C203	BASIC ELECTRONICS	2	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C204	MECHANICS OF SOLIDS	3	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C205	PROBLEM SOLVING USING COMPUTERS	2	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-C206	UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS	3	-	25	25	1 hrs	50	50	2 hrs	100
BTEG-UG-L207	ENGINEERING CHEMISTRY LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTEG-UG-L208	PROGRAMMING LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTEG-UG-L209	ENGINEERING GRAPHICS AND DESIGN	2.5	35	-	15	1 hrs	50	50	2 hrs	100

Semester III

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTCO-UG-C301	ENGINEERING MATHEMATICS III	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C302	COMPUTER ORGANIZATION AND ARCHITECTURE	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C303	DATA STRUCTURE	4	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C304	DIGITAL ELECTRONICS & LOGIC DESIGN	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C305	OBJECT ORIENTED CONCEPTS & PROGRAMMING USING C++	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C306	INTELLECTUAL PROPERTY RIGHTS	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-L307	DATA STRUCTURE LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L308	DIGITAL ELECTRONICS & LOGIC DESIGN LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L309	PROGRAMMING USING C++ LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-M310	CONSTITUTION OF INDIA/ ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	-	-	25	25	1 hrs	50	50	2 hrs	100

Semester IV

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTCO-UG-C401	ENGINEERING MATHEMATICS IV	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C402	DATABASE MANAGEMENT SYSTEMS	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C403	DESIGN AND ANALYSIS OF ALGORITHMS	4	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C404	MICROPROCESSORS AND PERIPHERAL DEVICES	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C405	OPERATING SYSTEMS	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-O406	OPEN ELECTIVE I	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-L407	DATABASE MANAGEMENT SYSTEMS LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L408	OPERATING SYSTEMS LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L409	ALGORITHMS LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100

Semester V

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTCO-UG-C501	COMPUTER NETWORKS	4	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C502	FORMAL LANGUAGES AND AUTOMATA THEORY	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P503	PROGRAMME ELECTIVE I	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P504	PROGRAMME ELECTIVE II	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C505	PROGRAMMING IN JAVA	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C506	SOFTWARE ENGINEERING	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-L507	COMPUTER NETWORKS LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L508	PROGRAMMING IN JAVA LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100

Semester VI

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTCO-UG-C601	COMPILER DESIGN	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C602	PARALLEL COMPUTER ARCHITECTURE AND PROGRAMMING	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P603	PROGRAMME ELECTIVE III	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P604	PROGRAMME ELECTIVE IV	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P605	PROGRAMME ELECTIVE V	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-L606	COMPILER DESIGN LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L607	PARALLEL PROGRAMMING LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-I608	INDUSTRIAL TRAINING/ SEMINAR	1	50	-	-	-	50	50	2 hrs	100

Semester VII

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTCO-UG-C701	DISTRIBUTED AND CLOUD COMPUTING	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-C702	ESSENTIALS OF MANAGEMENT	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P703	PROGRAMME ELECTIVE VI	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-P704	PROGRAMME ELECTIVE VII	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-O705	OPEN ELECTIVE II	3	-	25	25	1 hrs	50	50	2 hrs	100
BTCO-UG-L706	INTELLIGENT SYSTEM LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-L707	INTERNET TECHNOLOGIES LABORATORY	1.5	50	-	-	-	50	50	2 hrs	100
BTCO-UG-D708	MINI PROJECT	2	-	-	-	-	50	50	-	100

Semester VIII

Course Code	Name of the Course	Credits	Internal Assessment					End Semester Examination		Total Marks
			Continuous mode	Sessional Exam		Duration	Total	Marks	Duration	
				S1	S2					
BTCO-UG-D801	MAJOR PROJECT	12	-	-	-	-	50	-	-	50

BTEG-UG-C101: ENGINEERING MATHEMATICS I (3L 1T 0P)

(Calculus)

Course Objective: This paper contains Differential calculus, Integral Calculus, Analytical Solid geometry and Infinite Series. The objective of teaching this paper is to give idea on these topics which will help the students in studying and understanding the mathematical as well as engineering subjects.

Course Outcome: On successful completion of course, the students will be able to:

1. Understand the basics of Differential calculus, Integral Calculus,
2. Understand the basics of Analytical Solid geometry and Infinite Series.

UNIT I **10 hrs**	**Differential Calculus:** Successive differentiation, Leibnitz's theorem, Polar curves, Angle of intersection of two curves, Derivatives of arcs (Cartesian and polar), Asymptotes, Curvature, Radius of curvature, Multiple points, Points of inflection, Concavity, Convexity.
UNIT-II **10 hrs**	Rolle's theorem, Mean value theorems, Expansion of functions in Taylor's and Maclaurin's series, Indeterminate forms. Partial differentiation, Euler's theorem, Total differential, Errors and approximation, Differentiation of composite and implicit functions. Tracing of standard curves.
UNIT- III **20 hrs**	**Integral calculus:** Reduction formulae for standard integrals. Length, Area and Volume of revolution involving simple curves. **Infinite series:** Convergence, Divergence, Comparison test, Ratio test, Cauchy's root test, Cauchy's integral test, Alternating series, Leibnitz's test, absolute and conditional convergence.
UNIT-IV **20 hrs**	**Analytical solid geometry:** Direction Cosines, Planes, Straight lines, Spheres, Right circular cone and Right circular cylinder.

Text books :

1. Shanti Narayan: Differential Calculus, S Chand & Company
2. Shanti Narayan: Integral Calculus, S Chand & Company
3. Erwin Kreyszig: Advanced Engineering Mathematics , Wiley
4. R.K. Jain & S R K Iyengar, Advanced Engineering Mathematics V Ed, Narosa

Reference Books:

1.G.B. Thomas, Jr. and R. L. Finney: Calculus and Analytical Geometry
2. B S Grewal, Engineering Mathematics, Khanna Publisher
3. R G Bertle and D R Sherbert, Introduction to Real Analysis, Willey
4. Das and Mukherjee: Differential Calculus, U N Dhur & Company
5. Das and Mukherjee: Integral Calculus, U N Dhur & Company

BTEG-UG-C102: ELEMENTS OF MECHANICAL ENGINEERING (2L 1T 0P)

Course Objective: The objective of this course is to inculcate the basic concepts and principles of mechanical engineering subjects such as thermodynamics, fluid mechanics, I.C Engines, power transmission, welding and machine tools.

Course Outcome: On successful completion of course, the students will be able to:

1. Understand the basic concept of Thermodynamics and its application in the field of energy technology.
2. Have idea of different IC engines, working of 2 stroke & 4 stroke petrol and diesel engines.
3. Able to understand application and working of Belt drives, chain drives. Gear drives and Gear trains (Simple & Compound Gear trains).
4. Understand the behavior of Fluid Flow.
5. Know about the various machine tools and machining process.

UNIT-I **5 hrs**	**Thermodynamics:** Introduction, systems and surroundings, property, state and process; reversible and irreversible process, cyclic process; heat, work and energy. First law of thermodynamics: energy equations for non-flow and steady flow processes, limitations of first law. Second law of thermodynamics: statements, equivalence of second law. **Properties of gases:** Introduction, characteristic equation for gases, specific heats of gases and their relation with gas constant.
UNIT- II **10 hrs**	**Thermodynamic processes:** Relationship between P, V, T, expressions for work done, heat transferred and change in internal energy and enthalpy for - constant volume process, constant pressure process, constant temperature process, isentropic process, and polytropic process – simple calculations. **Internal Combustion Engines:** Introduction, classification, Otto and Diesel cycles (no derivation), expression of efficiency, spark ignition and compression Ignition engines, working principles of 4-stroke and 2-stroke cycle engines.
UNIT- III **15 hrs**	**Fluid Mechanics:** Introduction- definition of fluid, fluid properties (Density, Sp. weight, Sp. volume, Sp. gravity), Viscosity- dynamic and kinematic, Newton's law of viscosity, different types of fluid. Definitions of compressible and incompressible fluid. Fluid statics- Statement of Pascal's law, Hydrostatic law (no derivations)**.** **Fluid Kinematics:** Continuity equation in a pipe of varying cross-section from the conservation of mass. **Fluid Dynamics**: Introduction-equation of motion, Statement and explanation of Bernoulli's equation for compressible flow (no derivation). **Transmission of Motion and Power:** Introduction, modes of transmission; belt drive – types of belts used, open and crossed belt drive, velocity ratio – slip in belt drive, simple calculations; Gear drive – types of gears, spur gear nomenclature, simple and compound gear trains – simple calculations.

UNIT- IV **15 hrs**	**Welding:** Introduction, classification, welding rods and fluxes, principles of gas, resistance and electric arc welding processes (no other specific welding process). **Metal Cutting and Machine Tools:** Introduction, definition of machine tools, cutting sped, feed and depth of cut. **Lathe:** Classification, description and function of lathe parts (details of function not necessary), list of operations performed on a lathe. **Drilling Machine:** Classification, operations on drilling machine.

Text books:

1. Elements of Mechanical Engineering: Roy, Hazra Choudhury & Hazra Choudhury-; Media Promoters and Publishers Pvt. Ltd.
2. Elements of Mechanical Engineering: Mathur & Domkundwar - Dhanpat Rai & Co.

Reference books:

1. Elements of Workshop Technology vol. II: Hazra Choudhury & Hazra Choudhury: Media Promoters and Publishers Pvt. Ltd.
2. Basic Mechanical Engineering: Gupta: Dhanpat Rai & Co.
3. Mechanical Engineering Science: Gopalakrishna: Subhash Publications.
4. A Text Book of Fluid Mechanics and Hydraulic Machine: R. K. Bansal: Laxmi Publications.
5. Thermodynamics: P.K.Nag: Tata McGraw-Hill.

BTEG-UG-C103: COMMUNICATION ENGLISH (2L 1T 0P)

Course Objective: To make them aware about the need of communication skills in the contemporary world by honing their speaking reading and writing skills. To make them industry ready by honing their personality and body language.

Course Outcome: On successful completion of course, the students will be able to:

i. To help the students to hone their oral as well as written communication skills so as to make them job and industry ready.

UNIT-I **5 hrs**	Tense and Concord Basic Transformations: Positive and Negative Sentences Simple, Complex and Compound Sentences Change of Voice
UNIT- II **15 hrs**	Change of Narration Question Tag and Short Responses Preposition and Determiners Some Common Errors in English
UNIT- III **15 hrs**	Reading Comprehension and Writing Skill Reading Comprehension (Practice of Unseen Passages) Essay on Literal, Cultural and Legal Topics Formal and Informal Correspondence
UNIT- IV **10 hrs**	Précis Writing Report Writing: Status and Policy Reports Writing Proposals

Text books:

1. Bolton, David and Noel Goodey (2005) English Grammar in Steps. Orient Blackswan; New Delhi.
2. Eastwood, John. (1999) Oxford Practice Grammar.Oxford University Press; New Delhi.
3. Hewings, Martin. (2007) Advanced Grammar in Use. Cambridge University Press; New Delhi.
4. Murphy, Raymond. (2000) Essential Grammar in Use. Cambridge University Press; New Delhi.
5. Quirk, Randolph and Greenbaum, (1985) A University Grammar of English. Essex; ELBS. Longman.

Reference books:

1. Swan, Michael and Walter, Catherine. (2006) The Good English Grammar Book.Oxford University Press; New Delhi.
2. Swan, Michael. (1997) Basic English Usage.Oxford University Press; Kolkata.
3. Ashley, A. (1995) The Oxford Handbook of Commercial Correspondence. Oxford University Press;
4. New Delhi.
5. Folens, (1991) Core Skills in English: Grammar Comprehension, Creative Writing. Folens Limited.
6. Seely, John. (1998) The Oxford Guide to Writing and Speaking.Oxford University Press; New
7. Delhi.

BTEG-UG-C104: ENGINEERING PHYSICS (2L 1T 0P)

Course Objective:

1. The course focuses at developing the basic background in physics that will be required by an engineering student to pursue his B.Tech. course. The fundamental concepts and applications of the laws of physics through real life applications are embodied in the course.
2. The course start with a brief discussion on oscillation and then gives thorough idea about damped and forced oscillation, mechanical waves and wave optics required in different branches of engineering.
3. An introduction to the quantum mechanics is given so that the students can understand its application in their advanced courses in higher semesters.
4. The physics of band theory of solid is introduced which forms the backbone of electronics.
5. Overall the course aims for use of an integrated system where mathematical and scientific skills such as measuring, predicting, formulating explanations, drawing conclusions, and solving problems that are used in technology and its development. Scientific information will be made with real life examples and laboratory experiments where possible.

Course Outcome: On successful completion of course, the students will be able to:

1. Understand the oscillation and waves in perspective of engineering application.
2. Learn the phenomenon of interference and diffraction of light waves and signal propagation through optical fibers.
3. Learn the fundamentals and importance of Quantum Mechanics.
4. Concept of free electron theory, band theory of solid and semiconductor.

UNIT-I **5 hrs**	**Oscillations:** Overview of vibrations with emphasis on damped and forced oscillators, resonance. **Wave:** Overview on waves, wave equation, plane waves, phase velocity, superposition, group velocity.
UNIT- II **15 hrs**	**Optics:** Interference of light waves, Young's experiment, Thin film interference and its applications, Diffraction of light – Fresnel and Fraunhofer class, Fraunhofer diffraction for single slit (derivation). Diffraction at multiple slits (qualitative discussion). **Fiber optics:** Principle and propagation of light in optical fibers, Numerical aperture and Acceptance angle, Qualitative discussions of attenuation in optical fiber.
UNIT- III **15 hrs**	**Development of Quantum Mechanics:** Inadequacy of classical mechanics, Black body radiation, Planck's radiation law, Planck's quantum hypothesis, Photoelectric effect, Wave particle duality, de Broglie waves, Matter waves, Davisson-Germer experiment, Group velocity and phase velocity. **Applications of Quantum Mechanics:** Wave packets and Heisenberg's uncertainty principle, wave function and its physical significance, Schrodinger's equation, Schrodinger's 1-D time independent equations, Potential well.

UNIT- IV **10 hrs**	**Band Theory of Solids:** Concept of free electron theory, quantum theory of free electrons, Fermi energy, Effect of temperature in Fermi-Dirac distribution, Concept of energy levels and bands, Distinction between Insulator, Semi-conductors and Conductors in terms of energy band, p-n junction.

Text books:

1. Physics by Resnick, Halliday and Krane, Vol 1&2; 5th Edn, John Wiley and Sons Inc.
2. Optics by N. Subrahmanyam, and Brij Lal., S. Chand and Company, New Delhi.
3. Physics for Scientists and Engineers with Modern Physics, by Serway and Jewatt, Volume 2; 6th Edn., Thomson
4. Concept of Modern Physics by Arthur Beiser, 6th Edn., Tata Mc Graw Hill.

Reference books:

1. Berkley Physics Course by Kittel, Knight, Ruderman, Helmholz and Moyer , Vol. 1 ; Tata Mc Graw Hill.
2. Berkley Physics Course by Crawford, Vol 3; Tata Mc Graw Hill.
3. Berkley Physics Course by Wichmann, Vol 4; Tata Mc Graw Hill.
4. Engineering Physics, by H. K. Malik and A. K. Singh, 1st Edn., Tata Mc Graw Hill.
5. Engineering Physics, by Dattu R Joshi, 1st Edn., Tata McGraw Hill.

BTEG-UG-C105: ELEMENTS OF ELECTRICAL ENGINEERING (2L 0T 0P)

Course Objective: This course focuses on DC Circuits, Magnetic Circuits, Single-Phase and Three-Phase AC Circuits, Transformer and Three-phase Induction Motors. To impart basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand its impact on the technologies associated with it. The course also introduces fundamental concepts and analysis techniques in electrical engineering to students across all disciplines. Basic and most frequently used electrical machines and its applications are also introduced.

Course Outcome: On successful completion of course, the students will be able to:

1. Demonstrate an understanding to the magnetic circuits, electrical DC and AC circuits and terminologies associated with it.
2. Demonstrate an ability to solve and analyze magnetic circuits, electrical DC and AC circuits.
3. Apply the basic concepts in electrical engineering for multi-disciplinary tasks.
4. Identify the construction parts of transformer, three-phase induction motors.

UNIT-I **5 hrs**	**DC CIRCUITS:** Review of fundamental terminologies related to dc circuits, mesh current and node voltage analysis of DC circuits, star-delta and delta-star transformation. **MAGNETIC CIRCUITS**: Review of fundamental terminologies related to magnetic circuits, analogy with electric circuits, analysis of magnetic circuits, self and mutual inductances.
UNIT- II **10 hrs**	**SINGLE PHASE AC CIRCUITS**: Review of fundamental terminologies related to single-phase AC circuits. representation of sinusoidal voltages and currents, rms value and average value, j-operator, phasors, voltages and currents relationship and instantaneous and average power in a pure resistor, pure inductor and pure capacitor, impedance, admittance, analysis of circuits, power, power factor.
UNIT- III **15 hrs**	**THREE PHASE AC CIRCUITS:** Review of fundamental terminologies related to three-phase AC circuits, Symmetrical sinusoidal supply systems, voltage, current and power relationship in 3-phase balanced star and delta connected loads, Analysis of three phase balanced star and delta connected loads.
UNIT- IV **15 hrs**	**TRANSFORMERS:** Construction, principle of operation, emf equation, transformer on no-load and on-load, phasor diagrams on no-load and on-load. **THREE PHASE INDUCTION MOTOR:** Construction, principle of operation, revolving field, slip, rotor induced emf, rotor frequency, rotor reactance, expression of torque developed from rotor input and torque-slip characteristic.

Text books:

1. Fundamentals of Electric Circuits by Charles K Alexander and Matthew N. O. Sadiku, TMH Publication, 5th Edition, 2013.
2. Basic Electrical Engineering by Abhijit Chakrabarti, Sudipta Nath, and Chandan Chanda, TMH Publication, 2013.
3. Electrical Machinery by P.S. Bimbhra, Khanna Publishers, 7th Edition.

Reference books:

1. Electrical Engineering Fundamentals by Vincent Del Toro, PHI Publication, Second Edition.

2. Electrical Technology by H Cotton, CBS Publishers and Distributors,7th Edition, 2005.

BTEG-UG-L106: ENGINEERING PHYSICS LABORATORY (0L 0T 3P)

Course Objective:

1. Verify the laws of physics as discussed in theory.
2. Develop idea for modeling and construction of experimental setups.
3. Interpret the observations by graphical and analytical means.
4. Draw logical conclusions from the observations and calculations and present it.
5. Understand the sources of error in conduction of experiments and minimization of errors.

Course Outcome: On successful completion of course, the students will be able to:

1. Experimental verification of resonance, inertia, damping effect and find the spring constant in oscillatory bodies.
2. Experimental verification wave optics phenomena of interference and diffraction.
3. Experimental verification of Quantum nature of light using photoelectric effect.
4. Experimental verification of the basic properties of semiconductor and its application.

LIST OF EXPERIMENTS: (Minimum of any 12 experiments)

1. To draw (A) Normal distribution error curve, and (B) to compute arithmetic mean; standard deviation and probable error of the measured lengths of the side of a rectangular metallic block.
2. To determine the force constant of a spring and to investigate resonance in forced oscillations.
3. To determine the damping constant of an under damped oscillatory motion and plot the graph between amplitude versus frequency to get the resonance frequency.
4. Determine the moment of inertia of a body by means of a torsion pendulum.
5. To find the velocity of sound in the given liquid using Ultrasonic Interferometer
6. To determine the Planck's constant and to verify the inverse square law of radiation.
7. To determine the radius of curvature of the given Plano-convex lens by Newton's Ring method.
8. To determine (a) the grating element, number of lines per unit length (1cm/1inch) in the given grating by normal incidence method and (b) the wavelength of the lines in the mercury spectrum.
9. To determine the diameter of the given thin wire using an air wedge.
10. To determine (a) the slit width of a single slit and the wavelength of an unknown light source using diffraction of light.
11. To draw the I-V characteristic curve of a semiconductor diode (Ge and Si) and determine its knee voltage, and forward dynamic resistance.
12. To draw the I-V characteristic curve of a zener diode and determine its break down voltage, forward knee voltage, and zener resistance.
13. To determine Hall-coefficient of the given semiconductor and its charge carrier density.
14. To determine the ripple factor of a half-wave and a full-wave rectifier with and without filter.
15. To determine the forbidden energy gap of a semiconductor.

Text Books:

1. A Textbook of Practical Physics by Indu Prakash, Ram Krishna, A. K. Jha, Kitab Mahal, (2012).
2. Engineering Physics Practical by S K Gupta Krishna Prakashan Media P. Ltd.-Meerut (2015).

Reference Books:

1. Advanced Practical Physics for Students by B.L. Worsnop (Author), H.T. Flint Littlehampton Book Services Ltd; 9th Revised edition Edition.

BTEG-UG-L107: ELECTRICAL ENGINEERING LABORATORY (0L 0T 3P)

Course Objective: This course on Electrical Engineering Laboratory mainly focuses on providing the students with the hands-on experiences with working on and verifying the concepts and laws associated with DC Circuits and AC Circuits. Students are also exposed to the measurement of electrical parameters like resistance inductance, power etc. Exposure to the construction, working, analysis and tests on electrical machines like transformers and three-phase induction motors.

Course Outcome: On successful completion of course, the students will be able to:

1. Demonstrate practical understanding to the laws, responses and theorem associated with electrical DC and AC circuits.
2. Demonstrate an ability to make measurements with various electrical parameters like, resistances, inductances, power etc.
3. Ability to put electrical machines to drive the loads, perform tests on it to determine its parameters, load performances etc.

List of Experiments

1. Verification of Kirchhoff's Current and Voltage Laws.
2. Resonance in series R-L-C circuit.
3. Transient Response of RLC Series circuit using DC excitation.
4. Measurement of resistance and inductance of a coil.
5. Verification of network theorems -Thevenin's theorems with resistive elements DC supply.
6. Verification of network theorems - Norton's theorems with resistive elements DC supply.
7. Verification of network theorems - Superposition theorems with resistive elements DC supply.
8. Measurement of three-phase power using two wattmeter method.
9. Open and short circuit test on single-phase transformer to determine its equivalent circuit parameters, efficiency and voltage regulation.
10. Load test on squirrel cage rotor three-phase induction motors.

BTEG-UG-C108: WORKSHOP PRACTICES (0L 0T 3P)

Course Objective: To familiarize with the basic manufacturing processes and to study the various tools and equipment used, hands-on training is given in different sections. Essentially student should

1. Prepare basic joints used in carpentry
2. Prepare edges for better joint for fitting
3. Prepare basic joints in plumbing
4. Prepare various shapes and objects by using sheet metals and soldering process.

Course Outcome: On successful completion of course, the students will be able to:

1. The student will be able to use different tools (Carpentry, Fitting, sheet metal working, Plumbing, Soldering) processes required to manufacture a product from the raw materials.
2. They will be able to use different measuring, marking, cutting tools used in workshop.
3. They will be aware of the safety precautions while working in workshop.

List of Experiments

- **Carpentry:** Use of carpentry tools, preparation of joints involving the following operations: plaining, chipping, tenoning and mortising. Minimum two models to be prepared; Demonstration of wood working machines
- **Plumbing:** Use of plumber's tools, various pipe fittings, exercises in thread cutting on pipes.
- **Fitting:** Use of fitter's tools; Exercises involving the following operations: measuring and marking, chipping, filing, drilling, tapping, and external threading. Minimum two models to be prepared.
- **Soldering:** Use of soldering tools, exercises involving sheet metal joints and electrical circuits/ cable joints.

Text books:

1. Elements of Workshop Technology vol. I & II: Hazra Choudhury & Hazra Choudhury: Media Promoters and Publishers Pvt. Ltd.

BTEG-UG-M109: ENVIRONMENTAL STUDIES	**(3L 1T 0P)**
Course Objective: The course exposes students to various types of environmental problems, their mitigation and prevention. It aims to generate awareness and active participation in environment related issues in workplace and society.	
Course Outcome: On successful completion of course, the students will be able to: 1. The students will be able to relate the various features of environment and their impact on the life. 2. The students will understand the gravity of pollution problem and should be able to devise methods to mitigate the problem 3. Students will able to solve numerical problem related with BOD, COD and other aspects of environment.	
UNIT-I **15 hrs**	**Environment and Ecosystem:** Introduction, Importanceand Scope of Environmental Studies Components of Environment; Atmosphere, Hydrosphere, Lithosphere and Biosphere Ecosystems: Concept, Structure and Function of an Ecosystem; Energy Flow, Food Chains, Food Webs Ecological Pyramids, Ecological Niche and Keystone Species.
UNIT-II **15 hrs**	**Resources and Conservation** Introduction and Classification of Resources Problems Associated with Resources and Conservation; Forest resources, Water Resources, Energy Resources, Land Resources Biodiversity: Introduction, Issues and Conservation
UNIT-III **15 hrs**	**Environmental Pollution and Issues** Introduction to Environmental Pollution Causes, Effects and Control Measures of: Air Pollution, Water Pollution, Soil Pollution, Noise Pollution, Nuclear Pollution Environmental Issues; Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion etc. Firecracker and Associated Issues
UNIT-IV **15 hrs**	**Human and Environment** Human-Environment Relationship, Sustainable Development: Concept and Issues Role of Information Technology in Environmental Management Solid Waste Management Environmental Refugees Environmental Ethics: Issues and possible solutions
Text books:	

1. Fundamentals of Ecology - Eugene P. Odum & Garry W. Barrett
2. Environmental Chemistry - A.K. De
3. Environmental Science & Engineering – J. Glynn. Henry & Gary W. Heinke

Reference Books:

1. Renewable Energy – Power for a sustainable future – Godfrey Boyle

BTEG-UG-C201: ENGINEERING MATHEMATICS II (3L 1T 0P)

Course Objective: This paper covers Ordinary differential equation, Laplace transform, linear algebra and calculus. Differential Equation is a tool which is used for modelling of real life problems mathematically. Laplace transforms help in solving complex problem with a very simple approach. Ordinary differential equation, Laplace transform has tremendous applications in electrical engineering; Linear algebra has applications in computer sciences. Linear algebra has applications is different subjects such as Graph theory, Cryptography, Genetics, Economics, Networks etc. Calculus II is prerequisite for many mathematical and engineering subjects.

Course Outcome: On successful completion of course, the students will be able to:

1. Understand the basics of Differential calculus, Integral Calculus,
2. Understand the basics of Analytical Solid geometry and Infinite Series.

UNIT I **20 hrs**	**Ordinary Differential Equations (ODE):** Formation of ODE, order, degree and solutions of ODE. Homogeneous and non-homogeneous equations, exact equations, Linear equations, Bernoulli's equations. Linear equations with constant coefficients, Non homogeneous equations, Method of variation of parameters, Cauchy's homogeneous linear equations, simultaneous equations. Applications Engineering problems.
UNIT-II **12 hrs**	**Laplace Transforms**: Transforms of elementary functions, Transforms of derivatives, Inverse transforms, Unit step function, Shifting theorems, Applications to engineering problems.
UNIT- III **16 hrs**	**Linear Algebra:** Vector spaces and subspaces, Simple examples. Linear dependence and independence; Basis, Dimension, Matrices, Elementary transformations, Inverse, Rank, Consistency of system of linear equations, Consistency, Solution by Gauss elimination method.
UNIT-IV **12 hrs**	**Multivariate Calculus:** Taylor's theorem, Extreme values, Lagrange's method of undetermined multipliers. Multiple integrals: Change of order of integration, Change of variables. Jacobians. Area and volume. Beta and Gamma functions.

Text books :

1. Shanti Narayan: Differential Calculus, S Chand & Company
2. Shanti Narayan: Integral Calculus, S Chand & Company
3. Erwin Kreyszig: Advanced Engineering Mathematics, Wiley
4. R.K. Jain & S R K Iyengar, Advanced Engineering Mathematics V Ed, Narosa

Reference Books:

1. E.D. Rainville and P. E. Bedient: A short course in differential equation.
2. B S Grewal, Engineering Mathematics, Khanna Publisher
3. R G Bertle and D R Sherbert, Introduction to Real Analysis, Willey
4. Das and Mukherjee: Differential Calculus, U N Dhur & Company
5. Das and Mukherjee: Integral Calculus, U N Dhur & Company

BTEG-UG-C202: ENGINEERING CHEMISTRY (2L 0T 0P)

Course Objective: The course will introduce students to concepts of chemistry and its application in various types of industries.

Course Outcome: On successful completion of course, the students will be able to:

1. Understand concepts of electrochemistry and its application in electrochemical devices.
2. Understand the fundamentals of corrosion and how to mitigate the problem.
3. Understand the basics of fuel chemistry and provide solutions for various associated problems.
4. Understand the importance of liquid crystal chemistry in designing display panels.

UNIT-I **6 hrs**	Electrochemical changes - half reactions, origin of electrode potential, measurement of electrode potential, Nernst equation and its applications, electrochemical series & its applications, electrochemical cell and its classifications (galvanic cell, electrolytic cell), electromotive force, standard cell. Overview on Primary and secondary cell: The lead-acid storage cell, lithium-ion battery. Fuel Cell: H_2–O_2 fuel cell
UNIT- II **8 hrs**	Corrosion and its control: Corrosion – cause of corrosion, types and mechanism of corrosion - dry corrosion, Pilling Bedworth rule, electrochemical or wet corrosion (mechanism via Hydrogen evolution & Oxygen absorption), types of electrochemical corrosion (galvanic corrosion, concentration cell corrosion, water line corrosion, stress corrosion - caustic embrittlement, passivity, galvanic series, factors influencing corrosion, corrosion control-corrosion inhibitors, cathodic protection - sacrificial anodic and impressed current cathodic protection.
UNIT- III **8 hr**	Fuels: Introduction – Classification, Calorific value, Numerical problems,Liquid fuels, Petroleum- Refining, Cracking, Synthetic petrol,Petrol knocking, Diesel knocking, Octane and Cetane ratings, Anti-knock agents, Power alcohol, Bio-diesel, Gaseous fuels, Natural gas, LPG and CNG,Combustion, Calculation of air for the combustion of a fuel, Flue gas analysis, Orsat apparatus, Numerical problems on combustion. Explosives:- Rocket fuels.
UNIT- IV **8 hrs**	Chemistry of Materials Liquid crystals: Introduction, classification of liquid crystals-thermotropic & lyotropic liquid crystal, different phases of thermotropic & lyotropic liquid crystal, chemical constitution and liquid crystalline behaviour, liquid crystalline behavior in homologous series, molecular ordering in different meso phases, applications of liquid Crystals in displays (LCD), OLED.

Text books:

1. A Text book of Engineering Chemistry - Shashi Chawla

2. A Text book of Engineering Chemistry - P.C. Jain & Monika Jain

3. Engineering Chemistry - O G Palanna

Reference books:

1. Chemistry of Engineering Materials - C.V. Aggrawal

2. An Introduction to Electrochemistry - Samuel. Glasston

BTEG-UG-C203: BASIC ELECTRONICS (2L 0T 0P)

Course Objective: This course focuses on

1. To introduce analog and digital electronics and their applications.
2. To introduce the communication systems and its applications.

Course Outcome: On successful completion of course, the students will be able to:

1. Explain the working of diode and transistor and their applications.
2. Understand the basic digital circuits.
3. Understand the basic communication systems and its applications in modern era.

UNIT I **8 hrs**	**Analog Electronics-I:**. Working of PN Junction diode, V-I characteristics- Forward bias and reverse bias, Diode circuits-Half wave and Full wave rectifiers, Zener diode as voltage regulator, Special purpose diodes- LED, Photo detector. **Applications**- LED bulb, OLED Display, AMOLED Display.
UNIT-II **8 hrs**	**Analog Electronics-II:** Working of PNP and NPN transistors (BJT), CE, CB, CC mode configurations and Input/output characteristic curves, Types of transistor biasing, Introduction to FET. **Applications:** single stage RC coupled amplifier, transistor as a switch.
UNIT- III **8 hrs**	**Digital Electronics:** Number systems, Basic logic gates, Universal Logic gates, Boolean algebra, Implementation of Boolean functions using logic gates, MUX-DeMUX, encoder-decoder, **Applications:** RAM, ROM, Flash memory.
UNIT-IV **6 hrs**	**Communication Engineering:** Block diagram of basic communication system, Introduction to wireless communication- 1G, 2G, 3G, 4G, 5G. **Applications:** Internet of Things (IoT).

Text books :

I. Robert L. Boylestad and Louis Nashelsky: Electronic Devices and Circuit Theory, *Pearson*.2013

2. Albert Malvino and David Bates: Electronic Principles, McGraw Hill. 2016

3. Simon Haykin : Communication Systems, Willey.

Reference Books:

1. RMD Sundaram Shriram K Vasudevan, Abhishek S Nagarajan.: Internet of Things, Willey

2. M. Morris Mano and M.D. Ciletti: Digital Design, *Pearson*

BTEG-UG-C204: MECHANICS OF SOLIDS (2L 0T 0P)

Course Objective: This course focuses on

Course Objectives:

1. The main aim of the course is to teach basic mechanics of solid bodies and their responses.
2. To teach the student problem solving problems related to different force parameters, inertia and energy.
3. To introduce the student about the shape and geometry of the body and concept of moment of inertia and its applications.

Course Outcome: On successful completion of course, the students will be able to:

1. Solve moderately difficult problem on Force systems.
2. Have clear ideas of stress strains.
3. Can find out the CG and MI of any simple or composite body.
4. Have a firm idea on the inertia of a body and can solve energy related problems.

UNIT I **8 hrs**	**Coplanar Concurrent and non-concurrent Force System:** Importance of Mechanics in engineering; Types of forces, Resultant of a force system, graphical principles- parallelogram law, triangle law, polygon rule, analytical method, conditions of equilibrium, Concept of free body diagrams, Lami's theorem. Moment of a force, Varignon's theorem, couple, properties of couples, resultant of non-concurrent force system, conditions of equilibrium
UNIT-II **8 hrs**	**Centroids and Moment of Inertia:** Centroid: Concept of centre of gravity, centroid of area, centroid of line, concept of line of symmetry, location of centroid by direct integration of rectangular, triangular, semi-circular and quarter circular areas, centroid of composite areas, problems. (b) Moment of Inertia: MI of plane figure with respect to an axis in its plane, MI of plane figure with respect to an axis perpendicular to the plane of the figure; Parallel axis theorem; Mass moment of inertia of symmetrical bodies, e.g. cylinder, sphere, cone.
UNIT- III **8 hrs**	**Simple Stresses and Strains:** Mechanical properties of materials, concept of stresses and strains, stress-strain diagrams, yield stress, ultimate stress, limit of proportionality, elastic limit, working stress, factor of safety, Hooke's law, Young's modulus (Modulus of elasticity), rigidity modulus, bulk modulus, Poisson's ratio, relationship among the elastic constants, bars of varying cross sections, elongation due to self-weight.
UNIT-IV **6 hrs**	**Kinetics of Particles:** Newton's second law; Equation of motion; D.Alembert's principle and free body diagram; motion of connected bodies, Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction. Principle of work and energy; Principle of conservation of energy; Power and efficiency. Problems.

Text Books:

1. "Engineering Mechanics" by S. Timoshenko et.al. Mcgrawhill Education India Pvt. Ltd.
2. Mechanics for Engineers Ferdinand P Beer & amp; McGraw Hill(Statics & Dynamics) R.R.Johnson (Jr.)
3. Engineering Mechanics J.L.Meriam & John Wiley(Vol. I & II) L.G.Kraige

Reference Books:

1. Text Book of Applied Ramamrutham S Dhanpat Rai Mechanics.
2. Engineering Mechanics K.L.Kumar Tata McGraw Hill
3. Engineering Mechanics S.S.Bhavikatti ; Wiley Eastern.
4. Mechanics of Materials E.J.Hearn Pergamon Press
5. Strength of Materials S.S.Bhavikatti Vikas
6. Strength of Materials Ferdinand L Singer Harper & Row
7. Strength of Materials B.S.Basavarajaiah Khanna
8. Strength of Materials S.Ramamrutham Dhanpat Rai.

BTEG-UG-C205: PROBLEM SOLVING USING COMPUTERS (2L 0T 0P)

Course Objective: This course focuses on

1. To formulate simple algorithms for arithmetic and logical problems
2. To translate the algorithms to programs (in C language)
3. To test and execute the programs and correct syntax and logical errors
4. To implement conditional branching, iteration and recursion
5. To decompose a problem into functions and synthesize a complete program using divide and conquer approach
6. To use arrays, pointers and structures to formulate algorithms and programs
7. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems
8. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration

Course Outcome: On successful completion of course, the students will be able to:

1. Conceptualize solutions
2. Realize solutions using suitable data structure and programming constructs

UNIT I **8 hrs**	**Introduction to Programming:** Introduction to Programming (Flow chart/pseudocode, compilation etc.), Variables (including data types) **Arithmetic expressions and precedence** **Conditional Branching and Loops:** Writing and evaluation of conditionals and consequent branching, Iteration and loops
UNIT-II **8 hrs**	**Arrays** Arrays (1-D, 2-D), Character arrays and Strings **Basic Algorithms** Searching, Basic Sorting Algorithms, Finding roots of equations, idea of time complexity
UNIT- III **8 hrs**	**Function and Recursion** **F**unctions (including using built in libraries), Recursion with example programs such as Quick sort, Ackerman function etc.
UNIT-IV **6 hrs**	**Structure and Pointers** Pointers, Structures (including self referential structures e.g., linked list, notional introduction) **File handling**

Text books :

1. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

Reference Books:

2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

BTEG-UG-C206: UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS (2L 1T 0P)

Course Objective: This course is designed to inculcate relation among human being, human-nature.

Course Outcome: On successful completion of course, the students will be able to:

1. Develop a critical ability to distinguish between essence and form; or between what is of value and what is superficial in life (to appreciate the importance of fundamental issues related to their happiness and real success in the life & profession).
2. Move from discrimination to commitment (to develop sensitivity and awareness leading to commitment and courage to act on the basis of their own understanding, rather than merely on the basis of assumptions)
3. Discover what they consider valuable. Accordingly, they should be able to discriminate between valuable and the superficial in real situations in their life.

UNIT I **(10 hrs)**	**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education** Understanding the need, basic guidelines, content and process for Value Education Self Exploration–what is it? - its content and process; „Natural Acceptance" and Experiential Validation- as the mechanism for self exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfill the above human aspirations: understanding and living in **harmony** at various levels
UNIT-II **(10 hrs)**	**Understanding Harmony in the Human Being - Harmony in Myself:** Understanding human being as a co-existence of the sentient " I" and the material "Body" Understanding the needs of Self ("I") and „Body" - Sukh and Suvidha Understanding the Body as an instrument of "I" (I being the doer, seer and enjoyer) Understanding the characteristics and activities of "I" and harmony in "I" Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail Programs to ensure Sanyam and Swasthya Practice Exercises and Case Studies will be taken up in Practice sessions.
UNIT- III **(15 hrs)**	**Understanding Harmony in the Family and Society - Harmony in Human- Human Relationship:** Understanding harmony in the Family-the basic unit of human interaction

	Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship Understanding the meaning of Vishwas; Difference between intention and competence. Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family! Practice Exercises and Case Studies will be taken up in Practice Sessions
UNIT-IV **(10 hrs)**	**Understanding Harmony in the Nature and Existence - Whole existence as Co- existence:** Understanding the harmony in the Nature Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all- pervasive space Holistic perception of harmony at all levels of existence -Practice Exercises and Case Studies will be taken up in Practice Sessions.

Text books :

1. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2
2. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics – Teachers Manual, Excel books, New Delhi, 2010.

Reference Books:

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III,
6. 1972, limits to Growth, Club of Rome"s Report, Universe Books.
7. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
8. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
9. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
10. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Relevant websites, movies and documentaries

1. Value Education websites, http://uhv.ac.in, http://www.uptu.ac.in
2. Story of Stuff, http://www.storyofstuff.com
3. Al Gore, An Inconvenient Truth, Paramount Classics, USA

4. Charlie Chaplin, Modern Times, United Artists, USA
5. IIT Delhi, Modern Technology – the Untold Story
6. Gandhi A., Right Here Right Now, Cyclewala Productions

BTEG-UG-L207: ENGINEERING CHEMISTRY LABORATORY (0L 0T 3P)

Course Objective: This course focuses on

The course aims to enable the students to understand the practical aspects of chemistry, quantitative analysis and instrumentation techniques.

Course Outcome: On successful completion of course, the students will be able to:

1. The students will be able to carry out various type of titrations and quantitatively assess the analytes.
2. Understanding and use of various instruments like spectrophotometer, potentiometer, conductometer, pH meter to assess various properties of a given compound.

At least Ten Experiment to be carried out in a semester

1. To estimate the weight of Mohr's salt crystal dissolved in 250 ml using KMnO4 solution and pure oxalic acid crystals.
2. To estimate the total hardness of given sample of water using EDTA solution and CaCO3.
3. To estimate the weight of FeCl3 using K2Cr2O7 and Mohr's salt.
4. To estimate the percentage of MnO2 in a given sample of pyrolusite using Oxalic Acid and KMnO4 solution.
5. To prepare a titration curve for phosphoric acid and sodium hydroxide by using pH meter.
6. Determination of strength of given HCl solution by titrating against NaOH conductometrically.
7. Determination of concentration of KMnO4 solution by spectrophotometer.
8. To determine the amount of sodium and potassium in a given water sample by flame photometer.
9. To determine the amount of Fe in the given solution by Potentionmetric titration.
10. To determination Ferrous ions in given sample of water spectrophotometrically.
11. To determine the number of components, present in organic mixture by thin layer chromatography and Rf value.
12. Synthesis and characterization of organic compounds (e.g. Iodoform).
13. Synthesis and characterization of inorganic compounds.

Text books :

1. Experimental Chemistry Note Book for Engineers- Dr.Lalit Kumar Sharma, Rajesh Kumar
2. Laboratory Manual on Engineering Chemistry- Anupama Rajput
3. Essentials of Experimental Engineering Chemistry- Shashi Chawla

Reference Books:

1. Vogel's Quantitative Chemical Analysis – J Mendhan, RC Denncy, JD Barnes, MJK Thomas
2. Instrumental methods of analysis – Willard, Merit & Dean

BTEG-UG-L208: PROGRAMMING LABORATORY (0L 0T 3P)

Course Objective: This course focuses on

The course aims to enable the students to understand the use of various programming constructs and data structures.

Course Outcome: On successful completion of course, the students will be able to:

1. To formulate the algorithms for simple problems
2. To translate given algorithms to a working and correct program
3. To be able to correct syntax errors as reported by the compilers
4. To be able to identify and correct logical errors encountered at run time
5. To be able to write iterative as well as recursive programs
6. To be able to represent data in arrays, strings and structures and manipulate them through a program
7. To be able to declare pointers of different types and use them in defining self referential structures.
8. To be able to create, read and write to and from simple text files.

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Numerical methods (Root finding, numerical differentiation, numerical integration):
9. Programming for solving Numerical methods problems
10. Recursive functions
11. Pointers and structures
12. File operations

BTEG-UG-L209: ENGINEERING GRAPHICS AND DESIGN (0L 0T 4P)

Course Objective: The course is aimed at developing basic graphic skills, skills in preparation of basic drawings and skills in reading and interpretation of engineering drawings.

Course Outcome: On successful completion of course, the students will be able to:

1. Use the drawing instruments effectively and able to dimension the given figures
2. Understand the standards and common cases as well as dimensioning in technical drawings development.
3. Understand the concept of projection and acquire visualization skills, projection of points and able to draw the basic views related to projections of Lines, Planes, Solids
4. Able to develop multi-aspect sketches, sectional views and geometries of the development of design projects.
5. Visualize objects in all dimensions and learn displaying techniques for graphical communication in design process.

UNIT-I	**Lettering, conventions and dimensioning. Scales:** Representative fraction, construction of plain and diagonal scales. Principles of orthographic projections following 1st angle projection.
UNIT- II	**Projection of points and Straight Lines:** Projection of points in all quadrants, Projections of lines in different positions with respect to the reference planes, true length, angle of inclination of lines with reference planes. **Projection of planes:** Projection of plane lamina of different geometrical shapes in different positions with respect to the reference plane
UNIT- III	**Projection of solids**: Projection of solids of different geometrical shapes by change of position method. **Section of Solids:** Section of solids of different geometrical shapes by change of position method.
UNIT- IV	**Orthographic Projection:** Conversion of pictorial views into orthographic projections of simple machine parts. **Isometric Projection:** Isometric axes, lines, planes and Isometric scale, Isometric Projections of prisms, pyramids, cylinders, cones and simple machine parts. **Computer Aided Drawing:** Introduction to AutoCAD, Basic commands for 2D drawing like: Line, Circle, Polyline, Rectangle, Hatch, Fillet, Chamfer, Trim, Extend, Offset, Dim style, etc.

Text books:

1. Engineering Drawing Vol. I & II, by Gopalakrishna
2. Engineering drawing by N.D.Bhatt

Reference books:

1. Machine drawing by N.D.Bhatt

BTCO-UG-C301: ENGINEERING MATHEMATICS III (2L 1T 0P)

(Discrete Mathematics for Computer Science)

Course Objective: This course focuses on Logic, Set Theory, Algebraic Structures, Combinatorics and Graph Theory which appear frequently in many areas such as Algorithm analysis , data structures , database management system. Discrete mathematics plays a crucial role in enabling students of computer science to tackle these problems. Graph theory has tremendous application in Computer Networks, Switching. Group theory has enormous applications coding theory and related areas.

Course Outcome: On successful completion of course, the students will be able to:

1. Understand the Logic, Set Theory
2. Have basic idea of Algebraic Structures, Combinatorics and Graph Theory
3. Build better understanding related to their problems and enhance the capability of performing critical analysis using mathematical tools contained in the syllabus.

UNIT-I **10 hrs**	**Propositional logic:** Syntax, semantics, valid, satisfiable and unsatisfiable formulas, encoding and examining the validity of some logical arguments. **Proof techniques :** Forward proof, proof by contradiction, contrapositive proofs, proof of necessity and sufficiency.
UNIT-II **10 hrs**	**Sets, relations and functions:** Operations on sets, relations and functions, binary relations, partial ordering relations, equivalence relations, principles of mathematical induction. **Size of a set:** Finite and infinite sets, countable and uncountable sets, Cantor's diagonal argument and the power set theorem, Schröder-Bernstein theorem.
UNIT- III **15 hrs**	**Combinatorics:** Basic counting techniques: inclusion and exclusion, pigeon-hole principle, permutation, combination, summations. Introduction to recurrence relations and generating functions. **Algebraic structures and morphisms:** Algebraic structures with one binary operation - semigroups, monoids and groups, congruence relation and quotient structures. Free and cyclic monoids and groups, permutation groups, substructures, normal subgroups. Algebraic structures with two binary operations - rings, integral domains and fields. Boolean algebra and Boolean ring.
UNIT-IV **10 hrs**	**Graphs and trees:** Graphs and their basic properties - degree, path, cycle, subgraphs, isomorphism, Eulerian and Hamiltonian walks, graph coloring, planar graphs, trees.

Text books :

I. Jean-Paul Tremblay and Manohar, R: Discrete Mathematical Structures with application to Computer Science, McGraw Hill.

2. C.L. Liu: Elements of discrete mathematics, McGraw Hill.

3. NarasinghDeo :Graph theory with applications to Computer Science , PHI.

Reference Books:

1. B. Kolman, R.C. Busby & S. Ross.: Discrete Mathematical Structures, Pearson

2. Principles of Artificial Intelligence; N. J. Nielson,

3. E. S. Page & L.B. Wilson: An introduction to Computational Combinatorics, Cambridge University.

BTCO-UG-C302: COMPUTER ORGANIZATION AND ARCHITECTURE (2L 1T 0P)

Course Objectives: The main objectives of this course are to develop an understanding of the functional blocks of a computer and the inter-relation between them. It emphasizes on the design of the processing unit as well.

Course outcomes: On successful completion of course, the learner will be able to:

1. Understand the interrelation between computer hardware components and their functioning.
2. Interpret data expressed in binary, decimal, and hexadecimal and perform basic operations on data.
3. Have an overview of processor advancement.
4. Have an in-depth understanding of pipelined computer systems.

UNIT-I **5 hrs**	**Introduction:** Basic organization of the computer and block level description of the functional units from program execution point of view, Fetch, Decode and Execute cycle. Introduction to microprocessors, Evolution, a brief overview of more advanced processors (Pentium, Motorola and Zilog).
UNIT-II **10 hrs**	**Memory organization:** A review of random and serial access memories, Basic concept of main memory: Static and dynamic memory, ROM, Error correction, Computer memory system overview, Memory hierarchy, Cache memory: Mapping functions, Replacement algorithms, Virtual memory, Logical to physical memory mapping, External memory: Magnetic disk, RAID.
UNIT- III **15 hrs**	**Input/Output:** External devices, I/O Modules, Programmed I/O, Interrupt driven I/O, DMA, I/O channels and processors, The processing unit: Fetching a word from memory, Storing a word in memory, Register transfers, Performing an arithmetic or logic operation Addressing modes, Instruction format: Three, Two, One and zero address instruction, Control Unit:Hardwired control unit, Micro programmed control unit. **Arithmetic**: Number representation, Fixed point addition and subtraction, Multiplication of fixed point numbers: Booth's multiplication, Integer division: Restoring and non-restoring.
UNIT-IV **15 hrs**	**Fundamentals of processor design:** Instruction set processor design, Exploitation of instruction-level parallelism (ILP), Processor micro- architecture, Principles of processor performance, Vector processing and array processing, **Pipelined processor architecture:** Fundamentals of pipelining, Flynn's classification of computers (SISD, SIMD, MISD, MIMD) Arithmetic pipeline design, Instruction pipeline design, Balancing pipeline stages, Stalls in pipeline, Methods for reduction of stalls in pipeline. **Reduced instruction set computers:** Reduced Instruction Set Architecture, differences between RISC and CISC processors.

Text Books:

1. V. C. Hamacher, Zaky, Vranesic, "Computer Organization", McGraw Hill
2. William Stallings, "Computer organization & Architecture – Designing for Performance", Pearson Education.
3. GaonkarR.S.,"MicroprocessorArchitecture,Programming and Applications", 5th Ed., Penram International.

Reference Books:

1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann.
2. J. P. Hayes, "Computer Architecture and Organization", McGraw Hill.

3. Morris Mano, “Computer System Architecture”, Pearson
4. P. Pal Chaudhuri, “Computer Organization and Design”, PHI

BTCO-UG-C303: DATA STRUCTURE (3L 1T 0P)

Course Objectives: The objectives of this course are to:

- Understand the data organization
- Define the term ‘data structure
- Know the classifications of data structures, i.e., linear and non-linear understand the basic operations on linear and non- linear data structures
- Explain the memory representation of all types of data structures
- Explain how to implement the all kinds of data structures.

Course Outcomes: On successful completion of course, the students will

1. Have a comprehensive knowledge of the data structures and algorithms on which file structures and data bases are based.
2. Understand the importance of data and be able to identify the data requirements for an application.
3. Have in depth understanding and practical experience of algorithmic design and implementation.
4. Have practical experience of developing applications that utilize databases.
5. Understand the issues involved in algorithm complexity and performance.

UNIT-I **20 hrs**	**Introduction:** Basic Terminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic notations: Big-Oh, Time-Space trade-off. Abstract Data Types (ADT) Arrays: Definition, Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Application of arrays, Sparse Matrices and their representations. Linked lists: Array Implementation and Dynamic Implementation of Singly Linked Lists, Doubly Linked List, Circularly Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List.
UNIT-II **20 hrs**	**Stacks:** Abstract Data Type, Primitive Stack operations: Push & Pop, Array and Linked Implementation of Stack in C, Application of stack: Prefix and Postfix Expressions, Evaluation of postfix expression, Recursion, Tower of Hanoi Problem, Simulating Recursion, Principles of recursion, Tail recursion, Removal of recursion Queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, Array and linked implementation of queues in C, Dequeue and Priority Queue. **Trees:** Basic terminology, Binary Trees, Binary Tree Representation: Array Representation and Dynamic Representation, Complete Binary Tree, Algebraic Expressions, Extended Binary Trees, Array and Linked Representation of Binary trees, Tree Traversal algorithms: Inorder, Preorder and Postorder, Threaded Binary trees, Traversing Threaded Binary trees, Huffman algorithm.
UNIT- III **10 hrs**	**Graphs:** Terminology, Sequential and linked Representations of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi list **Graph Traversal :** Depth First Search and Breadth First Search, Connected Component, Spanning Trees, **Minimum Cost Spanning Trees:** Prims and Kruskal algorithm. Transistive Closure and Shortest Path algorithm: Warshal Algorithm and Dijikstra Algorithm, Introduction to Activity Networks

UNIT-IV **10 hrs**	**Searching:** Sequential search, Binary Search **Comparison and Analysis Internal Sorting:** Insertion Sort, Selection, Bubble Sort, Quick Sort, Two Way Merge Sort, Heap Sort, Radix Sort, Practical consideration for Internal Sorting. **Search Trees:** Binary Search Trees(BST), Insertion and Deletion in BST, Complexity of Search Algorithm, AVL trees, Introduction to m-way Search Trees, B Trees & B+ Trees **Hashing:** Hash Function, Collision Resolution Strategies ,Storage Management: Garbage Collection and Compaction.

Text Books:

1. Ellis Horowitz and SartajSahni, “Fundamentals of Data Structures”, Galgotia.
2. Samanta, D., “Classic Data Structures”, PHI.
3. Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein “Data Structures Using C and C/C++” , PHI

Reference Books:

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson
2. E.M. Reingold and W.J. Hansen, “Data Structures”, CBS.
3. A. S. Tanenbaum, Y. Langsam, M.J. Augenstein, “Data Structures using C”, Pearson.
4. M. A. Weiss, “Data Structure and Algorithm Analysis in C”, Pearson.
5. Jean Paul Trembley and Paul G. Sorenson, “An Introduction to Data Structures with applications”, McGraw Hill
6. R. Kruse etal, “Data Structures and Program Design in C”, Pearson Education
7. Lipschutz, “Data Structures” Schaum’s Outline Series, TMH
8. G A V Pai, “Data Structures and Algorithms”, TMH

BTCO-UG-C304:DIGITAL ELECTRONICS & LOGIC DESIGN (2L 1T 0P)

Course Objectives:

1. To study various number systems, knowledge of these number systems is essential in core computer science subjects.
2. To explore brief idea about the different digital circuits which are used to develop the digital devices.
3. Understand the concepts of Memories, Programmable Logic Devices & Digital ICs.
4. To motivate the students to develop their logic to design new digital circuits usable for hardware design.
5. To motivate our students to use these digital circuits in integrated circuit design.

Course Outcomes:

After completion of this course, students will be able to -

1. Acknowledge about the fundamentals of digital circuit design.
2. Understand the operation of Latch circuits & Flip flops.
3. Take interest to designing & develop ICs in VLSI industries.
4. Learn operation of different Semiconductor Memories.

UNIT-I **10 hrs**	Overview of Boolean algebra and Logic gates: Codes: Binary codes: Weighted & Non-weighted codes, Sequential codes, self-complementing codes, Cyclic codes, 8-4-2-1 BCD code, Excess-3 code, Gray code: Binary to Gray and Gray to binary code conversion, Error detecting code, Error correcting code, 7-bit Hamming code, ASCII code, EBCDIC code. Binary Arithmetic, Boolean Algebra, Minimization of Switching Function , Demorgan's Theorem, Karnaugh's Map Method, Quine-McCluskey's Method (Tabular Method). Universal logic Gates, Realization of switching functions using gates.
UNIT-II **10 hrs**	Digital Logic Families: Transistor Inverter: Basic Concepts of RTL and DTL; TTL: Open collector gates, TTL subfamilies, IIL, ECL; MOS Logic: CMOS Logic, Dynamic MOS Logic, Interfacing: TTL to ECL, ECL to TTL, TTL to CMOS, CMOS to TTL, and Comparison among various logic families.
UNIT- III **15 hrs**	Combinational Circuits: Adder &Subtractor: Half adder, Full adder, Half-subtractor, Full- subtractor, Parallel Binary adder, Look Ahead carry adder, Serial adder, BCD adder. Code converter, Parity bit generator/Checker, Comparator. Decoder: 3-line to 8-line decoder, 8-4-2-1 BCD to Decimal decoder, BCD to Seven segment decoder.Encoder: Octal to binary and Decimal to BCD encoder. Multiplexer: 2- input multiplexer, 4-input multiplexer. Demultiplexer: 1-line to 4-line, study of Multiplexer as Universal Logic Function Generator.
UNIT-IV **10 hrs**	Sequential Circuits: Flip-Flops and their conversion, Excitation Tables. Introduction to registers and counters:Synchronous and Asynchronous counters and Designing of sequential circuits: code converter and counters. Mode-k and divide by K counters, Counter applications.

Text Books:

1. R. P. Jain: "Modern Digital electronics", TMH
2. B. Somanathan Nair, "Digital Electronics & Logic Design", Prentice-Hall of India

Reference Books:

1. R J Tocci, "Digital System principles and Applications"
2. "Digital Electronics " byA.K.Maini, Wiley India.

3. M.M. Mano:" Digital design", PHI.
4. MillmanTaub, "Pulse, Digital and Switching Waveforms "TMH
5. M.M. Mano: "Digital logic and computer design", PHI.
6. Floyd: "Digital fundamentals", UBS.

BTCO-UG-C305: OBJECT ORIENTED CONCEPTS & PROGRAMMING USING C++ (2L 1T 0P)

Course Objectives:

1. Understand object-oriented programming features in C++,
2. Apply these features to program design and implementation,
3. Understand object-oriented concepts and how they are supported by C++,
4. Understand implementation issues related to object-oriented techniques,
5. Build good quality software using object-oriented programming technique

Course Outcomes:

1. Knowledge and Understanding- At the end of a course the student will understand the concepts of:

a) Variables, data Types (including strings and arrays) and Expressions

b) Flow of Control

c) Functional and procedural abstraction and its importance in good program design

d) Pointers and memory allocation (static and dynamic)

e) Iteration and Recursion

2. Skills - At the end of the course, a student will be able to:

a) Analyse a simple programming problem specification

b) Design a high-level (programming language independent) solution to the problem using functional abstraction and general

imperative programming language constructs.

Write, compile, execute and debug a C++ program which maps the high-level design onto concrete C++ programming constructs

UNIT-I **5 hrs**	**Object-Oriented Programming Concepts**: Introduction, comparison between procedural programming paradigm and object-oriented programming paradigm, basic concepts of object-oriented programming—concepts of an objectand a class, interface and implementation of a class, operations on objects, relationship among objects, abstraction, encapsulation, data hiding, inheritance, overloading, polymorphism, messaging.
UNIT-II **15 hrs**	**Standard Input/Output:** Concept of streams, hierarchy of console stream classes, input/output using overloaded operators >> and << and member functions of i/o stream classes, formatting output, formatting using ios class functions and flags, formatting using manipulators. Classes and Objects: Specifying a class, creating class objects,accessing class members, access specifiers, static members, use of constkeyword, friends of a class, empty classes, nested classes, local classes, abstract classes, container classes, bit fields and classes.
UNIT- III **10 hrs**	**Pointers and Dynamic Memory Management:** Declaring and initializing pointers, accessing data through pointers, pointer arithmetic, memory allocation (static and dynamic), dynamic memory management using new and delete operators, pointer to an object, this pointer, pointer related problems - dangling/wild pointers, null pointer assignment, memory leak and allocation failures. Constructors and Destructors: Need for constructors and destructors, copy constructor, dynamic constructors, explicit

	constructors, destructors, constructors and destructors with static members, initializer lists. **Operator Overloading and Type Conversion:** Overloading operators, rules for overloading operators, overloading of various operators, type conversion - basic type to class type, class type to basic type, class type to another class type.
UNIT-IV **15 hrs**	**Inheritance:** Introduction, defining derived classes, forms of inheritance, ambiguity in multiple and multipath inheritance, virtual base class, object slicing, overriding member functions, object composition and delegation, order of execution of constructors and destructors. **Virtual functions & Polymorphism**: Concept of binding - early binding and late binding, virtual functions, pure virtual functions, abstract clasess, virtual destructors. Exception Handling: Review of traditional error handling,basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, rethrowingan exception, specifying exceptions. Templates and Generic Programming: Template concepts, Function templates, class templates, illustrative examples. Files: File streams, hierarchy of file stream classes, error handling during file operations, reading/writing of files, accessing records randomly, updating files.

Text Books:

1. Lafore R., Object Oriented Programming in C++, Waite Group.

2. E. Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill.

Reference Books:

1. R. S. Salaria, Mastering Object-Oriented Programming with C++, Salaria Publishing House.

2. BjarneStroustrup, The C++ Programming Language, Addison Wesley.

3. Herbert Schildt, The Complete Reference to C++ Language, McGraw Hill-Osborne.

4. Lippman F. B,5. R. S. Salaria, Test Your Skills in Object-Oriented Programming With C++, Salaria Publishing House.

BTCO-UG-C306: INTELLECTUAL PROPERTY RIGHTS (2L 1T 0P)

Course Objectives:

- To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries.
- To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
- To disseminate knowledge on copyrights and its related rights and registration aspects
- To disseminate knowledge on trademarks and registration aspects
- To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
- To aware about current trends in IPR and Govt. steps in fostering IPR

Course Outcomes:

- The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works
- During their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search. This provide further way for developing their idea or innovations • Pave the way for the students to catch up Intellectual Property(IP) as an career .

UNIT-I **10 hrs**	**Concept of Intellectual Property:** National and International Perspectives Concept of Intellectual Property: meaning and nature International Dimension of Intellectual Property Rights: WIPO and TRIPS
UNIT-II **15 hrs**	**Types of Intellectual Property:** **Patents**: Basic Legal Framework/Salient Features of Indian Law **Copy Right:** Basic Legal Framework/ Salient Features of Indian Law **Trade Marks**: Basic Legal Framework/ Salient Features of Indian Law Geographical Indication and Trade Secrets/ Undisclosed Information Industrial Designs
UNIT-III **5 hrs**	**Enforcement of IPRs:** Enforcement: Its different modes in different Intellectual Property Rights
UNIT-IV **15 hrs**	**Emerging Areas of IPRs:** IPRs and Biotechnology IPRs and Computer Software IPRs and Biodiversity IPRs, Traditional Knowledge and Folklore Protection of Plant Variety

Text Books:

1. Anne-Marie Mooney Cotter (2003) Intellectual Property Law. Routledge Cavendish
2. Torremans, Paul (2008) Intellectual Property Law. Oxford: Oxford University Press

Reference book:

1. Tina Hart, Linda Fazzani, Simon Clark (2006) Intellectual Property Law, Palgrave Macmillan
2. Kluwer, (1998) Patent Co-Operation Treaty Hand Book. Sweet and Maxwell
3. Cornish, W.R, (1999) Intellectual Property Law .Sweet and Maxwell
4. Special attention should be given to literature of the U.N. System, WIPO and the UNESCO.

BTCO-UG-L307: DATA STRUCTURES LABORATORY (0L 0T 3P)

Reviewing the concepts of pointers and structures. Studying the operation of stacks and queues and the associated application programs. Creating dynamic allocation of memory for linked list and applying it to examples using single, doubly, circular linked list. Implementing sorting and searching techniques, Creation of trees and the application associated with the trees.

Recommended Books ::

1. Behrouz A. Forouzan, Richard F. Gilberg, “A Structured Programming Approach Using C”, (3e), Cengage Learning India Private Limited, India, 2007.
2. Ellis Horowitz, SartajSahni, Susan Anderson and Freed, “Fundamentals of Data Structures in C”, (2e), Universities Press, India, Reprint 2011.
3. Richard F. Gilberg, Behrouz A. Forouzan, “Data structures, A Pseudocode Approach with C”, (2e), Cengage Learning India Pvt. Ltd, India, 2009.
4. Robert Kruc& Bruce Lening, “Data structures & Program Design in C”, (2e), Pearson, 2007.
5. DebasisSamanta, “Classic Data Structures”, (2e), PHI Learning Pvt. Ltd., India, 2010

BTCO-UG-L308: DIGITAL ELECTRONICS & LOGIC DESIGN LABORATORY (0L 0T 3P)

Simulation of Logic Circuits Using Verilog: Verification of Logic Gates and Boolean Algebra Simplification of Expressions using Kmap: SOP and POS Forms, Multilevel NAND, NOR Circuits, Arithmetic Circuits: Half Adder, Full Adder, Multi-Bit Adder/Subtractor, BCD Adder, Multiplexers, Decoders and Encoders, Code Converters and Comparator, Flip-Flops: D, JK, and T Flip-Flops, Registers: Shift Register, Ring Counter, Johnson Counter, Binary and BCD Counters

Recommended Books:

1. Stephen Brown and ZvonkoVranesic, “Fundamentals of Digital Logic with Verilog Design”, (1e),Tata McGraw Hill Publishing Co. Ltd., 2014

2. J. Bhasker, “A VHDL Primer”, (3e), PHI Pvt. Ltd., 2005.

BTCO-UG-L309: PROGRAMMING USING C++ LABORATORY (0L 0T 3P)

Programs on control statements, arrays, classes objects and methods, Inheritance, Interfaces, packages, exceptions, multithreading, Generics, Strings, input-output streams.

Recommended Books :

1. Programming with C++ : D Ravichandran
2. OOP's with C++ : E. Balaguruswamy .
3. Programming with C++ :Venugopal .
4. Object Oriented Programming in C++ :StroutStrups.
5. OOP with C++ : Robert Lafore
6. Let us C++ :YaswantKanetkar.

BTCO-UG-M310: CONSTITUTION OF INDIA (2L 0T 0P)

Course Objectives: Following are the objectives of this course

- To know about Indian constitution.
- To know about central and state government functionalities in India.
- To know about Indian society.

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

1. Understand the functions of the Indian government
2. Understand and abide the rules of the Indian constitution.
3. Understand and appreciate different culture among the people.

UNIT-I **5 hrs**	**Introduction:** Historical Background, Constituent Assembly of India, Philosophical foundations of the Indian Constitution , Preamble, Fundamental Rights, Directive Principles of State Policy, Fundamental Duties, Citizenship, Constitutional Remedies for citizens.
UNIT-II **5 hrs**	**Parliamentary form of government:Executive**: President; Prime Minister and Council of Ministers - Election, Powers and Functions; **Legislature**:Lok Sabha and Rajya Sabha– Composition, Powers and Functions. **Judiciary**– Supreme Court, Composition, Powers, Functions and Judicial Review- Judicial Activism.
UNIT- III **10 hr**	**Amendment of the constitution:** Powers and procedure; State Government – Governor, Chief Minister and Council of Ministers – Powers and Functions. **Party System:** National and regional Parties; Trends in Party System Election Commission – Electoral Reforms and voting Behavior.
UNIT-IV **10 hrs**	**Election Commission: Election Commission:** Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women. **Rural Local Government:** Evolution Structure and Function**;** Gram Sabha; Gram Panchayat; Panchayat Samiti; Zila Panchayat. **Urban Local government:** Evolution structure and function; Municipal corporation**;** Nagar panchayat.

Text Books:

1. Durga Das Basu, “Introduction to the Constitution of India “, Prentice Hall of India, New Delhi.
2. R.C.Agarwal, (1997) “Indian Political System”, S.Chand and Company, New Delhi.
3. Maciver and Page, “ Society: An Introduction Analysis “, Mac Milan India Ltd., New Delhi.
4. K.L.Sharma, (1997) “Social Stratification in India: Issues and Themes”, Jawaharlal Nehru University, New Delhi.
5. Our Constitution: An Introduction to India’s Constitution and Constitutional law by KashyapSubhash
6. Introduction to the Constitution of India by D. D. Basu

Reference Books:

1. Sharma, Brij Kishore, “ Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
2. U.R.Gahai, “Indian Political System “, New Academic Publishing House, Jalaendhar.
3. R.N. Sharma, “Indian Social Problems “, Media Promoters and Publishers Pvt. Ltd.

BTCO-UG-M310: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE (2L 0T 0P)

Course Objectives:

- The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature.
- Holistic life styles of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.
- The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care system

Course Outcome:

1. Ability to understand , connect up and explain basics of Indian Traditional knowledge modern scientific perspective.

UNIT-I **10 hrs**	**Basic structure of Indian knowledge system.** Basic features and importance of Vedic knowledge; AstadashVidhya- 4 Vedas, (Rig-Veda, Sama-Veda, Yajur-Veda, and Atharva) 4 Upa Vedas (Dhanurveda, Gandharvaveda, Ayurveda and Arthasastra), 6 Vedangs (Siksha, Chhanda, Vyakarana, Nirukta, Jyotisha and Kalpa) And 4 Upangas (Dharma Sastra, Memangsa, Purana and Tarka Sastra). **Modern Science and Indian Knowledge:** Basic features, significance and relevance in modern society. The Idea of Zero, the Decimal System, Numeral Notations, Fibonacci Numbers, Binary Numbers, a Theory of Atom, Plastic Surgery and Ayurveda.
UNIT-II **5 hrs**	**Yoga and holistic health care:** Origin of Yoga & its brief development, Meaning of Yoga & its importance, Yoga as a Science of Art (Yoga Philosophy), Meaning of meditation and its types and principles. **Principles of Yogic Practices:** Meaning of Asana, its types and principles, meaning of Pranayama, its types and principles, Meaning of Kriya its types and principles.
UNIT- III **5 hrs**	**Philosophical Traditions:** Serve DarsanaSangraha: meaning features and significance (CharvakaSystem,Bauddha System, Arhata or ,Jaina System, Ramanuja System, Purna-prajna System, Nakulis-PasupataSystem,Saiva System, Pratyabhijna or Rcognitive System, Rasesvara or Mercurial System, Vaiseshika or Aulukya System, Akshapada or Nyaya System, Jaiminlya System, Papiniya System, Sankhya System)
UNIT-IV **10 hrs**	**Indian Linguistic Tradition**: **Theoretical**: Phonetics: Sounds of a language–Phonology: Sound patterns–Morphology: Word formation and structure–Syntax: Sentence structure–Semantics: Study of meaning. **Applied**–Understanding and teaching other languages, translation, speech therapy. **Indian Artistic Tradition:** Basic features, significance and importance and region associated: Chitra Kala , Murti Kala, Bastu Kala, and Sangit, (The Famous Traditional Art Forms in India: Warli Art, Gond Art, Madhubani, Miniature Paintings ,Tanjore Paintings, Kalamkari , Kalighat Pats PhadPai)

Text books:

1. V Shivakrishnan (Ed) : Cultural Heritage Of India Course Material VidhyaBhawan Mumbai 5th Edition , 2014
2. The Sarva-Darsana-Samgraha, Or Review Of The Different Systems Of Hindu Philosophy By Madhava Acharya Publication Date 1882 ,Topics Hinduism ,Publisher London,Contributor Robarts - University Of Toronto.

3. K.S Subrahmanialyer, Vakyapadiya Of Bhartrihari(Brahman Kanda) Deccan College Pine 1965. Panini Shiksha, MotilalBanarasidas

Reference Books:

1. V.N Jha , Language, Thoughts And Reality.
2. Pramod Chandra, Indian Arts , Abhinav Publications 1897
3. Light on Yoga by B.K.S. Iyengar
4. The Heart of Yoga: Developing a Personal Practice by T.K.V. Desikachar
5. The Seven Spiritual Laws of Yoga by Deepak Chopra
6. The Secret Power of Yoga: A Woman's Guide to the Heart and Spirit of the Yoga Sutras by Nischala Joy Devi
7. Yoga: The Iyengar Way by Silva, Mira, and Shyam Mehta

COM-UG-C401: ENGINEERING MATHEMATICS IV (2L 1T 0P)

(Probability, Stochastic Process and Statistics)

Course Objective: The objective of this course is to enhance the capability of students to analyze the problems related to random phenomena. Concepts on probability theory will be of immense help to the students in analyze random experiments. Statistical Analysis plays a big role in areas like data mining and information retrieval. Stochastic models have tremendous applications in queuing theory. Students will find adequate tools in these modules which will be effective enough to solve their problems.

Course Outcome: The first unit will enable students to apply to the problems which are non- deterministic in nature and arrive at some predictions through sound mathematical reasoning. The second unit helps to obtain estimate of some groups of data and estimate the results given some past information. Theory of stochastic processes is helpful in determining waiting time queues which are widely used designing OS and IT enabled applications.

UNIT-I **10 hrs**	**Probability Theory:** Axioms of probability, Probability space, Conditional probability, Independence, Baye's rule, Random variable, Some common discrete and continuous distributions, Distribution of Functions of Random Variable, Moments, Generating functions, Two and higher dimensional distributions, Functions of random variables, Order statistics, Conditional distributions, Covariance, correlation coefficient, conditional expectation, Modes of convergences, Law of large numbers, Central limit theorem.
UNIT-II **10 hrs**	**Stochastic Processes:** Definition of Stochastic process, Classification and properties of stochastic processes, Simple stochastic processes, Stationary processes, Discrete and continuous time Markov chains, Classification of states, Limiting distribution, Birth and death process, Poisson process, Steady state and transient distributions, Simple Markovian queuing models (M/M/1, M/M/1/N, M/M/c/N, M/M/N/N).
UNIT- III **10 hrs**	**Statistics:** Measures of central tendency, Dispersion, Skewness, Kurtosis, Data Representation using Histogram, Pie Chart, Boxplot, Biplot, Multi Dimensional Scaling etc. Concept of Random Variable, Some common discrete and continuous distributions, Distribution of Functions of Random Variables, Bivariate and Multivariate random variables
UNIT-IV **15 hrs**	**Sampling Distribution**, Theory of Estimation, Properties of an estimator, Cramer Rao Theorem, Rao Blackwellization, One-sample and Two sample tests of Proportion, mean, variance, Critical regions, Neyman Pearson Lemma. Tests for Goodness of fit, Chi-square Test, Kolmogorov Smirnov Test, One sample and paired sample tests: Sign Test, Signed-rank Test, Run tests etc. Linear regression, Non-linear regression, Logit and Probit Methods.

Text Books:

1. Introduction to Probability and Stochastic Processes with Applications, Liliana Blanco Castaneda, Viswanathan Arunachalam, SelvamuthuDharmaraja, Wiley, Asian Edition, Jan. 2016.
2. Probability and Statistics with Reliability, Queueing and Computer Science Applications, Kishor S. Trivedi, John Wiley, second edition, 2001.
3. Introduction to Probability Models, Sheldon M. Ross, Academic Press, tenth edition, 2009.
4. Thony J Hayter; Probability and Statistics for Engineers, Cengage learning, 4th Edition, 2012.

5. Freund, Wilson and Mohr: Statistical Methods, Academic Press, 3rd Edition, 2010.
6. Hogg and Tanis: Probability and Statistical Inference, Pearson, 9th Edition, 2014.

Reference Books:

1. Introductory Probability and Statistical Applications, Paul L. Meyer, Addison-Wesley, 1966.
2. Stochastic Processes, J. Medhi, New Age International Publishers, 3rd edition, 2009.
3. Stochastic Processes, Video course, NPTEL Phase II.
4. Introduction to Probability Theory and Stochastic Processes, Video course, NPTEL Phase II.
5. Probability, Random Variables and Stochastic Processes, Athanasios Papoulis and S. Unnikrishna Pillai, Tata Mcgraw-Hill, fourth edition, 2002.
6. An Introduction to Probability Theory and its Applications, Vol. I & II, William Feller, Wiley Eastern, third edition, 2000.

BTCO-UG-C402: DATABASE MANAGEMENT SYSTEMS (2L 1T 0P)

Course Objective:

1. To understand the role of a database management system and its users in an organization.
2. To understand database concepts, including the structure and operation of the relational data model.
3. Can successfully apply logical database design principles, including E-R diagrams and database normalization.
4. Construct simple and moderately advanced database queries using Structured Query Language (SQL).
5. To understand the concept of transaction, its properties and how to persist the data in complex concurrent users environment.

Course Outcome:

1. Will be able to describe the basic concepts of RDMBS and relational data model
2. Be familiar with the relational database theory & be able to write relational algebra expressions for queries
3. Understand DML, DDL and will be able to construct queries using SQL by knowing the importance of data &its requirements in any applications.
4. Be familiar with the basic issues of transaction, its processing and concurrency control.
5. Be familiar with basic database storage structures and access techniques: file and page organizations, indexing methods including B-tree, and hashing.

UNIT-I **10 hrs**	Data base System Applications, data base System VS file System, View of Data, Data Abstraction, Instances and Schemas, data Models, the ER Model, Relational Model, Other Models, Database Languages, DDL, DML, database Access for applications Programs, data base Users and Administrator, Transaction Management, data base System Structure, Storage Manager, the Query Processor. History of Data base Systems. Data base design and ER diagrams, Beyond ER Design Entities, Attributes and Entity sets, Relationships and Relationship sets, Additional features of ER Model, Concept Design with the ER Model, Conceptual Design for Large enterprises.
UNIT-II **15 hrs**	**Introduction to the Relational Model:** Integrity Constraint Over relations, Enforcing Integrity constraints, Querying relational data, Logical data base Design, Introduction to Views, Destroying altering Tables and Views. Relational Algebra, Selection and projection set operations, renaming, Joins, Division, Examples of Algebra overviews, Relational calculus, Tuple relational Calculus, Domain relational calculus, Expressive Power of Algebra and Calculus. **Basic SQL Query:** Examples of Basic SQL Queries, Introduction to Nested Queries, Correlated Nested Queries Set, Comparison Operators, Aggregative Operators, NULL values, Comparison using Null values, Logical connectivity's, AND, OR and NOT, Impact on SQL Constructs, Outer Joins, Disallowing NULL values, Complex Integrity Constraints in SQL Triggers and Active Data bases.
UNIT- III **10 hrs**	**Schema refinement:** Problems Caused by redundancy, Decompositions, Problem related to decomposition, reasoning about FDS, FIRST, SECOND, THIRD Normal forms, BCNF, Lossless join Decomposition, Dependency preserving Decomposition, Schema refinement in Data base Design, Multi valued Dependencies, FORTH Normal Form Transaction Concept, Transaction State, Implementation of Atomicity and Durability, Concurrent, Executions, Serializability Recoverability, Implementation of

	Isolation, Testing for serializability, Lock, Based Protocols, Timestamp Based Protocols Validation, Based Protocols, Multiple Granularity
UNIT-IV **10 hrs**	**Recovery and Atomicity:** Log, Based Recovery, Recovery with Concurrent Transactions, Buffer Management, Failure with loss of nonvolatile storage,Advance Recovery systems, Remote Backup systems Data on External Storage, File Organization and Indexing, Cluster Indexes, Primary and Secondary Indexes, Index data Structures, Hash Based Indexing, Tree base Indexing, Comparison of File Organizations, Indexes and Performance Tuning, Intuitions for tree Indexes, Indexed Sequential Access Methods (ISAM), B+ Trees: A Dynamic Index Structure.

Text Books:

1. Raghurama Krishnan, Johannes Gehrke," Data base Management Systems", TATA McGraw Hill 3rd Edition
2. Elmasri and Navathe: "Fundamentals of Database Systems", Addison Wesley.
3. Silberschatz, Korth, Sudarshan, "Database System Concepts", McGraw-Hill.

Reference Books:

1. Thomas Connolly, Carolyn Begg, "Database Systems – A Practical Approach to Design, Implementation and Management", Pearson Education.
2. Jefrey D. Ullman, Jenifer Widom, "A First Course in Database Systems", Pearson Education.
3. Bipin C Desai, "An Introduction to Database Systems", Galgotia.
4. AtulKahate, "Introduction to Database Management Systems", Pearson.
5. Ian Robinson, Jim Webber, Emil Eifrem,"Graph Databases",O'Reilly Media.

BTCO-UG-C403: DESIGN AND ANALYSIS OF ALGORITHMS (3L 1T 0P)

Course Objective: This course builds upon preliminary knowledge delivered in Data Structures. The main objectives of the course are to provide thorough knowledge and understanding of different algorithm analysis techniques, design strategies and their applications. Special purpose machines, some critical problems and innovative techniques are used in solving them.

Course objectives: On successful completion of course, the learners will be able to

1. Understand asymptotic notations and learns to calculate time and space complexities of an algorithm.
2. Describe, apply and analyze the complexity of certain divide and conquer, greedy, and dynamic programming algorithms.
3. Identify and analyze criteria and specifications appropriate to new problems, and choose the appropriate algorithmic design technique for their solution.
4. Explain and apply backtracking and branch and bound techniques to deal with some hard problems.
5. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP- Complete.

UNIT-I **10 hrs**	**Algorithms:** Definition, Aim of the subject, Designing algorithms and Analyzing algorithms: An introduction, Performance of a program: Space and Time complexity, Asymptotic notations and common functions, Example: Insertion sort.
UNIT-II **20 hrs**	**Recurrences and divide and conquer:** The basics of divide & conquer method, Merge sort, Quick sort, Solving recurrences: Substitution method, Recursion tree method, Master method: Proof of master method, Finding maximum and minimum, Strassen's matrix multiplication, Binary search, Greedy method: Basics of greedy method, Applications- 0/1 Knapsack Problem – Topological sorting – Bipartite Cover, Heapsort, Huffman codes, Activity selection, Minimum spanning tree-Kruskal's algorithm, Prim's algorithm, Single source shortest path: Dijkstra's algorithm.
UNIT- III **15 hrs**	**Dynamic programming:** Basics of dynamic programming, Applications- Matrix chain multiplication, Longest common subsequence, Traveling salesperson problem, all pair shortest path-Floyd and Wars hall's algorithm.
UNIT-IV **15 hrs**	**Back Tracking:** Backtracking Method, Applications-Container Loading, 0/1 Knapsack Problem, Max Clique, Travelling Salesperson, Board Permutations, Branch And Bound: Branch and Bound Method, Applications, 0/1 Knapsack Problem, Travelling Salesman Problem. **NP completeness:** Basic Concepts, P NP, NP Complete, NP Hard problems, Cook's theorem.

Text Books:

1. Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, "Fundamentals of Computer Algorithms", Galgotia Publications.
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, "Introduction to Algorithms", PHI.
3. SartajSahni, "Data Structures, Algorithms amd Applications in C++ ", University Press

Reference Books:

1. Levitin, "Introduction to the Design and Analysis of Algorithms", Pearson Education

2. S. Basse, A. Van Gelder, “Computer Algorithms-Introduction to Design and Analysis”, Pearson
3. Alfred V. Aho, John E. Hop croft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Addison Wesley.
4. M. A. Weiss, “Data Structure and Algorithm Analysis in C”, Pearson Education.

BTCO-UG-C404: MICROPROCESSORS AND PERIPHERAL DEVICES (2L 1T 0P)

Course Objective: The course is intended to give students good understanding of internal architectural details and functioning of 8085 and 8086 microprocessors. The students will have thorough and in-depth knowledge of microprocessors, its architecture, working principles including timing diagrams and assembly language programming using hand assembly as well as assembler.

Course outcomes: On successful completion of this course, learners should be able to

1. Identify the basic element and functions of the 8085/8086 microprocessor.
2. Describe the architecture of the 8085/8086 microprocessor and its peripheral devices.
3. Demonstrate the operation between the microprocessor and its interfacing devices.
4. Write programs for microprocessor applications using the assembly language.
5. Complete the experiments in laboratory and present the technical report.

UNIT-I **10 hrs**	**Introduction to Basic Microprocessors:** Historical Background, the Harvard and Princeton architecture, The Microprocessor-Based Personal Computer Systems. The Microprocessor 8085, 8088 basics and comparison (Block & Pin diagram only).
UNIT-II **15 hrs**	**Microprocessor Architecture 8086:** 8086 basic block diagram, Internal Microprocessor Architecture, Real Mode Memory Addressing, Registers, pin configuration, segmentation. Data Movement Instructions: MOV, PUSH/POP, Load-Effective Address, String Data Transfers, Miscellaneous Data Transfer Instructions, Segment Override Prefix, Assembler Details. Arithmetic and Logic Instructions: Addition, Subtraction and Comparison, Multiplication and Division, BCD and ASCII Arithmetic, Basic Logic Instructions, Shift and Rotate, String Comparisons. Program Control Instructions: The Jump Group, Controlling the Flow of the Program, Procedures, and Introduction to Interrupts, Machine Control and Miscellaneous Instructions. Assembler directives, assembler instructions, Assembly Language Programming.
UNIT- III **10 hrs**	**Assembly language programming using 8086:** An introduction to assembly language programming in 8086, assembler directives, macros, procedures, and DOS interrupt 21H functions. **Introduction to Peripheral Devices:** Introduction to 8259 PIC, 8254 PIT, 8255 PPI, 8251 USART.
UNIT-IV **10 hrs**	**Introduction to 80286, 80386 and 8051 microcontroller:** Internal architectures of 80286 and 80386, special registers of 80286 and 80386, Memory management in 80286 and 80386, Architecture 16 bit & 32 bit processors.

Text Book:

1. Barry B Brey: The Intel Microprocessors, 8th Edition, Pearson Education.
2. Ramesh S. Gaonkar : Microprocessor Architecture, programming and Application with 8085, 4th Edition, Wiley,2012
3. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications, by Walter A. Triebel and Avtar Singh, Pearson Education, Fourth Edition.
4. Microprocessors and Microcomputer based system design, by MahamedRafiquzzaman, UBS

Reference Books:

1. Microprocessor X86 Programming - K R Venugopal and Raj Kumar, BPB Publications, 1995.

2. IBM PC Assembly Language Programming , by Peter Abel, Pearson Education Asia, Fifth edition.
3. Advanced Microprocessors & Peripherals Architecture, Programming &Interfacing , by A K Ray, K M Bhurchandi, Tata Mcgraw Hill Publishing Company Limited, 2000.
4. Douglas V. Hall: Microprocessors and Interfacing, Revised 2nd Edition, TMH, 2006.
5. James L. Antonakos: The Intel Microprocessor Family: Hardware and Software Principles and Applications, Cengage Learning, 2007.
6. Nilesh B. Bahadure: Microprocessors: The 8086/8088, 80186/80286, 80386/80486 and the Pentium family, 2nd edition (2014)

BTCO-UG-C405: OPERATING SYSTEMS (2L 1T 0P)

Course Objectives:

To study and apply concepts relating to operating systems, such as concurrency and control of asynchronous processes, deadlocks, memory management, processor and disk scheduling, parallel processing, and file system organization.

Course Outcomes:

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

1. To learn what is operating system and how it makes computers work
2. To know how operating system manages complexity through appropriate abstraction of CPU, memory, files, semaphores etc.
3. To get knowledge about different components of operating system like Process Management, Concurrency mechanisms, Deadlock handling, Memory Management techniques, Virtual Memory, File System and Secondary Storage Management, Security & protection etc.

UNIT-I **10 hrs**	**INTRODUCTION:** Operation System objective and function, The Evolution of operating Systems, Batch, interactive, time sharing and real time systems, Protection. Operating System Structure,System Components, operating system service, System structure. Distributed Computing,The Key Architecture Trend; Parallel Computation, Input-Output Trends.
UNIT-II **15 hrs**	**CONCURRENT PROCESSES:** Process concept: Introduction, Definitions of "Process", Process States, Process StateTransitions, The process Control Block, Operations on Processes, Suspend and Resume,Interrupt Processing. Mutual Exclusion, the Producer / Consumer problem, the critical section problem, Semaphores, Classical problems in concurrency, inter process communication.Asynchronous Concurrent Process: introduction, parallel Processing, A Control Structure for indicating parallelism. CPU scheduling: concepts, performance criteria, and scheduling Algorithms. Algorithm evaluation, Multiprocessor scheduling.
UNIT- III **10 hrs**	**DEAD LOCKS:** System model, Deadlock characterization. Prevention, Avoidance and Detection, Recovery from deadlock, combined approach. **MEMORY MANAGEMENT:** Base machine, resident Monitor, multiprogramming with fixed partition, Multiprogramming with variable partitions, Paging, Segmentation, paged - segmentation, virtual Memory concepts, Demand paging, performance, page Replacement algorithms, Allocation of frames, Thrashing, cache memory organization impact on performance.
UNIT-IV **10 hrs**	**I/O MANAGEMENT &DISK SCHEDULING:** I/O device and the organization of the I/O function, I/O Buffering, Disk I/O, Operating system Design issues. File system: File Concepts – File organization and Access mechanism, File Directories, File sharing, Implementation issues. Case studies: UNIX system, a virtual machine OS.

Text Books:

1. Operating System concepts by Silberscatz A and Peterson, J.L, PE- LPE.
2. Operating System Design & Implementation by Tanenbaum, A.S., PHI.
3. Operating system concepts Galvin by Silberscatz, John Weiley& Sons

4. Operating systems by H.M.Deital, Pearson Education

Reference Books :

1. Operating System in Depth Design and Programming by Thomas Doeppner, Wiley India
2. Operating System Concept & Design, Milenkovic M, McGraw Hill.
3. Operation System, Stalling William, Maxwell MCMillan International Editions.

BTCO-UG-O406: OPEN ELECTIVE I **(2L 1T 0P)**

To be chosen from pool of electives.

BTCO-UG-L407: DATABASE MANAGEMENT SYSTEMS LABORATORY (0L 0T 3P)

Implementation of ER diagrams using DIA tool, Designing the different databases and working with queries using SQL. Working with Advanced SQL like, Exceptions Cursors, Procedures, Functions and Packages, Mini-Project work using Java as front end and Oracle/PostgresSQL as back end.

References:

1. Thomas Connolly, Carolyn Begg, “Database Systems A Practical Approach to Design, Implementation and Management”, (4e), Pearson Education, England, 2005.

2. Peter Rob, Carlos Coronel, “Database Systems Design, Implementation and Management”, (10e), Course Technology, Boston, 2013.

3. Ivan Bayross, “SQL, PL/SQL”, (4e), BPB Publications, USA, 2009.

BTCO-UG-L408: OPERATING SYSTEMS LABORATORY (0L 0T 3P)

Operating System Structures, Virtual Machines, Process Scheduling, Operations on Processes, Interprocess Communication, Multithreaded Models, Scheduling Algorithms, Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of Synchronization, Monitors, Deadlock Characterization, Methods for handling deadlocks, Logical Versus Physical Address Space, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Allocation Kernel Memory, File Concept, Access Methods, Directory Structure, File System Mounting, Sharing, Protection. Disk Scheduling, Goals of Protection, Principles of Protection, Domain of Protection, implementation of Access Matrix, Case Study- Linux Systems, Design Principles, Process and Memory Management, Scheduling in Linux System, Kernel modules.

References:

1. A. Silberschatz, P. B. Galvin and G. Gagne, “Operating System Concepts”, (8e), Wiley and Sons(Asia) Pt. Ltd., 2009.

2. MclenMilenkovic, “Operating systems: Concepts and Design”,
McGraw Hill, New York, 1987.

3. H. M. Dietel, “An Introduction to Operating Systems”, Addison Wesley, 1990.

4. Andrew S. Tanenbaum, “Operating System: Design and Implementation”, Prentice Hall of India, 1991.

5. Maurice J Bach, “Design of Unix Operating System”, Prentice Hall of India, 1988

BTCO-UG-L409: ALGORITHMS LABORATORY (0L 0T 3P)

Implement a doubly linked list & BST, GCD Techniques, Bubble sort, Selection sort, Linear search, String Matching, Merge Sort, Quick sort, binary search, insertion sort, DFS, BFS, topological sorting, AVL tree, 2- 3 tree, heap sort, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm, N queens problem, subset-sum problem, branch and bound technique.

References:

1. AnanyLevitin, “Introduction to The Design and Analysis of Algorithms”,(3e), Pearson Education, India, 2012.

2. Ellis Horowitz and SartajSahni, “Computer Algorithms/C++”, (2e), University Press, 2007.

3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, “Introduction to Algorithms”, (2e), PHI, 2006.

BTCO-UG-C501: COMPUTER NETWORKS	**(3L 1T 0P)**
Course Objective: This course emphasizes on several computer network concepts, applications and protocols in OSI as well as TCP/IP layered architecture. It also covers the various protocols of various layers, their operations and applications. Further it discusses the concept of network security, challenges and their counter measures.	
Course Objectives: At the end of the course, students will be able to understand 1. The concept of data communication protocols and standards. 2. The concept of open Systems, giving an overview of Transport and Application Support Protocols. 3. The key concepts of protocols and algorithms in networking 4. The complexity of networks, their structure and utility 5. The networking applications, network infrastructure and the network management. 6. Concept of Security provisioning in computer Network.	
UNIT-I **20 hrs**	**Introduction to data communications:** Data representation and data flow, Concepts of communication in computer networks, Layered architecture, OSI, TCP/IP, Addressing of network devices. **Physical layer:** Data and signal fundamentals, Analog and digital signals, Transmission impairments, Digital encoding techniques, Scrambling techniques, Pulse Code Modulation, Multiplexing and Switching methods:FDM, WDM, CDM, Time division multiplexing (synchronous and statistical), Spread spectrum (FHSS and DSSS), Circuit-switched, Datagram and virtual circuit networks, Transmission Media and modes (parallel, serial). **Data link layer:** Data link layer design issue, Error detection and correction: Parity bit, Modulo-2 arithmetic, Polynomial, FEC-Hamming code, Internet checksum, Elementary data link protocol: Stop-and-wait ARQ, Sliding window, Go-back-n, Selective repeat. Random Access: CSMA, CSMA/CA, CSMA/CD, Controlled Access: Reservation, Polling. Channelization: FDMA, TDMA, CDMA, Ethernet LAN.
UNIT-II **15 hrs**	**Network layer:** Design issues of network layer protocols, Network layer protocols of TCP/IP model: ARP, RARP, ICMP, IGMP, Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6), IPv4 and IPv6 packets and addressing, Subnetting and Network Address Translation (NAT) mechanism, **Routing protocols for wired network :**Unicast routing protocols: Shortest Path, Flooding, Distance Vector routing (DVR), Link state routing, Multi cast routing protocols. Interior gateway protocol: Open Shortest Path First (OSPF).
UNIT- III **10 hrs**	**Transport layer:** Functions of transport layer protocols: Congestion control, Reliable service, Introduction to Transmission Control Protocol (TCP) as Transport Layer Protocol, Header description, Congestion control mechanism of TCP, Transport Protocols User Datagram Protocol (UDP), Use of UDP, Header description, Stream Control Transmission Protocol (SCTP).
UNIT-IV **15 hrs**	**Application layer:** Brief overview of protocols in Application Layer: Domain Name Systems, Hyper Text Transmission Protocol, TELecomunicationsNETwork (TELNET), File Transfer Protocol, Dynamic Host Configuration Protocol. E-mail. **Network security:** Principles, Symmetric and Asymmetric Cryptography, Confidentiality, Authenticity, Integrity and Non-repudiation. Symmetric key algorithms: Data Encryption Standard (DES), Public key algorithms: Rivest, Shamir andAdleman algorithm (RSA).

Text Books:

1. Andrew S. Tanenbaum, “Computer Networks”, PHI.
2. Behrouz A. Forouzan, “Data Communications and Networking”, Tata McGraw-Hill.

Reference Books:

1. William Stallings, “Data and Computer Communications”, PHI.
2. Alberto Leon-Garcia, IndraWidjaja, “Communication Networks – Fundamental Concepts and KeyArchitectures”, Tata McGraw-Hill
3. Kurose Ross, “Computer Networks – A Top-Down Approach featuring the Internet”, Pearson.

BTCO-UG-C502: FORMAL LANGUAGES AND AUTOMATA THEORY (2L 1T 0P)

Course Objectives: This course builds upon preliminary knowledge delivered in discrete structure for computer science and computer programming concepts. The main objectives of the course are to provide learners with a detailed understanding of the mathematical models of the machines and their evolution through requirement generation and advancement in languages.

Course Outcome:

At the end of this course students will:

1. Be able to construct finite state machines and the equivalent regular expressions.
2. Be able to prove the equivalence of languages described by finite state machines and regular expressions.
3. Be able to construct pushdown automata and the equivalent context free grammars.
4. Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
5. Be able to construct Turing machines and Post machines.

UNIT-I **15 hrs**	**Introduction:** Language, Grammar, Automata, Relation between language, Grammar and automata, Importance of automata theory. **Finite Automata:** Informal introduction: Drawing examples from everyday life to bring out the essence of finite automata, Finiteness and its importance in automata theory. Deterministic finite automata: Definition, Processing strings, Transition functions, Language of a DFA; Nondeterministic finite automata: Non-determinism, Definition, Extended transition functions, Language of a NFA, Equivalence of DFA and NFA, Kleene's theorem, Epsilon transitions, Applications of Finite automata in text search.
UNIT-II **10 hrs**	**Regular expressions and regular languages:** Memory required to recognize a language, Regular expressions, Regular expression to finite automata, Finite automata to regular expression, Algebraic laws for regular expressions, applications of regular expressions, Criterion for regularity, Regular languages, **properties of regular languages:** Pigeonhole principle, Pumping lemma for regular languages, Closure properties.
UNIT- III **5 hrs**	**Context free grammars and languages:** Definition, Leftmost and rightmost grammars, Parse trees, Ambiguity: Ambiguous grammar, removing ambiguity. Normal forms, Applications of context free grammars: Parsers.
UNIT-IV **15 hrs**	**Pushdown Automata and Turing Machines:** Definition of pushdown automata, Representing pushdown automata, Acceptance by pushdown automata: By final state, By empty stack, Deterministic pushdown automata, Equivalence of pushdown automata and context free grammars, Testing membership of context free, Decision problems for context free languages. Definition and Language of a Turing Machine, Programming Turing Machines, The Church-Turing Thesis, A simple programming language, Extensions of the Basic Turing Machine. **Recursively enumerable languages:** Definition, Enumeration, Chomsky hierarchy, **Undecidability:** The halting problem, the post correspondence problem.

Textbooks:

1. John. E. Hopcroft, Rajeev Motwani, Jeffry.Ullman, Introduction to Automata Theory, Languages and Computation,

Pearson Education.

2. Peter Linz, An Introduction to Formal Languages and Automata, Narosa

Reference books:

1. James. L. Hein, Discrete Structures, Logic and Computability, Narosa
2. ParthaNiyogi, The Computational Nature of Language Learning and Evolution, PHI.
3. C.K. Nagpal, Formal Languages and Automata Theory, Oxford University Press, 2011.
4. John Martin , Introduction to Languages and the Theory of Computation, Tata McGraw Hill.

BTCO-UG-P503:PROGRAMME ELECTIVE I (2L 1T 0P)

To be chosen from pool of electives.

BTCO-UG-P504:PROGRAMME ELECTIVE II (2L 1T 0P)

To be chosen from pool of electives.

BTCO-UG-C505:PROGRAMMING IN JAVA (2L 1T 0P)

Course Objective: The Java Programming Language course provides students with a solid foundation for programming with JAVA. It also highlights the creation of graphical user interfaces (GUIs), exceptions, file input/output (I/O), and threads; and network programming.

COURSE OUTCOME:

1. Can develop solutions for a range of problems using object-oriented programming.
2. Be able to implement, compile, test and run Java programs comprising more than one class, to address a particular software problem.
3. Demonstrate the ability to use simple data structures like arrays in a Java program.

UNIT-I **10 hrs**	**Introduction:** Introduction to Java and Java programming Environment. Object Oriented Programming. Fundamental Programming Structure: Data Types, variable, Typecasting Arrays, Operators and their precedence. **Control Flow:** Java's Selection statements (if, switch, iteration, statement, while, do-while, for, Nested loop) Concept of Objects and Classes, Using Exiting Classes building your own classes, constructor overloading, static , final, this keyword
UNIT-II **10 hrs**	**Inheritance:** Using Super to Call Super class constructor, Method overriding, dynamic method Dispatch, Using Abstract Classes, Using final with inheritance. The Object Class. **Packages & Interfaces:** Packages, Access Protection, Importing package, Interface, Implementing Interfaces, variables in Interfaces, Interfaces can be extended. **Exception Handling:** Fundamentals, Types Checked , Unchecked exceptions, Using try & catch, Multiple catch, throw , throws, finally, Java's Built in exceptions, user defined exception.
UNIT- III **15 hrs**	**Multi-Threading:** Java Thread Model, Thread Priorities, Synchronization, Creating a thread, Creating Multiple threads, Using isAlive ( ) and join ( ), wait () & notify ( ). **String Handling:** String constructors, String length, Character Extraction, String Comparison, Modifying a string. **Java I/O:** Classes & Interfaces, Stream classes, Byte streams, Character streams, Serialization. **Applets:** Basics, Architecture, Skeleton, The HTML APPLET Tag, Passing Parameters to Applets, Applet context and show documents (). **Event Handing:** Delegation Event model, Event Classes, Event Listener Interfaces, Adapter classes. **JDBC:** Fundamentals, Type I, Type II, Type III, Type IV drivers. **Networking:** Basics, Socket overview, Networking classes, & interfaces, TCP/IP client sockets, whois, URL format, URL connection, TCP/IP Server Sockets.
UNIT-IV **10 hrs**	**AWT:** AWT Classes window fundamentals, component, container, panel, Window, Frame , Canvas, Creating a frame window in an Applet , working with Graphics , Control Fundamentals , Layout managers, Handling Events by Extending AWT components. Core java API package, reflection, Remote method Invocation (RMI) **Swing:** J applet, Icons & Labels, Text fields, Buttons, Combo boxes, Tabbed panes, Scroll panes, Trees, Tables. **Exploring Java-lang:** Simple type wrappers, Runtime memory management, object (using clone () and the cloneable Interface), Thread, Thread Group, Runnable.

Textbooks:

1. Introduction to Java Programming: Liang, Pearson Education, 7th Edition.

2. Java The complete reference: Herbert Schildt, TMH, 5th Edition.

Reference Books:

1. Balguruswamy, Programming with JAVA, TMH.
2. Programming with Java: Bhave&. Patekar, Pearson Education.
3. Big Java: Horstman, Willey India, 2nd Edition.
4. Java Programming Advanced Topics: Wigglesworth, Cengage Learning.
5. Java How to Program: H.M. Deitel& Paul J. Deitel, PHI, 8th Edition

BTCO-UG-C506: SOFTWARE ENGINEERING	**(2L 1T 0P)**
Course Objectives: This course presents a comprehensive study of software quality assurance, including software quality control management, processes, systems, methods, standards, certification, and reliability measurement.	
Course Outcomes: After the completion of this course, the students will 1. Learn various methods of software quality management. 2. Get exposure to software quality assurance, quality measures, and quality control. 3. Apply quality management concepts at the applications level. 4. Be exposed to software testing, complexity analysis and ISO certification. 5. Demonstrate proficiency in rapid software development techniques and cost estimation. 6. Author a software testing plan. 7. Manage a project including planning, scheduling and risk assessment/ management.	
UNIT-I **10 hrs**	**Introduction to Software Engineering:** The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI), Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Prototype model, Evolutionary model, Spiral model, RAD model, Agile models.
UNIT-II **15 hrs**	**Software Requirements Specification (SRS):** Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management. System models: Context Models, behavioural models, Data models, Object models, structured methods. **Software Design:** Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design. Software Measurement and Metrics: Various Size Oriented Measures: Hallstead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graphs.
UNIT- III **10 hrs**	**Coding and testing:** Coding, Code review, Testing, Testing in the large vs. testing in the small, Unit testing, Black-box testing, Debugging, Program analysis tools, Integration testing, System testing, Some general issues associated with testing, Test driven development, testing tools, Introduction to Agile software development and DevOps. **Software project management:** Responsibilities of project manager, Project planning, Metrics for project size estimation techniques, Empirical estimation techniques, COCOMO, Halstead's software science, Staffing level estimation, Scheduling, Staffing, Risk management, Software configuration management.
UNIT-IV **10 hrs**	**Software reliability and quality management:** Software reliability, Statistical testing, Software quality and management, ISO 9000, SEI capability maturity model, Personal software process (PSP), Six sigma, Software quality metrics, **Software maintenance and reuse:** Characteristics of software maintenance,

	Software reverse engineering, Software maintenance processes model, Estimation maintenance cost. Basics issues in any reuse program.

Text Book:

1. Software Engineering: A practitioner's Approach, Roger S Pressman, sixth edition. McGrawHill International Edition.
2. Richard Fairley, "Software Engineering Concepts", Tata McGraw Hill.
3. Rajib Mall, "Fundamentals of Software Engineering", PHI.

Reference Books:

1. Jalote Pankaj, "An integrated approach to Software Engineering", Narosa.
2. Pressman R, "Software Engineering- Practioner Approach", McGraw Hill.
3. Somerville, "Software Engineering", Pearson
4. Software Engineering1: Abstraction and modeling, Diner Bjorner, Springer International edition.

BTCO-UG-L507: COMPUTER NETWORKS LABORATORY (0L 0T 3P)

Computer Networks Laboratory

Review of Linux system calls and working with UNIX Network commands, UDP Based Client Server Programs, TCP Based Client Server Programs, Concurrent TCP Servers, Implement the various TCP Protocols- Simple, Go Back N, Selective Reject, Link State Routing, Shortest Path Routing, Distance Vector Routing, Checking the class of IPv4 Addresses, Encapsulation and Decapsulation of IP Packets, Fragmentation, Calculating Cyclic Redundancy Check and Frame Sorting, Synchronous Multiplexing using SELECT System Call.

References:

1. Behrouz A. Forouzan, “Computer Networks A Top Down Approach”, Tata McGraw Hill Publication 2012.
2. W. Richard Stevens, “UNIX Network Programming”, (3e), PHI Publication, 2003.
3. Behrouz A. Forouzan, “TCP/IP Protocol Suite”, (5e), McGraw Hill Publication, 2010.
4. William Stalllings, “Data and Computer Communication”, (8e), PHI Publication, 2011.

BTCO-UG-L508: PROGRAMMING IN JAVA LABORATORY (0L 0T 3P)

Object Oriented Programming, Byte Code Concept, Data Types, Variables and Arrays, Operators, Control Statements, Classes and Methods, Inheritance, String Handling, Packages, Access Protection, Importing Packages, Interface, Exception Handling, Using Try And Catch, Multithreaded Programming, File Handling, standard streams, Byte Streams, File Input/Output Streams, Character Streams, Serialization, Applets-Architecture, display methods, passing parameters Event Handling mechanisms, delegation modes, classes, Event Listeners, Adapter Classes, Inner Classes, AWT Classes, Window Fundamentals, Working With Frame Windows, Introduction to Databases: JDBC Connectivity.

References:

1. Herbert Schildt, “The Complete Reference JAVA”, (8e), TataMcGraw Hill, 2011
2. Deitel and Deitel, “JAVA How to Program”, (10e), Pearson Edu., 2011
3. Steven Holzner, “JAVA 2 programming black book”, Dream Tech, New Delhi, reprint:2005.
4. Pratik Patel and KarlMoss, “JAVA Database programming with JDBC”, (2e), DreamTech, New Delhi, 2000.

BTCO-UG-C601: COMPILER DESIGN (2L 1T 0P)

Course Objectives: The course is aimed at offering complete knowledge on compiler design and ends with the development of a working compiler in parts. This will enable the learners to use formal attributed grammars for specifying the syntax and semantics of programming languages and their impact on compiler design.

Course outcomes: After completing the course, the students will

1. Understand the structure of compilers.
2. Understand the basic techniques used in compiler construction such as lexical analysis, top- down, bottom-up parsing, context-sensitive analysis, and intermediate code generation.
3. Understand the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, code optimizer and stack machines.
4. Design and implement a compiler using a software engineering approach.

UNIT-I **15 hrs**	**Introduction to Compiler:** single and multi-pass compilers, Translators, Phases of Compilers, Compiler writing tools, Bootstrapping, Backpatching. Finite Automata and Lexical Analyzer: Role of Lexical Analyzer, Specification of tokens, Recognition of tokens, Regular expression, Finite automata, from regular expression to finite automata transition diagrams, Implementation of lexical analyzer Tool for lexical analyzer LEX, Error reporting.
UNIT-II **10 hrs**	**Syntax analysis and parsing techniques:** Context free grammars, Bottom-up parsing and top down parsing. Top down Parsing : elimination of left recursion, recursive descent parsing, Predicative Parsing ,Bottom Up Parsing : Operator precedence parsing, LR parsers, Construction of SLR, canonical LR and LALR parsing tables, Construction of SLR parse tables for Ambiguous grammar, the parser generator – YACC, error recovery in top down and bottom up parsing.
UNIT- III **15 hrs**	**Syntax directed translation & intermediate code generation** : Synthesized and inherited attributes, dependency graph, Construction of syntax trees, bottom up and top down evaluation of attributes, S-attributed and L-attributed definitions ,Postfix notation; Three address codes, quadruples, triples and indirect triples, Translation of assignment statements, control flow, Boolean expression and Procedure Calls. **Runtime environment:** Storage organization, activation trees, activation records, allocation strategies, Parameter passing symbol table, dynamic storage allocation**.**
UNIT-IV **5 hrs**	**Code optimization & code generation:** Basic blocks and flow graphs, Optimization of basic blocks, Loop optimization, Global data flow analysis, Loop invariant computations. Issue in the design of Code generator, register allocation, the target machine, and simple Code generator.

Text Books:

1. A.V. Aho, R. Sethi, J.D. Ullman, “Compilers: Principles, Techniques and Tools”, Addison – Wesley.
2. Steven S. Muchnick, “Advanced Compiler Design and Implementation”, Elsevier.

Reference Books:

1. W. Appel, “Modern Compiler Implementation in C: Basic design”, Cambridge Press.
2. Fraser and Hanson, “A Retargetable C Compiler: Design and Implementation”, Addison-Wesley.

3. Dhamdhere, “Compiler Construction”, McMillan.
4. A. V. Aho and J. D. Ullman, “Theory of Parsing, Translation and Compiling”, Prentice Hall.

BTCO-UG-C602: PARALLEL COMPUTER ARCHITECTURE AND PROGRAMMING (2L 1T 0P)

Course Objective

1. To develop structural intuition of how the hardware and the software work, starting from simple systems to complex shared resource architectures.
2. Get a broad understanding of parallel computer architecture and different models for parallel computing
3. To understand concepts related to memory consistency models, cache coherence, interconnection networks, and latency tolerating techniques.
4. To know about current practical implementations of parallel architectures.
5. To learn how to design parallel programs and how to evaluate their execution.

Outcomes: On completion of this subject the student is expected to:

1. Have an understanding of parallel algorithms, analysis and architectures.
2. Be able to reason about ways to parallelize a problem
3. Design and analyze the algorithms that execute efficiently on parallel computers

UNIT-I **10 hrs**	**Introduction & Technique of Parallelism:** Trends towards parallel computing, parallelism in Uniprocessor systems, Architectural classification schemes, Amdahl's law, Moore's law, Principles of Scalable Performance, Parallel Processing in Memory, Parallel Algorithms, Parallel Algorithm Complexity, Models of Parallel Processing, Cache coherence, Cache coherence Protocols.
UNIT-II **10 hrs**	**Pipeline & Vector Processing:** Conditions of Parallelism: Data & Resource dependencies, Program flow mechanisms: Control-flow .vs. Data flow computers Principle of pipelining and vector processing: principles of linear pipelining, classification of pipeline processors. General pipelines and reservation tables. Instruction and arithmetic pipelines, vector processing, architecture of Cray –1, Pipeline hazards, VLIW computers, Array Processing.
UNIT- III **15 hrs**	**Parallel Models & Mesh-Based Architectures:** PRAM and Basic Algorithms, Data Broadcasting, Parallel Prefix Computation, Shared- Memory Algorithms, Parallel Selection Algorithm, Sorting and Selection Networks, Selection Networks, Circuit-Level Examples, Tree-Structured Dictionary Machine, Parallel Prefix Networks, Sorting on a 2D Mesh or Torus, Routing on a 2D Mesh or Torus, Types of Data Routing Operations, Greedy Routing Algorithms, Wormhole Routing, Numeric al 2 D Mesh Algorithms, Other Mesh-Related Architectures, Meshes of Trees, Low-Diameter Architectures, Hyper-cubes and Their Algorithms, Sorting and Routing on Hypercubes, Bitonic Sorting on a Hypercube, Dimension-Order Routing, Broadcasting on a Hypercube, Other Hypercubic architectures, Butterfly and Permutation Networks, Plus-or-Minus-2'Network, The Cube-Connected Cycles Network , Shuffle and Shuffle–Exchange Networks, A Sampler of Other Networks, Star and Pancake Networks, Ring-Based Networks.
UNIT-IV **10 hrs**	**Multiprocessor architecture and Programming:** Emulation and Scheduling, Emulations among Architectures, Distributed Shared Memory, Data Storage, Input, and Output, Multithreading and Latency Hiding, Parallel I/O Technology, Defect-Level Methods, Fault-Level Methods, Error-Level Methods, Parallel Programming Parallel Operating Systems, Parallel File Systems. **Parallel System**

	Implementations: Shared-Memory MIMD Machines, Variations in Shared Memory, MIN-Based BBN Butterfly, Vector-Parallel Cray Y-MP, CC-NUMA Stanford DASH, Message-Passing MIMD Machines, Data-Parallel SIMD Machines, Processor and Memory Technologies.

Text Books:-

1. Computer Architecture & Parallel processing - Kai Hwang 7 Briggs.(MGH).
2. Parallel Computers: Arch.&Prog., Rajaraman& Siva Ram Murthy, PHI.

Reference Books :-

1. Parallel Computer 2 –Arch..&Algo., Adam Hilger, R.W. Hockney, C.R. Jesshope,.
2. Advanced Computer Architecture with Parallel Programming", K. Hwang, MGH.
3. Parallel computing- Theory and practice - Michael J Quinn- Mc Graw Hill

BTCO-UG-P603:PROGRAMME ELECTIVE III (2L 1T 0P)

To be chosen from pool of electives.

BTCO-UG-P604:PROGRAMME ELECTIVE IV (2L 1T 0P)

To be chosen from pool of electives.

BTCO-UG-P605:PROGRAMME ELECTIVE V (2L 1T 0P)

To be chosen from pool of electives.

BTCO-UG-L606: COMPILER DESIGN LABORATORY (0L 0T 3P)

Preliminary Scanning Applications, Identification of Tokens in a given Program, Design of Lexical Analyzer, Design of Parser, Design of Code Generator, Usage of LEX and YACC.

References:

1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers Principles, Techniques and Tools”, (2e), Pearson Education, 2010
2. Kenneth C. Louden, “Compiler Construction - Principles and Practice”, (1e), Thomson, 2007.
3. Vinu V. Das, “Compiler Design using FLEX and YACC”, Prentice-Hall, 2007.

BTCO-UG-L607: PARALLEL PROGRAMMING LABORATORY (0L 0T 3P)

Study of Working Environment of Visual Studio, MPI Programs using Point to Point communication, MPI Programs using Collective communication, Error Handling in MPI, OpenCL program to perform Vector Addition, Matrix Multiplication, Sorting, String reverse, String sorting, Transpose of Matrix, Benchmarking parallel performance, Simple CUDA programs to perform operations on Vectors and Matrices.

References:

1. D. Kirk and W. Hwu, “Programming MASSIVELY Parallel Processors A Hands-on approach”, (1e), Elsevier Inc., 2010.
2. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw Hill Edition, 2003.
3. Benedict R. Gaster, Lee Howes, David R, Perhaad Mistry, Dana Schaa, “Heterogeneous Computing with OpenCL”, (1e),Elsevier Inc., 2012.
4. Shane Cook, “CUDA Programming: A DEVELOPER'S guide to parallel computing with GPUs”, Morgan Kaufman Publication, Elsevier, 2013.
5. “CUDA C Programming Guide”, Nvidia, 2012.

BTCO-UG-I608: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of TWO weeks. This may be taken in a phased manner during the vacation starting from the end of fifth semester or to attend summer training course on courses beyond the scope of normal curriculum organized by the department by calling experts from outside. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry or by department.

BTCO-UG-C701: DISTRIBUTED AND CLOUD COMPUTING (2L 1T 0P)

Course Objectives: This course is designed to present

- The concepts of heterogeneous multi-computer systems and distributed operating systems. Communication in a client/server model using RPC, Message oriented communications, remote object invocation, and distributed processes and software agents.
- An introduction to cloud computing and its techniques - Infrastructure as a Service (IaaS), Platform-as-a-Service (PaaS), Software as a Service (SaaS) and issues.

Learning outcomes: A student successfully completing this unit will have

1. Understanding of the complexities of distributed system development
2. Understanding of the goals and architectures of distributed systems
3. Knowledge of important issues in distributed systems, including time, inter-process communication, state management, distributed computing paradigms, middleware and naming
4. Understanding of the middleware technologies that support distributed applications such as RPC, RMI and object-based middleware
5. Analyse the Service Oriented Architecture and Cloud Computing paradigms.
6. Analyse the enterprise models in cloud computing
7. Evaluate a Software As A Service (SaaS) application.

UNIT-I **10 hrs**	**Fundamentals of Distributed Systems:** Introduction and challenges of Distributed Systems, Systems models: Architectural models and fundamental models, Logical time and logical clocks, Global states.
UNIT-II **15 hrs**	**Coordination and agreement:** Distributed mutual exclusion, elections. **Distributed transactions:** Flat and nested distributed transactions, Atomic commit protocol. **Inter-process communication:** external data representation and marshalling, Multicast communication, Request-Reply Protocols, Remote Procedure Call, Remote Method Invocation.
UNIT- III **10 hrs**	**Understanding Cloud Computing:** Cloud architecture, Cloud storage, Privacy and its relation to cloud-based information systems, Security in the cloud, Common standards in the cloud, End-user access to the cloud computing.
UNIT-IV **10 hrs**	**Deployment models:** Infrastructure as a Service (IaaS): Introduction, Cloud resource virtualization, Virtual Machines Provisioning and Migration Services. The map-reduce programming model and implementations, SLA management in cloud computing.

Text Books:

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems: Concepts and Design”,Pearson
2. Andrew S. Tanenbaum, Maarten van Steen, “Distributed Systems: Principles and Paradigms”, Pearson
3. Michael Miller, “Cloud computing: Web based applications that change the way you work and collaborate online”, Pearson.
4. Haley Beard, “Cloud computing best practices for managing and measuring processes for on demand computing, Applications and data centers in the cloud with SLAs”, Emereo.

Reference Books:

1. Pradeep K. Sinha, “Distributed Operating Systems”, PHI.
2. Nancy A. Lynch, “Distributed Algorithms”, Elsevier.
3. Kenneth P. Birman, “Reliable distributed systems: Technologies, Web services, and applications”,Springer.
4. Paulo Veríssimo, Luis Rodrigues, “Distributed systems for system architects”, Springer.
5. Guy Bunker and Darren Thomson, “Delivering Utility Computing”, John Wiley & Sons.
6. George Reese, “Cloud Application Architectures”, O’Reilly.
7. Lee Gillam, “Cloud Computing: Principles, Systems and Applications”, Springer.
8. Brian J. S. Chee, Curtis Franklin, Jr., “Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center”, CRC Press.

BTCO-UG-C702: ESSENTIALS OF MANAGEMENT (2L 1T 0P)

Course Objectives:

1. To help the students gain understanding of the functions and responsibilities of managers.
2. To provide them tools and techniques to be used in the performance of the managerial job.
3. To enable them to analyze and understand the environment of the organization.
4. To help the students to develop cognizance of the importance of management principles.

Course Outcomes:

On completion of this course, the students will be able to

1: Understand the concepts related to Business.

2: Demonstrate the roles, skills and functions of management.

3: Analyze effective application of PPM knowledge to diagnose and solve organizational problems and develop optimal managerial decisions.

4: Understand the complexities associated with management of human resources in the organizations and integrate the learning in handling these complexities.

UNIT-I **10 hrs**	**Introduction:** Definition of management and systems approach, Nature & scope, The functions of managers, Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, Policies & planning premises, Strategic planning process and tools.
UNIT-II **10 hrs**	**Organizing:** Nature & purpose of organizing, Span of management, factors determining the span, Basic departmentalization, Line & staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training.
UNIT- III **10 hrs**	**Motivation:** Theories of motivation, Special motivational techniques. **Leadership** - leadership behaviour& styles, Managerial grid. Basic Control Process, Critical Control Points & Standards.
UNIT-IV **15 hrs**	**Budgets**: Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA & application of Theory Z. The nature & purpose of international business & multinational corporations, unified global theory of management. **Traits:** Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

References:

1. Koontz D., “Essentials of Management”, McGraw Hill, New York, 2004.
2. Peter Drucker, “Management, Task and Responsibility”, Allied Publishers, 2006.
3. Peter Drucker, “The practice of Management”, Butterworth Hein Mann, 2003.

BTCO-UG-P703:PROGRAMME ELECTIVE VI (2L 1T 0P)

To be chosen from pool of electives.

BTCO-UG-P704:PROGRAMME ELECTIVE VII	**(2L 1T 0P)**
To be chosen from pool of electives.	

BTCO-UG-O705: OPEN ELECTIVE II	**(2L 1T 0P)**

BTCO-UG-L706: INTELLIGENT SYSTEM LAB (0L 0T 3P)

Regression via polynomial curve fitting, SVMs for a multiclass classification problem, unsupervised learning methods for clustering data, Back-propagation algorithm to experiment with the use of Neural Networks for a multiclass classification problem, naïve Bayesian classifier for a sample training data set stored as a .CSV file, non-parametric Locally Weighted Regression algorithm in order to fit data points, k-Nearest Neighbour algorithm, GMM implementation, decision tree based ID3 algorithm, Auto-encoder for dimensionality reduction and image de-noising on MNIST data set.

References:

1. Ivan Bratko : Logic & prolog programming.
2. Carl Townsend : Introduction to Turbo Prolog, BPB, Publication.
3. W.F. Clocksin&Mellish : Programming in PRLOG, Narosa Publication House.

BTCO-UG-L707: INTERNET TECHNOLOGIES LABORATORY (0L 0T 3P)

Basics of WWW, HTTP, XHTML, HTML5 and CSS3, Client Side Scripting Vs Server Side Scripting, PHP, Java Web Technologies, ASP.NET, The C# Language, The Anatomy of an Web Application, Introducing Server Control, The Page Class, Application Events, Web Controls, Error Handling, Logging and Tracing, State Management, Validation, Styles, Themes and Master Pages, The Data Provider Model, Direct Data Access, Disconnected Data Access, Data Binding, Data Source

Controls, The Grid View, Files and Streams, XML, Understanding Security, Authentication and Authorization, Forms Authentication, Windows Authentication, Understanding Caching, Output Caching, Data Caching, Understanding the Need of Ajax, Building ASP.NET AJAX Applications, ASP.NET AJAX's Server-Side Controls, Using Multiple UpdatePanel Controls, jQuery.

References:

1. AchyutGodbole, AtulKahate, “Web Technologies”, (3e), McGraw Hill, 2013.

2. Jason N. Gaylord, Christian Wenz, Pranav Rastogi, Todd Miranda, Scott Hanselman, “Professional ASP.NET 4.5 in C# and VB”, Wrox, 2013.

3. Matthew MacDonald, “Beginning ASP.NET 4.5 in C#”, Apress, 2012.

4. Jennifer Niederst Robbins, “Learning Web Design: A Beginner's Guide to HTML, CSS, JAVASCRIPT, and Web Graphics”, (4e), O'Reilly 2012.

5. Jon Duckett, “HTML and CSS: Design and Build Websites”, (1e), Wiley, 2011.

BTCO-UG-D708: MINI PROJECT **(0L 0T 4P)**

Students are required to undertake innovative and research oriented project under the direct supervision of a faculty member of the department. The mini project should not only to reflect their knowledge gained in the previous semesters but also to acquire additional knowledge and skill of their own effort.

BTCO-UG-D801: MAJOR PROJECT

- The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions.
- The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks.
- A mid-semester evaluation of the project work shall be done.
- An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation.
- The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form.
- Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

BTCO-UG-O406: OPEN ELECTIVE I (2L 1T 0P)

E1: INTERNET TECHNOLOGY

Course Objective: The primary objective of this course is to develop an understanding of the impact created by technology and internet on the modern society. It also emphasizes on the ways to cope-up with the negative impacts.

Course objectives: On successful completion of course, the learners will be able:

1. To understand the impact of technology and internet on the modern society.
2. To appreciate the philosophy of free/libre software.
3. To identify fraudulent information online.
4. To safeguard personal information online.

UNIT-I **5 hrs**	**Basics**: WWW, HTTP, XHTML, HTML5 and CSS3, Client Side Scripting Vs Server Side Scripting, PHP, Java Web Technologies, ASP.NET, The C# Language, The Anatomy of an Web Application.
UNIT-II **5 hrs**	**Introduction to Multimedia System:** Architecture and components, Multimedia distributed processing model, Synchronization, Orchestration and Quality of Service (QOS) architecture.
UNIT-III **15 hrs**	**Software Freedom:** Code is Law, The regulation of code, Software ethics, Proprietary software, Digital Restrictions Management, Free Software Movement, Free/Libre software vs Open source software, Four essential software freedom, Secure Boot vs. Restricted Boot, Free JavaScript, GNU OS, Free BIOS Campaign
UNIT-IV **20 hrs**	**Software Licenses:** Intellectual Property Rights, Software Patents, Copyright vs. Copyleft, Creative Commons, EULA, Free and Open source licenses, GNU Licenses, **Protecting our privacy and freedom:** Free/libre OS, Free/libre software alternatives, Protecting privacy on internet, Protecting privacy on mobile phone, Email self defence, Free Android, Freedom Campaigns.

Text Books:

1. Achyut Godbole, AtulKahate, “Web Technologies”, (3e), McGraw Hill, 2013.
2. Jason N. Gaylord, Christian Wenz, Pranav Rastogi, Todd Miranda, Scott Hanselman, “Professional ASP.NET 4.5 in C# and VB”, Wrox, 2013.
3. Anabel Quan-Haase, “Technology and Society: Social Networks, Work, and Inequality”, Oxford University Press.
4. Lawrence Lessig, “Code version 2.0”, Basic Books.

Reference Books:

1. Matthew MacDonald, “Beginning ASP.NET 4.5 in C#”, Apress, 2012.
2. Jennifer Niederst Robbins, “Learning Web Design: A Beginner's Guide to HTML, CSS, JAVASCRIPT, and Web Graphics”, (4e), O'Reilly 2012.
3. Jon Duckett, “HTML and CSS: Design and Build Websites”, (1e), Wiley, 2011.

E2:COMPUTER HARDWARE MAINTENANCE

Course Objective: The objective of this course is to acquire basic knowledge in Computer hardware and peripherals for installation, trouble shooting and maintenance. This course is also aimed at being a curtain raiser for later courses on Computer Organization and Microprocessors.

Learning outcomes: On successful completion of PC hardware module the learner will be able to

1. Demonstrate an understanding of the organisation and underlying architecture of PCs.
2. Demonstrate an understanding of the basic electronics behind the components of a computer system.
3. Troubleshoot PC hardware problems.
4. Upgrade PC components safely.

UNIT-I **10 hrs**	**Microcomputer System:** Computer Organization, Memory, Arithmetic and Logic Units, Control Unit, Instruction pre-fetch, Interrupts, I/O techniques, Device Controllers, Microprocessors**, Peripheral Devices:** Keyboard and keyboard interface; CRT display monitor, Printer, Magnetic Storage Devices, Floppy Disk Drive, Hard disk drive.
UNIT-II **10 hrs**	**PC Hardware Overview:** Hardware-BIOS-DOS interaction, PC family, PC hardware, motherboard logic, memory space, I/O port addresses, I/O data transfer, DMA channels. **Hardware Components and IC's:** Hardware components - discrete and integrated; Pulse, Circuits and waveforms, positive and negative logic.
UNIT-III **15 hrs**	**Motherboard support chips and circuits:** Clock generator, Interrupt controller, Programmable Interval Timer, 8255A- PPI(Programmable Peripheral Interface). Motherboard functions and logic (RAM, ROM, Reset). Control, Address, and Data bus logic. Motherboard connectors and jumpers, SMPS.
UNIT-IV **10 hrs**	**Troubleshooting and Overview of Advance PCs:** Computer Faults, Nature of faults and its types. Diagnostic Programs and tools. Fault elimination process, diagnosis and rectification. Systematic Troubleshooting, POST, Motherboard problem diagnosis.

Text Books:

1. B. Govindarajalu, "IBM PC and Clones", Tata McGraw-Hill.
2. A. Ray, K. M. Bhurchandi, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing", Tata McGraw Hill.

Reference Books:

1. Clements, Alan, "Principles of Computer Hardware", Oxford University Press.
2. Rajaram, "Fundamentals of Computer", Prentice Hall of India.
3. Mathivanam, "Microprocessors PC Hardware and Interfacing", Prentice Hall of India.
4. Peterson, "Computer Organization and Design, The Hardware/Software Interface", Elsevier

E3: PYTHON PROGRAMMING

Course Objectives: The course is designed to provide Basic knowledge of Python. Python programming is intended for software engineers, system analysts, program managers and user support personnel who wish to learn the Python programming language.

Course Outcomes: After learning the course the students should be able to:

- Implement a given algorithm as a computer program (in Python).
- Adapt and combine standard algorithms to solve a given problem (includes numerical as well as non-numerical algorithms).
- Adequately use standard programming constructs: repetition, selection, functions, composition, modules, aggregated data (arrays, lists, etc.).
- Explain what a given program (in Python) does.
- Identify and repair coding errors in a program.
- Understand and use object based software concepts (constructing OO software will be dealt with in the course Software Engineering).
- Use library software for (e.g.) building a graphical user interface, web application, or mathematical software

UNIT-I **10 hrs**	**Basics**: Introduction to Python, Python Interpreter and its working, Syntax and Semantics, Data Types, Assignments and Expressions, Control Flow Statements, Sequences and Dictionaries, Functions and lambda expressions.
UNIT-II **10 hrs**	**Advanced features:** Iterations and Comprehensions, Handling text files, Python Object–based programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class, Inheritance, overlapping and overloading operators.
UNIT-III **15 hrs**	**Exception Handling:** Difference between an error and Exception, Handling Exception, try except block, Raising Exceptions, User Defined Exceptions, **Python Regular Expression:** Powerful pattern matching and searching, Real time parsing of networking or system data**,** Widgets and basic components**.**
UNIT-IV **10 hrs**	**Python Database Interaction and File Operation:** SQL Database connection using python, Creating and searching tables, Reading and storing config information on database, Programming using database connections, **Network And Web Programming:** Socket Programming : Handling Multiple Clients, Client side scripting, Server side scripting.

Text Books:

1. Mark Lutz, “Programming Python”, O'Reilly.
2. W.Chun, “Core Python Programming”, Pearson.

Reference Books:

1. Allen Downey, “Think Python”, Green Tea Press
2. Mark Lutz, “Learning Python”, 3rd Edition, O'Reilly
3. Guido van Rossum and Jr. Fred L. Drake , “An Introduction to Python”, Network Theory Ltd.

E4: SOCIAL NETWORK ANALYSIS

Course Objective:

• To understand how the world is connected -- socially, strategically and technologically and why it matters

• To introduce the basic notions and model used for social network analysis.

Course outcomes: On successful completion of this course, the learners will be able to:

1. Use social network analysis tool, notations and models to understnd social netoworking.
2. Understand mathematical notations of social network.
3. Model network fomation using well known models.
4. Perform mining and analysis of social network data.

UNIT-I **5 hrs**	**Introduction to Social Web**, Nodes, Edges and Network measures, Describing Nodes and Edges, Describing Networks, Layouts, Visualizing Network features
UNIT-II **12 hrs**	**Tie Strength:** The role of Tie Strength, Measuring Tie Strength, Tie Strength and Network Structure, Tie Strength and Network Propagation, **Link Prediction**:Entity Resolution, Link Prediction: Case Study Friend Recommendation.
UNIT-III **13 hrs**	**Introduction to Community Discovery**: Communities in Context, Quality Functions, The Kernighan-Lin algorithm, Agglomerative Algorithms, Spectral Algorithms, Multi-level Graph Partitioning, Markov Clustering, Other Approaches
UNIT-IV **15 hrs**	**Introduction to Social Influence**: Influence Related Statistics, Social Similarity and Influence, Homophily, Existential Test for Social Influence, Influence and Actions, Influence and Interaction, Influence Maximization in Viral Marketing

Textbooks:

1. Jennifer Goldbeck, “Analyzing the Social Web”, Morgan Kaufmann Publications, 2013.

2. Charu C. Aggarwal, “Social Network Data Analytics”, Springer Publications, 2011.

3. John Scott, “Social Network Analysis”, (3e), SAGE Publications Limited, 2013.

Reference Books:

4. Jay Goldman, “Facebook Cookbook”, O'Reilly, 2009.

5. Shamanth Kumar, Fred Morstatter, Huan Liu, “Twitter Data Analytics”, Springer Publications, 2013.

E5: COMPUTER GRAPHICS

Course Objective: The primary objective of this course is to learn the basic principles of computer graphics. These topics will include the following:

- Transformational geometry -- utilizing transforms to positioning and manipulate objects in 3-dimensional space. This includes the positioning of virtual cameras and light sources.
- Rendering of complex models -- accurately drawing illustrations of complex objects with arbitrary camera and light source.
- Curves and surfaces -- methods for rendering and shading curved objects

Course outcomes: On successful completion of this course, the students will be able to:

1. Know and be able to describe the general software architecture of programs that use 3D computer graphics.
2. Know and be able to discuss hardware system architecture for computer graphics. This includes, but is not limited to: graphics pipeline, frame buffers, and graphic accelerators/co-processors.
3. Know and be able to use a current 3D graphics API (e.g., OpenGL or DirectX).
4. Must be able to use the underlying algorithms, mathematical concepts, supporting computer graphics.

UNIT-I **10 hrs**	**Introduction**: Application areas of Computer Graphics, overview of graphics systems, video-display devices, raster-scan systems, random scan systems, graphics monitors and work stations and input devices. **Output primitives**: Points and lines, line drawing algorithms, mid-point circle and ellipse algorithms. Filled area primitives: Scan line polygon fill algorithm, boundary-fill and flood-fill algorithms
UNIT-II **10 hrs**	**2-D geometrical transforms:** Translation, scaling, rotation, reflection and shear transformations, matrix representations and homogeneous coordinates, composite transforms, transformations between coordinate systems. **2-D viewing** : The viewing pipeline, viewing coordinate reference frame, window to view-port coordinate transformation, viewing functions, Cohen-Sutherland and Cyrus-beck line clipping algorithms, Sutherland –Hodgeman polygon clipping algorithm.
UNIT-III **15 hrs**	**3-D object representation :** Polygon surfaces, quadric surfaces, spline representation, Hermite curve, Bezier curve and B-Spline curves, Bezier and B-Spline surfaces. Basic illumination models, polygon rendering methods. **3-D Geometric transformations:** Translation, rotation, scaling, reflection and shear transformations, composite transformations. **3-D viewing:** Viewing pipeline, viewing coordinates, view volume and general projection transforms and clipping.
UNIT-IV **10 hrs**	**Visible surface detection methods** : Classification, back-face detection, depth-buffer, scan-line, depth sorting, BSP-tree methods, area sub-division and octree methods. **Computer animation:** Design of animation sequence, general computer animation functions, raster animation, computer animation languages, key frame systems, motion specifications.

Textbooks:

1. “Computer Graphics *C version*”, Donald Hearn and M.Pauline Baker, Pearson Education.

2. “Computer Graphics Principles & practice”, second edition in C, Foley, Van Dam, Feiner and Hughes, Pearson Education.

Reference Books:

1. “Computer Graphics”, second Edition, Donald Hearn and M.Pauline Baker, PHI/Pearson Education.

2. “Computer Graphics Second edition”, Zhig and Xiang, Roy Plastock, Schaum’s outlines, Tata Mc- Graw hill edition.

3. Procedural elements for Computer Graphics, David F Rogers, Tata Mc Graw hill, 2nd edition.

4. “Principles of Interactive Computer Graphics”, Neuman and Sproul, TMH.

E6: SOFT SKILLS AND INTERPERSONAL COMMUNICATION

Course Objectives:

To enhance holistic development of students and improve their employability skills.

Learning outcomes: On completion of the course it is expected to endow the students with skills to

- Understand corporate communication culture
- Prepare business reports and proposals expected of a corporate professional
- Employ appropriate speech in formal business situations
- Exhibit corporate social responsibility and ethics
- Acquire corporate email, mobile and telephone etiquette

UNIT-I **15 hrs**	**English Language Enhancement:** Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English, **Art of Communication:** Communication process- Non-verbal Communication- Effective Listening.
UNIT-II **10 hrs**	**Interpersonal and Intra Personal Communication Skills**: Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles Leadership.
UNIT-III **10 hrs**	**Campus to Company**: Dressing and Grooming- The Corporate Fit- Business Etiquette Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.
UNIT-IV **10 hrs**	**Interview Handling skills**: Effective Resume-- Common Interview Mistakes- Body-languageContent Aid, Visual Aids- Entrepreneurial Skills Development.

Textbooks:

1. Robert M. Sherfield, Developing Soft Skills, Montgomery and Moody Fourth Edn. Pearson, 2009.

Reference Books:

1. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.

2. Robert Bramson, Coping with Difficult People, Dell, 2009

E7: COMPUTATIONAL AND QUANTITATIVE BIOLOGY

Course Objectives: This course seeks to introduce key concepts basics of biology such as cell structure and functions, inheritance & evolution, basic concepts of genetics, and an introduction to microbiology and its mathematical modelling, in the context of different type's biological networks. The course will cover important concepts from network biology, modelling of dynamic systems and parameter estimation, constraint-based metabolic modelling as well as quantify biological data and explain how these tools is best used. This course also touches upon some of the cutting-edge topics in the field.

Course outcomes: After studying the course, the student will be able to:

1. Convey that classification per se is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological.
2. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring.
3. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine.
4. Classify enzymes and distinguish between different mechanisms of enzyme action.
5. Identify DNA as a genetic material in the molecular basis of information transfer.
6. Analyze biological processes at the reductionistic level.
7. Apply thermodynamic principles to biological systems.
8. Identify and classify microorganisms.
9. Understand modelling of dynamic systems and parameter estimation, constraint-based metabolic modelling
10. Quantify biological data
11. Understand cutting-edge topics

UNIT-I **15 hrs**	**Biochemistry and Molecular Analysis:** Chemical Composition of Living Forms,Analysis of Chemical Composition, Carbohydrates, Amino acids and Proteins, Nucleic Acids, Lipids, Nature of Bonding and Qualitative Tests, **Enzymes:** Enzymes, Classification and Nomenclature of Enzymes, Co-Factors. **Introduction to Metabolism:** Metabolism and Its Concepts, Metabolic Basis for Living—Anabolic and Catabolic Pathways, Concept of Non-Equilibrium and Steady State, Photosynthesis, Photorespiration (C2 Cycle), C4 Pathways, CAM Cycle.
UNIT-II **10 hrs**	**Genetics**: Mendelian Law, Mendel's Laws of Inheritance, Gene Interaction, Multiple Alleles, Chromosomal Theory of Inheritance, Linkage, Recombination, Chromosome Mapping, Genetic Disorders. **Transfer of Genetic Information:** Central Dogma of Molecular Biology, Transcription, Genetic Code, Translation, Regulation of Gene Expression, **Evolution:** Origin of Universe, Origin of Life, Evolution of Life Forms, Evidences of Evolution, Adaptive Radiation, Theories of Evolution, Biological Evolution, Hardy–Weinberg Principle, A Brief Account of Evolution.
UNIT-III **10 hrs**	**Microbiology and Its Industrial Applications:** Microorganisms, Growth Kinetics, Culture Media, Sterilization, Microscopy, Applications of Microbiology, Immunology and Immunity, Cancer Biology,

	Stem Cell. **Mathematical Modelling**, Static Networks, Network Biology and Applications, Reconstruction of Biological Networks, Dynamic Modelling of Biological Systems, Solving ODEs & Parameter Estimation, Constraint-based approaches to Modelling Metabolic Networks, Perturbations to Metabolic Networks, Modelling Regulation; Applications of Constraint-based Modelling, Elementary Modes.
UNIT-IV **10 hrs**	**Advanced topics:** Robustness and Evolvability, Synthetic Biology; Perspectives & Challenges. **Quantitative Analysis and Presentation of Visual Data:** Effective Visual Display of Data, Elements of Design, Dot Matrix Visualization and Analysis of DNA, Phylogenetic Analysis, Rooted Tree Reconstruction, Tree Topology, The Principle of Parsimony, Color Blindness and Heat Maps .

Textbooks:

1. A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publications, 2013
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.
3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004
4. Computational Cell Biology, Christopher Fall, Springer, 2000.
5. Mathematical models in biophysics, Riznichenko Galina Yur'evna, Book Online, Biophysical society.

Reference Books

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
2. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
3. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012

BTCOM-UG-P503 & BTCOM-UG-P504: PROGRAMME ELECTIVE I & II(2L 1T 0P)

E1: SYSTEM PROGRAMMING

Course Objective: This course emphasizes on systems programs: operating systems, assemblers, compilers, interpreters, macro processors and loaders. This course also discusses the design of the system programs: assembler, linkers and loaders.

Course outcomes: Upon completion of this course, students will be able to

1. Have in-depth knowledge of system programs – assembler, loaders, macroprocessor, lauguage processor and compiler.
2. Develope system programs- one pass and two pass assembler, two pass Macroprocessor, absolute and DLL loader.
3. Develope modules for syntax and grammer checking for design of compiler.

UNIT-I **15 hrs**	**Scope of systems programming and background:** Introduction to application software and systems software, Concept of hardware, System software concept, System design and methods of system design, Properties of good and structured system, **General machine structure and machine language:** General machine structure, Instruction set, Machine language, Assembly language (IBM-360).
UNIT-II **10 hrs**	**Assemblers:** Assemblers, General design procedure, Design of assembler: One pass assembler, Two pass assembler. **Macros:** Macros language and macro processer: Macro instruction arguments, Conditional macro expansion, Macro calls within macros, Macro instructions defining macros, Implementation of restricted facility: A two pass algorithm.
UNIT-III **15 hrs**	**Loaders:** Loaders, Loader schemes, Compile and go loaders, General loader scheme: Absolute loaders, Subroutine linkages, Relocating loader, Loader schemes binders, Linking loaders, Overlays, Dynamic binders, Design of an absolute loader and design of a direct linking loader. **Language processor:** Introduction, Language processing activities, Fundamentals of language processing, Fundamentals of language specification**,** Language processor development tools.
UNIT-IV **5 hrs**	**Compilers:** Introduction to compilers, Aspects of compilation, Memory allocation, Compilation of expressions, Compilation of control structures, Code optimization, Interpreters.

Text Books:

1. John J. Donovan, “Systems Programming”, Tata McGraw Hill.

2. Srimanta Pal, “Systems Programming”, Oxford.

Reference Books:

1. D M Dhamdhere, “Systems Programming & Operating Systems”, Tata McGraw Hill.
2. Aho, Ulmann, Sethi , “Compiler Design”, Pearson Education.
3. Leland L.Beck, D.Manjula, “System Software-An Introduction to System Programming”, Pearson
4. A.C. Shalini, “System Software”, SCITECH Publication.

E2: SYSTEM MODELING AND SIMULATION

Course Objectives: This course envisages the fundamentals of discrete event simulation (DES), which includes discrete event simulation methodology, development of simulation models, verification and validation, and the design of simulation experiments.

Course outcomes: On completing this course students should be able to

1. Define basic concepts in modeling and simulation and demonstrate an understanding of system modeling through the competent use of computer simulation methods and mathematical modelling techniques
2. Determine the type of systems whose behaviour can be investigated using discrete event simulation and modeling as well as system dynamics-simulation modeling technique
3. Classify various simulation models and give practical examples for each category
4. Construct a model for a given set of data and motivate its validity
5. Generate and test random number variates and apply them to develop simulation models
6. Analyze output data produced by a model and test validity of the model

UNIT-I **10 hrs**	**System Definition and Components**, Stochastic Activities, Continuous and Discrete Systems, System Modeling, Types of Model, Static and Dynamic Physical Models, Static and Dynamic Mathematical Models, Full Corporate Model, Types of System Study.
UNIT-II **15 hrs**	System Simulation, Why to Simulate and When to Simulate, Basic Nature of Simulation, Technique of Simulation, Comparison of Simulation and Analytical Methods, Types of System Simulation, Real Time simulation, Hybrid Simulation, Simulation of Pure-Pursuit Problem Single-Server Queuing System and An Inventory Problem, Monte Carlo Simulation, Distributed Lag Models, Cobweb Model.
UNIT-III **10 hrs**	Simulation of Continuous Systems, Analog Vs, Digital Simulation, Simulation of Water Reservoir System, Simulation of A Servo System, Simulation of An Autopilot Discrete System Simulation, Fixed Time-Step Vs, Event-To-Event Model, Generation of Random Numbers, Test for Randomness, Generalization of Non-Uniformly Distributed Random Numbers, Monte-Carlo Computation Vs. Stochastic Simulation.
UNIT-IV **10 hrs**	System Dynamics, Exponential Growth Models, Exponential Decay Models, Modified Exponential Growth Models, Logistic Curves, Generalization of Growth Models, System Dynamics Diagrams, Feedback in Socio-Economic Systems. World Model: Critical Path Computation, Uncertainties in Activity Duration, Resource Allocation Simulation Software, Gerneral Purpose Vs Application-Oriented Simulation Packages

Textbooks:

1. Geoftrey Gordon, “System Simulation”, PHI
2. Narsingh Deo, “System Simulation with Digital Computer”,PHI
3. Averill M. Law, W. David Kelton, “Simulation Modeling and Analysis”, TMH

Reference Books:

1. Raj Jain, “The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling”, John Wiley & Sons.

1. Gordon, “System Simulation”, Prentice Hall.
2. Singh V.P, “System Modeling and Simulation”, New Age International.
3. Frank L. Severence, “System ModelingAnd Simulation: An Introduction”, Wiley.
4. Banks, Carson, Nelson, Nicol, “Discrete-Event System Simulation”, Pearson Education.

E3: BIOINFORMATICS

Course Objective

1. This course aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases.
2. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, prediction of protein function

Course Outcomes: After successful completion of the course,

- student will be able tohave a good working knowledge of basic bioinformatics tools and databases such as GenBank, BLAST, multiple alignment, and phylogenetic tree construction.
- students will understand the basic theory behind these procedures and be able to critically analyze the results of their analysis using such tools.

UNIT-I **15 hrs**	**Bioinformatics**- Introduction, Application, Data Bases and Data Management, Central Dogma; information search and Data retrieval, **Genome Analysis and Gene mapping**- Analysis, Mapping, Human Genome Project (HGP), Alignment of Pairs and Sequences; Alignment of Multiple Sequences and Phylogenetic Analysis.
UNIT-II **10 hrs**	**Tools for similarity Search and Sequence Alignment**- FASTA BLAST, Profiles and Hidden Marcov Models (HMMs); **Gene Identification and Prediction**-Basics, Pattern Recognition, Methods and Tools; Gene Expression and Micro arrays.
UNIT-III **10 hrs**	**Protein Classification and Structure Visualization**; Protein Structure Prediction; Proteomics; Computational methods-Analysis of Pathways, Metabolic Network Properties, Metabolic Control Analysis, Stimulation of Cellular Activities, Biological Mark Up Languages.
UNIT-IV **10 hrs**	**Drug Discovery**-Introduction, Technology and Strategies, Cell Cycle, G-protein, Coupled, Receptors, **Computer Aided Drug Design**-Introduction, Drug Design Approaches, Designing methods, ADME-Tox Property Prediction.

Textbooks:

1. Bioinformatics by S.C. Rastogy, 2nd Edition, Prentice Hall Of India. II.
2. Bioinformatics by V. R Srinivas, Prentice Hall of India

Reference Books:

1. Bioinformatics Computing by Bergeron, MIT Press.
2. Evolutionary Computation in Bioinformatics, Gary B. Fogel, David W. Corne (Editors), 2002
3. Introduction to Bioinformatics, Arthur M. Lesk, 2002, Oxford University Press
4. Current Topics in Computational Molecular Biology (Computational Molecular Biology), Tao Jiang, Ying Xu, Michael Zhang (Editors), 2002, MIT Press

E4: DIGITAL IMAGE PROCESSING

Course Objective

• Cover the basic theory and algorithms that are widely used in digital image processing

• Expose students to current technologies and issues that are specific to image processing systems

• Develop hands-on experience in using computers to process images

• Develop critical thinking about shortcomings of the state of the art in image processing

Outcomes: After successful completion of the course, student will be able to

• Describe, analyze and reason about how digital images are represented, manipulated, encoded and processed, with emphasis on algorithm design, implementation and performance evaluation.

• Apply principles and techniques of digital image processing in applications related to digital imaging system design and analysis.

• Analyze and implement image processing algorithms.

UNIT-I **10 hrs**	**Introduction:** Image formation model, Spatial & Gray level resolution, Image enhancement in special domain: Piecewise transformation functions, Histogram equalization, Histogram specification, image averaging, spatial filters smoothing and sharpening, Laplacian filter, Canny edge detector.
UNIT-II **10 hrs**	**Image Enhancement in Frequency Domain & Image segmentation :** 2D discrete Fourier transform & its inverse, filtering in frequency domain, Ideal & Gaussian low pass filters, High pass filtering, FFT, Line detection, Edge detection, Edge linking & boundary detection, Thresholding, Region based segmentation.
UNIT-III **10 hrs**	**Morphological Image Processing:** Logic operations involving binary image, Dialation & Erosion, Opening & Closing, Applications to Boundary extraction, region filling, connected component extraction.
UNIT-IV **15 hrs**	**Image compression:** Coding redundancy- Huffman coding, LZW coding, run length coding, Lossy compression- DCT, JPEG, MPEG, video compression. **Image representation & 3D:** Boundary descriptors, Shape numbers, Texture, Projective geometry, Correlation based and feature based stereo correspondence, shape from motion, optical flow.

Text Books:

1. Rafael C Gonzalez, Richard E Woods, “Digital Image Processing”, Pearson Education Publications.
2. Rajjan Shinghal, “Pattern Recognition”, Oxford Publications.

Reference Books:

1. Chanda and Majumder, “Digital Image Processing and Analysis”, Prentice Hall Publications.
2. Rafael C Gonzalez, Richard E Woods, “Digital Image Processing with Matlab”, Pearson Education Publications.
3. S. Sridhar, “Digital Image Processing”, Oxford University Press.
4. Jayaraman, “Digital Image Processing”, McGraw Hill.

E5: LOW POWER CIRCUITS AND SYSTEMS

Course Objectives: The course covers fundamentals of low power circuit and system design.

Course Outcomes: On completion of the course it is expected to endow the students with skills of calculating, estimating and managing power consumption as well as techniques at various levels: from architecture to circuits and devices.

UNIT-I **15 hrs**	**Basics of MOS circuits**: MOS Transistor structure and device modeling; MOS Inverters; MOS Combinational Circuits – Different Logic Families. **Sources of Power dissipation:** Dynamic Power Dissipation: Short Circuit Power; Switching Power; Gliching Power: Static Power Dissipation
UNIT-II **10 hrs**	**Supply Voltage Scaling Approaches:** Device feature size scaling; Multi-Vdd Circuits; **Architectural level approaches:** Parallelism, Pipelining; Voltage scaling using high-level transformations; Dynamic voltage scaling; Power Management.
UNIT-III **5 hrs**	Switched Capacitance Minimization Approaches: Hardware Software Tradeoff; Bus Encoding; Two's complement Vs Sign Magnitude; Architectural optimization; Clock Gating; Logic styles
UNIT-IV **15 hrs**	**Leakage Power minimization Approaches**: Variable-threshold-voltage CMOS (VTCMOS) approach; Multithreshold-voltage CMOS (MTCMOS) approach; Dual-Vt assignment approach (DTCMOS); Transistor stacking. **Switching and Synthesis**: Adiabatic Switching Circuits; Battery-aware Synthesis; Variation tolerant design

Text Books

1. Sung_Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Tata McGraw Hill

2. Neil H. E. Weste and K. Eshraghian, Principles of CMOS VLSI Design, 2nd Edition, Addison Wesley (Indian reprint).

Reference Books:

1. A. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press, 1995

2. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995

3. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-Interscience, 2000

E6: SPEECH AND NATURAL LANGUAGE PROCESSING

Course objective:

• To understand the concepts of morphology, syntax, semantics and pragmatics of the language.

• To recognize the significance of pragmatics for natural language understanding

• To describe the simple system based on logic and demonstrate the difference between the semantic presentation and interpretation of that presentation

• To describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing

Course Outcomes: After successful completion of the course, students

• Can set up, implement and evaluate natural language technology experiment step by step

• Will be familiar with a sample of machine learning techniques and can assess which ones are suitable for a given problem

• Can explain the interaction between rule based and probabilistic methods in language technology.

UNIT-I **15 hrs**	**Introduction and syntactic processing:** The study of Language, Linguistic background, Grammars and Parsing, Features and Augmented Grammars, Grammars for Natural Language, towards efficient parsing, Ambiguity Resolution. **Semantic interpretation:** Semantics and Logical Form, Linking Syntax and Semantics, Ambiguity Resolution, Strategies for Semantic Interpretation, Scoping and the Interpretation of Noun Phrases.
UNIT-II **10 hrs**	**Pragmatics:** Discourse: Reference Resolution, Syntactic and Semantic coherence, Text Coherence, An Inference based resolution algorithm. Dialogue and Conversational Agents: What makes dialogue different? Dialogue structure and coherence.
UNIT-III **10 hrs**	**Natural Language generation:** Introduction to language generation, architecture for generation, surface realization, systemic grammar, functional unification grammar, discourse planning. **Machine translation:** Language Similarities and Differences, transfer metaphor, syntactic transformations, lexical transfer, idea of Interlingua, direct translation, using Statistical Techniques
UNIT-IV **10 hrs**	**Speech:**Part of Speech tagging- Stochastic POS tagging, HMM, Transformation based tagging (TBL), Handling of unknown words, named entities, multi word expressions. A survey on natural language grammars, lexeme, phonemes, phrases and idioms, word order, agreement, tense, aspect and mood and agreement, Context Free Grammar, spoken language syntax.

Text Books:

1. Speech and Language Processing, by Jurafsky, D. & Martin, J.H.

2. Natural Language Understanding, Allen, J

Reference Books:

1. Foundations of General Linguistics by Atkinson, M, Kilby, D A & Roca, I

2. An Introduction to Language by Fromkin, V & Rodman, R

3. Natural Language Processing for Prolog Programmers by Covington, M A

4. Natural language processing in Prolog: an introduction to computational linguistics by Gazdar, G& Mellish.

E7: SIGNALS AND NETWORKS

Course Objectives:

i) To understand the basic properties of signal & systems and the various methods of classification

ii) To learn Laplace Transform &Fourier transform and their properties

iii) To know Z transform & DTFT and their properties

iv) To characterize LTI systems in the Time domain and various Transform domains

Course outcomes: On completion of the course it is expected to endow the students with skills of

i) Analyze the properties of signals & systems

ii) Apply Laplace transform, Fourier transform, Z transform and DTFT in signal analysis

iii) Analyze continuous time LTI systems using Fourier and Laplace Transforms

iv) Analyze discrete time LTI systems using Z transform and DTFT

UNIT-I **15 hrs**	**Classification of signals and systems:** Continuous time signals (CT signals) - Discrete time signals (DT signals) - Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential, Classification of CT and DT signals - Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - CT systems and DT systems-Classification of systems – Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Noncausal, Stable & Unstable.
UNIT-II **5 hrs**	**Analysis of continuous time signals:** Fourier series analysis-spectrum of Continuous Time (CT) signals- Fourier and Laplace Transforms in CT Signal Analysis - Properties.
UNIT-III **15 hrs**	**Linear time invariant- continuous time systems:** Differential Equation-Block diagram representation-impulse response, convolution integrals-Fourier and Laplace transforms in Analysis of CT systems, **Analysis of discrete time:** Baseband Sampling - DTFT – Properties of DTFT - Z Transform – Properties of Z Transform
UNIT-IV **10 hrs**	**Linear time invariant-discrete time systems:** Difference Equations-Block diagram representation-Impulse response - Convolution sum- Discrete Fourier and Z Transform Analysis of Recursive & Non-Recursive systems

Text Books:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, 2007.

2. B. P. Lathi, “Principles of Linear Systems and Signals”, Second Edition, Oxford, 2009.

Reference Books:

1. R.E.Zeimer, W.H.Tranter and R.D.Fannin, “Signals & Systems - Continuous and Discrete”, Pearson, 2007.

2. John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.

3. M.J.Roberts, “Signals & Systems Analysis using Transform Methods & MATLAB”, Tata McGraw Hill, 2007.

E8: ADVANCED ALGORITHMS

Course Objectives: Algorithm design and analysis is a fundamental and important part of computer science. This course introduces students to advanced techniques for the design and analysis of algorithms, and explores a variety of applications.

Learning outcomes: On completion of the course it is expected to endow the students with skills to

- Describe the divide-and-conquer paradigm and explain when an algorithmic design situation calls for it.
- Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. Explain the major graph algorithms and their analyses.
- Analyze randomized algorithms. Employ indicator random variables and linearity of expectation to perform the analyses. Recite analyses of algorithms that employ this method of analysis.
- Explain what competitive analysis is and to which situations it applies. Perform competitive analysis.

UNIT-I **15 hrs**	**Design Paradigms:** Overview of Divide and Conquer, Greedy and Dynamic Programming strategies. Basic search and traversal techniques for graphs, Backtracking, Branch and Bound. Introduction to string-matching problem, Naïve algorithm, Rabin Karp, Knuth Morris Pratt, BoyerMoore algorithms and complexity analysis.
UNIT-II **15 hrs**	**Complexity Classes:** P, NP and NP-Complete complexity classes; A few NP-Completeness proofs; Other complexity classes. **Approximation Algorithms:** Introduction, Combinatorial Optimization, approximation factor, PTAS, FPTAS, Approximation algorithms for vertex cover, set cover, TSP, knapsack, bin packing, subset-sum problem etc. Analysis of the expected time complexity of the algorithms.
UNIT-III **10 hrs**	**Parallel Algorithms:** Introduction, Models, speedup and efficiency, Some basic techniques, Examples from graph theory, sorting, Parallel sorting networks. Parallel algorithms and their parallel time and processors complexity.
UNIT-IV **5 hrs**	**Probabilistic Algorithms & Randomized Algorithms:** Numerical probabilistic algorithms, Las Vegas and Monte Carlo algorithms, Game-theoretic techniques, Applications on graph problems

Text Books:

1. Introduction to Algorithms : T.H. Cormen, C.E.Leiserson and R.L. Rivest
2. Fundamentals of Algorithmics : G.Brassard and P.Bratley

Reference Books:

3. Approximation Algorithms: Vijay V.Vazirani
4. Randomized Algorithms: R. Motwani and P.Raghavan
5. Reference book: Algorithmics :The spirit of computing: D.Harel

E9: ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Course objective:

• Introduce the basic principles of AI towards problem solving, inference, perception, knowledge representation and learning.

• Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural Networks and other machine learning models.

• Experiment with a machine learning model for simulation and analysis.

• Explore the current scope, potential, limitations, and implications of intelligent systems.

• To have a basic proficiency in a traditional AI language including an ability to write simple to intermediate programs and an ability to understand code written in that language.

Course outcome: After successful completion of the course, students will be able

• Demonstrate fundamental understanding of artificial intelligence (AI) and expert systems.

• Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.

• Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.

• Demonstrate proficiency in applying scientific method to models of machine learning.

UNIT-I **10 hrs**	**Overview & Search Techniques:** Introduction to AI, Problem Solving, State space search, Blind search: Depth first search, Breadth first search, Informed search: Heuristic function, Hill climbing search, Best first search, A* & AO* Search, Constraint satisfaction. Game tree, Evaluation function, Mini-Max search, Alpha-beta pruning, Games of chance.
UNIT-II **15 hrs**	**Knowledge Representation (KR):** Introduction to KR, Knowledge agent, Predicate logic, WFF, Inference rule & theorem proving forward chaining, backward chaining, resolution; Propositional knowledge, Boolean circuit agents. Rule Based Systems, Forward reasoning: Conflict resolution, backward reasoning: Use of Back tracking, Structured KR: Semantic Net - slots, inheritance, Frames- exceptions and defaults attached predicates, Conceptual Dependency formalism and other knowledge representations.
UNIT-III **10 hrs**	**Handling uncertainty & Learning:** Source of uncertainty, Probabilistic inference, Bayes' theorem, Limitation of naïve Bayesian system, Bayesian Belief Network (BBN), Inference with BBN, Dempster-Shafer Theory, Fuzzy Logic, Fuzzy function, Fuzzy measure, Non monotonic reasoning: Dependency directed backtracking, Truth maintenance systems. Learning: Concept of learning, Learning model, learning decision tree, Paradigms of machine learning, Supervised & Unsupervised learning, Example of learning, Learning by induction, Learning using Neural Networks.
UNIT-IV **10 hrs**	**Natural Language Processing (NLP) & Planning:** Overview of NLP tasks, Parsing, Machine translation, Components of Planning System, Planning agent, State-Goal & Action Representation, Forward planning, backward chaining, Planning example: partial-order planner, Block world. **UNIT**

	V Expert System & AI languages: Need & Justification for expert systems- cognitive problems, Expert System Architectures, Rule based systems, Non production system, knowledge acquisition, Case studies of expert system. Ai language: Prolog syntax, Programming with prolog, backtracking in prolog, Lisp syntax, Lisp programming.

Text Books:-

1. Artificial Intelligence by Elaine Rich and Kevin Knight, Tata MeGraw Hill.
2. Introduction to Artificial Intelligence and Expert Systems by Dan W.Patterson, Prentice Hall of India.

Reference Books :-

1. Principles of Artificial Intelligence by Nils J.Nilsson, Narosa Publishing house.
2. Programming in PROLOG by Clocksin & C.S. Melish, Narosa Publishing house.
3. Rule based Expert Systems-A practical Introduction by M. Sasikumar, S.Ramani, et. al., Narosa Publishing House.

E10: BIG DATA ANALYTICS

Course Objectives: This course provides an in-depth understanding of terminologies and the core concepts behind big data problems, applications, systems and the techniques, that underlie today big data computing technologies. It provides an introduction to some of the most common frameworks such as Apache Spark, Hadoop, MapReduce, Large scale data storage technologies such as in-memory key/value storage systems, NoSQL distributed databases, Apache Cassandra, HBase and Big Data Streaming Platforms such as Apache Spark Streaming, Apache Kafka Streams that has made big data analysis easier and more accessible.

Course outcome: After successful completion of the course, students will be able

Demonstrate fundamental understanding of Big Data and its Industrial applications.

Understand various analysis tools

UNIT-I **10 hrs**	**Introduction to Big Data:** Why Big Data and Where did it come from?, Characteristics of Big DataVolume, Variety, Velocity, Veracity, Valence, Value, Challenges and applications of Big Data, Introduction to Enabling Technologies for Big Data, Big Data Stack,Introduction to some Big Data distribution packages
UNIT-II **15 hrs**	**Big Data Platforms:** Overview of Apache Spark, HDFS, YARN,Introduction to MapReduce,MapReduce Programming Model with Spark,MapReduce Example: Word Count, Page Rank etc, Big Data Storage Platforms for Large Scale Data Storage,CAP Theorem, Eventual Consistency, Consistency Trade-O-s, ACID and BASE,Introduction to Zookeeper and Paxos,Introduction to Cassandra, Cassandra Internals,Introduction to HBase, HBase Internals
UNIT-III **10 hrs**	**Big Data Streaming Platforms** for Fast Data,Introduction to Big Data Streaming Systems,Big Data Pipelines for Real-Time computing,Introduction to Spark Streaming,Kafka,Streaming Ecosystem **Big Data Applications** (Machine Learning),Overview of Big Data Machine Learning,Mahout Big Data Machine learning Algorithms in Mahout- kmeans, Naïve Bayes etc.
UNIT-IV **10 hrs**	**Big data Machine learning with Spark,** Big Data Machine Learning Algorithms in SparkIntroduction to Spark MLlib,Introduction to Deep Learning for Big Data **Big Data Applications** (Graph Processing),Introduction to Pregel, Introduction to Giraph,Introduction to Spark GraphX

Textbooks:

1. Anand Rajaraman and Jeffrey David Ullman, “Mining of MASSIVE Datasets”, Cambridge University Press, 2011.

2. Tom White, “Hadoop: The Definitive guide”, (3e), O'reilly, Yahoo Press, 2012.

3. Shashank Tiwari, “Professional NOSQL”, Wiley India Pvt. Ltd., 2012

Reference Books:

4. Jimmy Lin, Chris Dyer, “Data Intensive Text Processing with MapReduce”, (1e), Morgan & Claypool Publishers, 2010.

5. Paul C Zikopoulos, Chris Eaton, Dirk Deroos, Thomas Deutch, George Lapis, “Understanding Big Data”,

McGraw Hill, 2012.

E11: GRAPH THEORY AND APPLICATIONS

Course Objectives: This course provides a formal introduction to the theory of graphs including paths, circuits, trees, matrix representation of graphs and their applications. The goal of this course is to make students aware of how graphs are used to model different situations and processes with special emphases on computer science and engineering applications.

Course Outcomes: Upon successful completion of this course, students should be able to

1. Understand the basic concepts of graphs, directed graphs, weighted graphs and bipartite graphs, Eulerian, Hamitonian and plane graphs
2. Find the components of a graph and the strongly connected components of a digraph.
3. Apply coloring algorithms to select the registers for memory location or to find its chromatic polynomial
4. Understand various applications of graphs.

UNIT-I **15 hrs**	**Basic Concepts:** Graphs and digraphs, incidence and adjacency matrices, isomorphism, theautomorphism group;**Trees:** Equivalent definitions of trees and forests, Cayleys formula, the Matrix-Tree theorem, minimum spanning trees;Connectivity: Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger theorem;Paths and Cycles: Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy andChvatal, girth, circumference, the Chinese Postman Problem, the Travelling Salesman problem, diameter and maximum degree, shortest paths.
UNIT-II **10 hrs**	**Matchings:** Berges Theorem, perfect matchings, Halls theorem, Tuttes theorem, Konigs theorem, Petersens theorem, algorithms for matching and weighted matching (in both bipartitie and general graphs), factors of graphs (decompositions of the complete graph), Tuttes f-factor theorem; **Extremal problems:** Independent sets and covering numbers, Turans theorem, Ramsey theorems.
UNIT-III **10 hrs**	**Colorings:** Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizings theorem; Graphs on surfaces: Planar graphs, duality, Eulers formula, Kuratowskis theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces. **Directed graphs:** Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, branchings.
UNIT-IV **10 hrs**	**Networks and flows:** Flow cuts, Max flow min cut theorems, perfect square; **Selected topics:** Dominating sets, the reconstruction problem, intersection graphs, perfect graphs, random graphs. **Applications:** Graph in sequential switching networks, graph in coding theory, graph in signal flow graph, graph in markov process, and graphics in computer programming. Applications in code generation, sequential switching networks, graphics.

Text Books:

1. N.Deo, “Graph Theory with applications to Engineering and Computer Science”, PHI
2. D.B.West: Introduction to Graph Theory, Prentice-Hall of India/Pearson, 2009

Reference Books:

1. J.A.Bondy and U.S.R.Murty: Graph Theory, Springer, 2008.

2. R.Diestel: Graph Theory, Springer(low price edition) 2000. 4. F.Harary: Graph Theory, Narosa, (1988)

3. C. Berge: Graphs and Hypergraphs, North Holland/Elsevier, (1973)

E12: UNIX AND SHELL PROGRAMMING

Course Objective:

- To familiarize students with the Linux environment.
- To learn the fundamentals of shell scripting/programming
- To familiarize students with basic Linux shell script programming.

Learning outcomes: The students who succeeded in this course will be able to:

1. Understand the evolution of UNIX/Linux Operating System.
2. Have an introductory knowledge about UNIX/Linux internals and utilities.
3. Use the “bash” shell with some basic commands in this shell and Awk programming.
4. Write scripts to run with bash in UNIX/Linux Operating System.
5. Understand standard UNIX file systems
6. Have basic abilities on the administrative issue of UNIX/Linux Operating System.
7. Explain open source software development concept.

UNIT-I **10 hrs**	**INTRODUCTION TO UNIX:** Architecture of Unix, Features of Unix , Unix Commands – PATH, man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip **UNIX UTILITIES:** Introduction to unix file system, vi editor, file handling utilities, security by file permissions, process utilities, disk utilities, networking commands, unlink, du, df, mount, umount, find, unmask, ulimit, ps, w, finger, arp, ftp, telnet, rlogin.Text processing utilities and backup utilities , detailed commands to be covered are tail, head, sort, nl, uniq, grep, egrep, fgrep, cut, paste, join, tee, pg, comm, cmp, diff, tr, awk, cpio
UNIT-II **15 hrs**	**INTRODUCTION TO SHELLS:** Unix Session, Standard Streams, Redirection, Pipes, Tee Command, Command Execution, -Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Options, Shell/Environment Customization. FILTERS: Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters, Files with Duplicate Lines, Count Characters, Words or Lines, Comparing Files. **GREP:** Operation, grep Family, Searching for File Content. SED: Scripts, Operation, Addresses, commands, Applications, grep and sed. **AWK:** Execution, Fields and Records, Scripts, Operations, Patterns, Actions, Associative Arrays, String Functions, String Functions, Mathematical Functions, User – Defined Functions, Using System commands in awk, Applications, awk and grep, sed and awk.
UNIT-III **10 hrs**	**The Buffer Cache and Internal Representation of Files:** Buffer Headers, Structure of Buffer Pool, Scenarios for Retrieval of Buffer, Reading and writing Disk Blocks, Advantages and disadvantages of Buffer Cache, System calls for file system, Inodes, Structure of a regular file, Directories, Conversions of a pathname to an Inode, Super Block, Inode assignment to a new file. **System calls for file systems:** Open, Close, File creation, Special files creation, Read, Write, File and record locking, Adjusting the position of file I/O, lseek, Change Directory, Change Root, Change Owner

	and Change Mode, stat, fstat, Pipes, Dup and Dup2, Mounting and un-mounting the file system, Link, Unlink, File System abstraction and maintenance.
UNIT-IV **10 hrs**	**The Structure of Processes and Process control:** Process States and Transitions, Layout of system memory, The Context of a Process, Manipulation of Process address space, Sleep Process creation and termination, User-ID of a Process, Changing the size of a Process, The Shell, System Boot and INIT process. **Process scheduling and memory management policies:** Process scheduling with round robin multilevel feedback scheduler, Memory management policies. **I/O Sub-systems and Inter-process Communications:** Driver interfaces, Disk Drivers, Terminal Drivers, Streams, Process tracing.

Text Books:

1. Bach, Maurice J., “The Design of the Unix Operating System”, PHI, 2004.

2. Karee Christian, “The Unix Operating System”, John Wiley & Sons.

3. Unix and shell Programming, Behrouz A. Forouzan, Richard F. Gilberg.Thomson

Reference Books:

1. Vahalia, “UNIX Internals: The New Frontiers”, Pearson Education Inc, 2003.

2. Uresh Vahalia, "UNIX Internals: The New Frontiers", Prentice Hall, 2000.

3. M. Beck, et.al , “Linux Kernel Programming”, Pearson Education Asia, 2002.

4. Sumitabha Das, “UNIX Concepts and Applications”, McGraw Hill.

E13: MACHINE LEARNING

Course Objectives: This course is intended to introduce some of the basic concepts of machine learning from a mathematically well motivated perspective. It also covers the different learning paradigms and some of the more popular algorithms and architectures used in each of these paradigms.

Course outcomes: After completing the course, the students:

1. Acquire knowledge of machine learning theories fundamentals and so they will be able to design pattern recognition program systems using approaches of these theories for solving various real-world problems.
2. Awake the importance of tolerance of imprecision and uncertainty for design of robust and low-cost intelligent machines.

UNIT-I **10 hrs**	**Basic Maths :** Probability, Linear Algebra, Convex Optimization**. Background:** Statistical Decision Theory, Bayesian Learning (ML, MAP, Bayes estimates, Conjugate priors)**, Regression :** Linear Regression, Multivariate Regression, Subset Selection, Shrinkage Methods, Principal Component Regression, Partial Least squares, Linear Classification, Logistic Regression, Linear Discriminant Analysis, Perceptron, Support Vector Machines.
UNIT-II **10 hrs**	**Neural Networks -** Introduction, Early Models, Perceptron Learning, Backpropagation, Initialization, Training & Validation, Parameter Estimation - MLE, MAP, Bayesian Estimation, Decision Trees, Regression Trees, Stopping Criterion & Pruning loss functions, Categorical Attributes, Multiway Splits, Missing Values, Decision Trees - Instability Evaluation Measures
UNIT-III **15 hrs**	**Bootstrapping & Cross Validation**: Class Evaluation Measures, ROC curve, MDL, Ensemble Methods - Bagging, Committee Machines and Stacking, Boosting, **Evaluation measures :** Gradient Boosting, Random Forests, Multi-class Classification, Naive Bayes, Bayesian Networks, Undirected Graphical Models, HMM, Variable Elimination, Belief Propagation, Partitional Clustering, Hierarchical Clustering, Birch Algorithm, CURE Algorithm, Density-based Clustering
UNIT-IV **10 hrs**	**Miscellaneous topics:** Gaussian Mixture Models, Expectation Maximization, Learning Theory, Introduction to Reinforcement Learning, Optional videos (RL framework, TD learning, Solution Methods, Applications), **Graphical Models:** Bayesian Networks.

Textbook:

1. C. M. Bishop. Pattern Recognition and Machine Learning. First Edition. Springer, 2006.

Reference Books:

1. P. Flach. Machine Learning: The Art and Science of Algorithms that Make Sense of Data. First Edition, Cambridge University Press, 2012.
2. S. J. Russell, P. Norvig. Artificial Intelligence: A Modern Approach. Third Edition, Prentice-Hall, 2010.
3. Y. S. Abu-Mostafa, M. Magdon-Ismail, H.-T. Lin. Learning from Data: A Short Course. First Edition, 2012.

E14: ADVANCED WEB TECHNOLOGY

Course Objective. In this course, students learn basic object oriented Java programming using a web browser for input and output. In addition, students will learn how to write and debug these other computer languages: HTML, XML, Ajax, PHP and Javascript and to create and populate a database (using MySql)

Course outcomes: On successful completion of this course, the learners will be able to:

1. Use HTML in web application development.
2. Apply javascript in making web application more interactive.
3. Develop a search engine optimized web application.
4. Create a database driven web application using Apache, MySQL and PHP.
5. Build a web system using a content management system.
6. Integrate web services to make a powerful web application.

UNIT-I **10 hrs**	**Introduction to Web Technology:** Hypertext Markup Language(HTML) and its components, HTML tags and attributes, Text formatting tags, List tags, Image tags, HTML tables, HTML Forms, Document Object Model (DOM), Cascading Style Sheets. **Events Handlers & Forms in Java Script:** Define Events, Events in JavaScripts, Event Handlers, this keyword, Event handlers in JavaScripts, Messaging & Timing Events in Java Script.
UNIT-II **10 hrs**	**XML and Ajax:** XML – Declaration, Root Element, Child Elements, Element Attributes, Entity References, Comments, Ajax – XML HttpRequest Object, Sending Ajax requests, Handling Ajax Responses, Adding Ajax Functionality in JavaScript, Adding Ajax Functionality to a Web Page. **PHP: Hypertext Preprocessor:** Getting Started with PHP - Basic PHP Syntax, Data Types, Variables, Constants, Operators, Control Structures, Functions, Connecting to MySQL using PHP, Building a Web Page using PHP.
UNIT-III **15 hrs**	**HTML 5:** Introduction, Common Infrastructure, Semantics, structure, and APIs of HTML documents, Elements, links, Tabular data, Forms & Script elements, Web Application APIs, The XHTML syntax. **MySql in Web development:** PHP revisited: Storing data, arrays & string manipulation, Re-using code & writing functions in PFP, Object oriented PHP, Using MySql: designing & creating your web database, working with mysql database, accessing mysql database from web with PHP, Advanced mysql administration, Advanced mysql programming, Build your own PHP & MySql project website
UNIT-IV **10 hrs**	**jQuery:** Why jQuery, features of jQuery library, Adding jQuery to web pages: Dowloading jQuery & jQuery CDN, jQuery Syntax & jQuery Selectors, jQuery Event Methods & their syntaxes, jQuery Effects: Hide and Show, Fading, Sliding, Animation, stop(), jQuery HTML: get & set content: text(), html(), and val(), jQuery - AJAX: Introduction, load(), get() and post() Methods. **Search Engines:** Define Search Engine & how does it work, Keywords & Metadata sculpting.

Text Books:

1. Deitel H.M., Deitel P.J., “Internet & World Wide Web: How to program”, Pearson Education.

2. Boronczyk, Naramore, “Beginning PHP, Apache, MySQL Web Development”, Wiley India Pvt. Ltd.

Reference Books:

1. Peter Smith, “Professional Website performance”, Wiley India Pvt. Ltd.

2. Kogent Learning, “Web Technologies: HTML, JavaScript, PHP, Java, JSP, XML, AJAX Black Book”, Wiley India Pvt. Ltd.

E15: USER INTERFACE/USER EXPERIENCE (UI/UX) DESIGN

Course Objective: To understand the basic process of web designing. To grasp the concept of user experience with respect to the user interface. To understand the trends of UI/UX development.

Course Outcomes:

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

1. Know the difference between user interface and user experience design.
2. Understand the various tools available for user interface design.
3. Understand how typography and layout enrich the user experience.

UNIT-I **10 hrs**	**Introduction to UI:** What is UI?, **UI Design Tools:** Wireframing - Introduction, Designing Process, Picking Tools, Setting a grid and determine a layout box, Typography, Grayscale, Conclusion, UI Design and Prototyping – Introduction, General Prototyping Scheme ,Other Tools – Golden Ratio Typography Calculator, Zeplin.
UNIT-II **15 hrs**	**Introduction to UX Design:** What is User Experience?,The distinction between UX and UI, UX Designers in the field, User-Centered Design (UCD) and Design Thinking: The user-centered design process and its benefits, Project: incorporating empathy into the design process, **User Research and Personas:** Developing a user-research plan,Various user research techniques and tools,Create screener surveys, conduct interviews and synthesize findings, Designing user interview protocol, Usability Analysis: 10 Usability Heuristics for Interface Design, Running a basic usability heuristic evaluation, Project: heuristic evaluation of project competitors.
UNIT-III **10 hrs**	**Empathy Mapping, Personas & Scenarios: Using** empathy maps to bridge the gap between personas and design concepts, Using observations and research to create personas and including them in your design workflow, Scenario mapping and storyboarding
UNIT-IV **10 hrs**	**Design for Mobile:** Designing for “mobile first”, Mobile design patterns and elements, Navigation for mobile, Card-based design ,**Lean UX:** What is an MVP?,Creating and implementing user stories, Visual Design: Visual design and UX, Color theory: creating your own palette, Using typography to create positive interactions, Creating a style guide, Logo design

Textbooks:

1. Dominik Pacholczyk, Web UI Design Best Practices, UXPin
2. Jerry Cao, Chris Bank, The Guide To UX DESIGN PROCESS & DOCUMENTATION , UXPin - 2015
3. Frank Chimero, The Shape of Design, First Edition 2012

BTCOM-UG-P603 & BTCOM-UG-P604& BTCOM-UG-P605: PROGRAMME ELECTIVE III& IV & V (2L 1T 0P)

E1: ADVANCED JAVA PROGRAMMING

Course Objectives: This course covers the advanced topics in java programming such as collection framework, language package, Network Programming, GUI programming using AWT and Swings, advanced Web Programming using Servlet and JSP, and Accessing Database with Java.

Course outcomes: At the end of the course the students will

1. Develop Swing-based GUI
2. Develop client/server applications and TCP/IP socket programming
3. Update and retrieve the data from the databases using SQL
4. Develop distributed applications using RMI
5. Develop component-based Java software using JavaBeans
6. Develop server side programs in the form of servlets

UNIT-I **10 hrs**	**Java basics**: applets, J2EE and J2SE, J2EE multitier architecture, design patterns, J2EE Database, database schema, jdbc driver types, jdbc packages, brief overview of jdbc process, statement objects and result set, HTML, XML, XHTML, generating an XML document, parsing XML
UNIT-II **15 hrs**	**Java servlets** and common gateway interface programming, HTTP request headers, HTTP response header and cookies, sessions, JSP Installation, JSP tags, Tomcat, Request string, user sessions, cookies, session objects, Enterprise java beans and JAR files, deployment descriptors**, Struts Architecture:** writing and executing struts application, Model View Controller layers, Validator and Tiles, Java Mail API, Java remote method invocation, Java message service, SOAP.
UNIT-III **10 hrs**	**Network programming in java:** Sockets, secure sockets, custom sockets, UDP datagrams, Multicast sockets, URL classes, Reading data from the server, Writing data, Configuring the connection, Reading the header,, Java messaging services
UNIT-IV **10 hrs**	**Applications in distributed environment:** Remote method invocation, activation models, RMI custom sockets, Object serialization, RMI, IIOP implementation, CORBA, IDL technology, Naming services, CORBA programming models, JAR file creation.

Textbooks:

1. James Keogh, “The Complete Reference J2EE”, Tata McGraw-Hill, 2002.
2. James Holmes, “Struts: The Complete Reference”, (2e), Tata McGraw-Hill, 2007.
3. Kogent Learning Solutions Inc., “JAVA SerVER Programming JAVA Black Book”, Dreamtech Press, Platinum edition, 2010.
4. Elliotte Rusty Harold, “Java Network Programming”, Shroff.

Reference Books:

1. Richard Monson Haefel, “J2EE web serVICES”, (1e), Pearson, 2004.
2. Bryan Basham, Bert Bates, Kathy Sierra, “Head First SerVLETS and JSP”, (2e), OReilly, 2011.

E2: INFORMATION RETRIEVAL

Course Objective: The objective of course is to make students understand the information retrieval models, be familiar with Web Search Engine, be exposed to Link Analysis and learn document text mining techniques.

Course outcomes: On completion of the course it is expected to endow the students with skills of

i) Apply information retrieval models.

ii) Design Web Search Engine.

iii) Use Link Analysis.

iv) Apply document text mining techniques.

UNIT-I **5 hrs**	**Introduction to Information Retrieval (IR)**, IR Systems, History of IR, Components of IR, Issues of IR, IR Strategies.
UNIT-II **15 hrs**	**Web search basics**: Web characteristics, Boolean Retrieval and Postings List, Information Retrieval Problem, Document delineation and character sequence decoding, Dictionaries and tolerant retrieval, Search structures for dictionaries, Index Construction, Types of indexes, Index Compression,
UNIT-III **10 hrs**	Types of compression, Parametric and zone indexes, Vector space model, Evaluation in Information Retrieval, Relevance assessment, Probabilistic Information Retrieval, Binary independence model.
UNIT-IV **15 hrs**	**Text Classification**: Classification problems, Classification models,Clustering in information retrieval,Clustering models, Evaluation in clustering,XML retrieval: Challenges and Evaluation of XML retrieval, XML retrieval strategies, Web Crawling and Link Analysis.

Textbooks:

1. Christopher D Manning, Prabhakar Raghavan and Hinrich Schutze, “Introduction to Information RetrieVal”, Cambridge University Press, 2008.

2. Stefan Buttcher, Charles L. A. Clarke , Gordon V. Cormack, “Information RETRIEVAL - Implementing and EVALUATING Search Engines”, (6e), MIT Press, 2011.

3. Baeza-Yates and Ribeiro-Neto, “Modern Information RETRIEVAL”, (2e), Addison Wesley, 2010.

Reference Books:

1. Soumen Charabarti, “Mining the Web”, Morgan-Kaufmann, 2003.

2. David A Grossman, OphitFrieder, “Information RETRIEVAL Algorithms and Heuristics”, (2e), Springer, 2004.

E3: INFORMATION THEORY AND CODING

Course Objectives: This course offers a broad introduction to information theory and its real-world applications. Emphasizes are given on the theory and applications of entropy and information.

Course outcomes: On completion of this unit the student will have the understanding of the:

1. Problems and techniques used for error correction coding.
2. Analysis and comparison of error detecting/correcting facilities of simple linear and cyclic codes for the symmetric binary channel
3. Non-binary codes including Reed Solomon codes
4. Measurement of quantity of information and entropy
5. Notions of channels, classes of channels, channel capacity and application of coding theorem
6. Simple methods for construction of error correcting codes

UNIT-I 5 hrs	Communication systems: Discrete systems, Continuous systems, News value & Information content.
UNIT-II 15 hrs	Discrete noiseless systems: Discrete sources, Information content of discrete sources, Entropy as an information measure, Properties of entropy, Uncertainty and entropy, A source coding system, Fixed length and variable length codes, Unique decipherability, Prefix codes, Kraft's inequality and Kraft's theorem, The Noiseless coding theorem.
UNIT-III 15 hrs	Communication through discrete noisy channels: Representation of a discrete noisy channel, Discrete memory less channel, Examples of discrete noisy channels, Conditional entropy and mutual information, Properties of conditional entropy, Properties of mutual information, Average mutual information, Properties of average mutual information, Capacity of a discrete noisy channel, Properties of Channel Capacity.
UNIT-IV 10 hrs	Coding for reliable digital transmission: Types of channel codes, Maximum likelihood decoding, Types of errors, Error control strategies, Linear block codes, Cyclic codes, BCH codes, Convolution codes

Text Books:

1. S. Lin and D. J. Costello, "Error Control Coding- Fundamentals and Applications", Prentice Hall, Inc. Englewood Cliffs, 1983.
2. T. M. Cover and J. A. Thomas, "Elements of Information Theory", Second Edition, Wiley Interscience, 2006.

Reference Books:

1. Bose, Ranjan, "Information theory coding and cryptography", Tata Mcgraw Hill, 2010.
2. Mackay, "Information theory, inference and learning algorithm", Cambridge University, 2004.
3. Gravano, Salvatore, "Introduction to error control codes", Oxford University Press.
4. Robert B. Ash, "Information theory", Dover Publishing Inc.

E4: DATA MINING AND WAREHOUSING

Course objective:

• To understand the overall architecture of a data warehouse.

• The different data mining models and techniques will be discussed in this course.

• Evaluate different models used for OLAP and data pre-processing;

• Design and implement systems for data mining and evaluate the performance of different data mining algorithms;

• Propose data mining solutions for different applications.

• Differentiate Online Transaction Processing and Online Analytical processing

Course outcome: After successful completion of this course students will be

• Design a data warehouse for an organization

• Develop skills to write queries using DMQL

• Extract knowledge using data mining techniques

• Adapt to new data mining tools.

• Explore recent trends in data mining such as web mining, spatial-temporal mining.

UNIT-I **10 hrs**	**Overview and Concepts**: Need for data warehousing, basic elements of data warehousing, Trends in data ware housing. Planning and Requirements: Project planning and management, Collecting the requirements. **Architecture And Infrastructure**: Architectural components, Infrastructure and metadata.
UNIT-II **10 hrs**	**Data Design And Data Representation**: Principles of dimensional modeling, Dimensional modeling advanced topics, data extraction, transformation and loading, data quality. **Information Access and Delivery**: Matching information to classes of users, OLAP in data warehouse, Data warehousing and the web. Implementation And Maintenance: Physical design process, data warehouse deployment, growth and maintenance.
UNIT-III **10 hrs**	**Data Mining:** Introduction: Basics of data mining, related concepts, Data mining techniques Data Mining Algorithms: Classification, Clustering, Association rules. Knowledge Discovery: KDD Process.
UNIT-IV **15 hrs**	**Web Mining**: Web Content Mining, Web Structure Mining, Web Usage mining. Advanced Topics: Spatial mining, Temporal mining. Visualization : Data generalization and summarization-based characterization, Analytical characterization: analysis of attribute relevance, Mining class comparisons: Discriminating between different classes, Mining descriptive statistical measures in large databases Data Mining Primitives, Languages, and System Architectures: Data mining Primitives, Query language, Designing GUI based on a data mining query language, Architectures of data mining systems Application and Trends in Data Mining: Applications, Systems products and research prototypes, Additional themes in data mining, Trends in data mining.

Text Books:

1. Data warehousing- concepts, Techniques, Products and Applications by Prabhu, Prentice hall of India
2. Insight into Data Mining: Theory & Practice by Soman K P, Prentice hall of India.
3. Data Mining Introductory and Advanced Topics by M.H. Dunham, Pearson Education.

Reference Books:

1. Data Warehousing Fundamentals by Paulraj Ponniah, John Wiley.
2. Introduction to Data mining with Case Studies by Gupta, PHI.
3. The Data Warehouse Lifecycle toolkit by Ralph Kimball, John Wiley.
4. Introduction to Building the Data warehouse, IBM, PHI.

E5: SOFTWARE TESTING AND QUALITY ASSURANCE

Course Objective:

• To study software testing objectives, process, criteria, strategies, and methods.

• To study various software testing issues and solutions in software unit, integration, regression, and system testing.

• To study planning of a test project, design test cases, conduction of testing operations, generation of a test report.

• To understand automation testing process, its problems and solutions.

Course outcome: After successful completion of the course, students will be

• To design and conduct a software test process for a software testing project.

• To identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.

• To use software testing methods and modern software testing tools for their testing projects.

UNIT-I **10 hrs**	**Introduction:** Quality Revolution, Software Quality, Role of Testing, Objectives of Testing, Concept of Complete Testing, Central Issue of Testing, Sources of Information for Test Case selection, Test Planning and Design, Monitoring and Measuring Test Execution, Test Tools and Automation, Test Team Organization and Management.
UNIT-II **10 hrs**	**Basic Concepts of Testing Theory,** Theory of Goodenough and Gerhart, Theory of Weyuker and Ostrand, Theory of Gourlay, Adequacy of Testing, Limitations of Testing, Static Unit Testing, Defect Prevention, Dynamic Unit Testing, Debugging.
UNIT-III **15 hrs**	**Testing:** Outline of Control Flow Testing, Control Flow Graph, Paths in Control Flow Graphs, Path Selection Criteria, Data Flow Testing criteria, Comparison of Data Flow and Test Selection Criteria, Domain Error, Testing of Domain Errors. System Test design, Test design Factors, Requirement Identification, Test Objective Identification, Structure of a System Test Plan, Assumptions, Test Approach, Test Suite Structure, Types of Acceptance Testing
UNIT-IV **10 hrs**	**Quality Assurance:** Five Views of Software Quality, Quality Control, Quality assurance, Cost of quality, Software Quality Assurance, SQA Plan, ISO 9000, Capability Maturity Model, Hierarchical models of Boehm and McCalls Quality Factors.

Text Books

1. Kshirasagar Naik, “Software Testing and Quality Assurance”, John Wiley & Sons.

2. William Perry, “Effective Methods for Software Testing”, John Wiley & Sons.

Reference Books

1. Cem Kaner and Jack Falk, “Testing Computer Software”, Wiley.

2. Ron Patton, “Software Testing”, SAMS Publications.

E6: REMOTE SENSING

Course Objective: Introduce the principles of remote sensing to students who are beginners in this field. Much as the text book has laid out, fundamental knowledge on the physics of remote sensing, aerial photographic techniques, photogrammetric, multispectral, hyperspectral, and thermal imaging, and RADAR and LIDAR image analysis will be introduced. The newest technology in the field will also be discussed.

Course Outcomes: At the end of the module the student should:

1. Be familiar with ground, air, satellite and marine based sensor platforms.
2. Have the ability to preprocessing, image analysis and information extraction from different types of imageries.
3. Be able to select and apply appropriate data manipulation and visualization methods for a number of earth science applications.

UNIT-I **5 hrs**	**Physics of Remote Sensing:** Introduction of Remote Sensing- Electromagnetic spectrum, physics of remote sensing-Effects of atmosphere- scattering- Different types- Absorption- Atmospheric Window- Energy interaction with surface features- Spectral Reflectance of vegetation, soil and water- atmospheric influence on spectral response patterns- multi concept in Remote Sensing.
UNIT-II **15 hrs**	**Data Acquisition:** Types of platforms- Different types aircraft- Manned and Unmanned space crafts – sun synchronous and geo synchronous satellites- Types and characteristics of different platforms – LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD, etc – Photographic products, B/W, colour, colour IR film and their characteristics – resolving power of lens and film – Opto mechanical electro optical sensors – across track and along track scanners – multi spectral scanners and thermal scanners – geometric characteristics of scanner imagery – calibration of thermal scanners.
UNIT-III **15 hrs**	**Scattering System:** Microwave scatterometry – types of RADAR – SLAR – resolution – range and azimuth – real aperture and synthetic aperture RADAR. Characteristics of Microwave images- topographic effect – different types of Remote Sensing platforms –air borne and space borne sensors – ERS, JERS, RADARSAT, RISAT – Scatterometer, Alimeter- LiDAR Remote Sensing, principles, applications. **Multi Spectral & Hyper Spectral Remote Sensing:** Sensors characteristics – principle of spectroscopy – imagine spectroscopy – field conditions, compound spectral curve, Spectral library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing – thermal sensors, principles, thermal data processing, applications.
UNIT-IV **10 hrs**	**Thermal Radiation Principles And Thermal Imaging:** Thermal remote sensing– thermal sensors, principles, thermal data processing, applications. **Data Analysis:** Resolution- Spatial, Spectral, Radiometric and temporal resolution- signal to noise ratio- data products and their characteristics – visual and digital interpretation –Basic principles of data processing –Radiometric correction –Image enhancement –Image classification – Principles of LiDAR, Aerial Laser Terrain mapping. **Applications of Remote Sensing.**

Text Books:

1. Jensen, John R., 2000, Remote Sensing of the Environment: An Earth Resource Perspective, New Jersey: Prentice Hall, 544 pages. ISBN 0-13-489733-1.
2. Lillsand T.M. and Keifer, R.W. Remote sensing and Image Interpretation, VI edition of John Wiley & Sons-2000.

Reference Books:

1. John R. Jesen, Introductory Digital Image Processing: A Remote Sensing Perspective, 2nd Edition, 1995.
2. John A.Richards, Springer-Verlag, Remate Sensing Digital Image Analysis 1999.
3. Paul Curran P.J. Principles of Remote Sensing, ELBS, 1995.
4. Charles Elachi and JakobJ.vanZyl, Introduction to the Physics and Techniques of Remote Sensing, Wiley Series in Remote Sensing and Image Processing, 2006.
5. Sabins, F.F.Jr, Remote Sensing Principles and Image Interpretation, W.H. Freeman &co, 1978.

E8: GEOGRAPHIC INFORMATION SYSTEMS

Course Objectives: To give students a basics of Geographic Information Systems (GIS) using free and open software. This course would discuss various issues and criticalities in producing accurate data. The concepts are illustrated with appropriate examples.

Couse outcomes: On completion of the course it is expected to endow the students with skills to:

i) Select and apply appropriate data manipulation and visualization method for a number of Earth Science applications, including GIS.
ii) Operate PC-based visualization software effectively.
iii) Plot, map, and interpret Earth Science data and present the result in an organized and concise fashion.
iv) Use the hand-held GPS units for demarking geographical location/ latitude /longitude/etc.

UNIT-I **10 hrs**	**Introduction to Geographic Information Systems (GIS):** What is GIS? Representing a real world in digital scape, Key elements of maps, Different components of GIS, Different types of vector data, Raster data models and their types, TIN data model, Non-spatial data (attributes) and their type.
UNIT-II **15 hrs**	**Raster data** compression techniques, Different raster data file formats, Spatial database systems and their types, Pre-processing of spatial datasets, Different map projections, Spatial interpolation techniques. Different types of resolutions, Advanced data models in GIS and Data Generation/Collection/Surveys, Global Positioning system.
UNIT-III **10 hrs**	**Database and Database Management System:** Introduction, Database query and Spatial analysis, Basic and Advanced Spatial analysis of data, Digital Elevation Model (DEM), Quality assessment of freely available DEMS, Quantum GIS introduction
UNIT-IV **10 hrs**	**Hands on working with maps**, data integration, collection, digitization and extraction, Hands on data generation and analysis using various sources, Data standards and Interoperability WEBGIS through GEOSERVER hands-on tutorials.

Text Books:

1. David JM, “Michael FG & David WR 1991: Geographical Information System”, Prentice Hall
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction to Geographical Information Systems”, 2nd Edition, Pearson Education.

Reference Books:

1. B. Bhatta, “Remote Sensing and GIS”, Oxford University Press.
2. Kang-tsung Chang, “An Introduction to Geographical Information Systems”, 4th Edition, Tata McGraw-Hill.
3. Canada Centre for Remote Sensing: Tutorial on RS.
4. Chrisman NR, “Exploring Geographic Information Systems”, John Wiley & Sons.

E8: COMPUTATIONAL NUMBER THEORY

Course Objectives: To give students a detailed description of the main modern algorithms in computational number theory. To implement all the algorithms and methods introduced in the course on a computer using a computer algebra system.

Couse outcomes: On completion of the course it is expected to endow the students with skills to:

i) to use the modern algorithms in computational number theory for searching information in targeted areas

ii) to use symbolic software packages to perform number-theoretic computations;

iii) to apply these methods to academic and simple practical instances.

UNIT-I **10 hrs**	**Algorithms for integer arithmetic:** Divisibility, GCD, modular arithmetic, modular exponentiation, Montgomery arithmetic, congruence, Chinese remainder theorem, Hensel lifting, orders and primitive roots, quadratic residues, integer and modular square roots, prime number theorem, continued fractions and rational approximations.
UNIT-II **10 hrs**	**Representation of finite fields:** Prime and extension fields, representation of extension fields, polynomial basis, primitive elements, normal basis, optimal normal basis, irreducible polynomials. **Algorithms for polynomials:** Root-finding and factorization, Lenstra-Lenstra-Lovasz algorithm, polynomials over finite fields.
UNIT-III **15 hrs**	**Elliptic curves:** The elliptic curve group, elliptic curves over finite fields, Schoof's point counting algorithm. Primality testing algorithms: Fermat test, Miller-Rabin test, Solovay-Strassen test, AKS test. **Integer factoring algorithms:** Trial division, Pollard rho method, p-1 method, CFRAC method, quadratic sieve method, elliptic curve method.
UNIT-IV **10 hrs**	**Computing discrete logarithms over finite fields:** Baby-step-giant-step method, Pollard rho method, Pohlig-Hellman method, index calculus methods, linear sieve method, Coppersmith's algorithm. Applications: Algebraic coding theory, cryptography.

Text Books:

1. V. Shoup, A computational introduction to number theory and algebra, Cambridge University Press.
2. M. Mignotte, Mathematics for computer algebra, Springer-Verlag.
3. Niven, H. S. Zuckerman and H. L. Montgomery, An introduction to the theory of numbers, John Wiley.

Reference Books:

1. J. von zur Gathen and J. Gerhard, Modern computer algebra, Cambridge University Press.
2. R. Lidl and H. Niederreiter, Introduction to finite fields and their applications, Cambridge University Press.
3. J. Menezes, editor, Applications of finite fields, Kluwer Academic Publishers.

E9: ADVANCED OPERATING SYSTEMS

Course Objectives: To understand the main concepts of advanced operating systems (parallel processing systems, distributed systems, real time systems, network

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

- Outline the potential benefits of distributed systems.
- Describe the internal architecture of Unix operating system.
- Summarize the major security issues associated with distributed systems along with the range of techniques available for increasing system Security.
- Operate different operating system with ease.

UNIT-I **5 hrs**	**Introduction:** Functions of operating systems, Design approaches: layered, kernel based and virtual machine approach, types of advanced operating systems (NOS, DOS, Multiprocessor OS, Mobile OS, RTOS, Cloud OS)
UNIT-II **15 hrs**	**Unix Kernel and File Management:** System Structure, User Perspective, Architecture of Unix Operating System, Buffer cache, **File Representation**: inodes: Structure of file Directories, Path conversion to inode, superblock, inode assignment, allocation of disk blocks, Unix Process and Memory management **Detailed design of Process Structure:** Kernel Data structures for process, Structure of Uarea and Process table, Process states and Transitions Context of a Process: Static and Dynamic area of context, Saving the Context Layout of System Memory, Regions, Mapping regions with Process, page table and mapping virtual address to physical address.
UNIT-III **15 hrs**	**Distributed Operating system concepts:** Goals, Distributed Computing Models, Hardware Concepts, Software Concepts, Architecture of DOS. Design Issues: Transparency, Flexibility, Scalability, Reliability, Performance, fault tolerance. **Multiprocessor Operating System:** Introduction, Basic multiprocessor system architectures, design issues, Threads, Process synchronization: the test and set instruction, the swap instruction, implementation of the process wait, **Processor scheduling:** Issues, Co-scheduling, Smart scheduling, Affinity Based scheduling
UNIT-IV **10 hrs**	**Real Time Operating Systems and Mobile OS:** Characteristics of Real Time operating Systems, Classification of Real Time Operating Systems, Scheduling in RTOS: Clock driven: cyclic, Event driven: EDF and rate monotonic scheduling. **Mobile OS:** Architecture, Android OS, iOS, Virtual OS, Cloud OS and their design issues.

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, “Operating System Concepts”, Wiley & Sons.Inc..
2. D M Dhamdhere, “Systems Programming & Operating Systems”, Tata McGraw-Hill.
3. Distributed Operating System By P. K. Sinha , IEEE Press

4. Understanding UNIX, K. Srirengan, PHI.

Reference Books:

1. Andrew S. Tanenbaum, “Modern Operating systems”, PHI.
2. Mukesh Singhal, Niranjan G.Shivaratri, “Advanced Concepts in Operating Systems”, Tata McGraw- Hill.
3. P. Balakrishna Prasad, “Operating Systems”, Scitech Publication.
4. William Stallings, “Operating Systems-Internals and Design Principles”, Pearson Education.
5. Operating System , Milan, TMH.
6. LINUX OS, BPB publication.

E10: COMPUTATIONAL GEOMETRY

Course Objectives: Detailed knowledge of the fundamental problems within computation geometry and general techniques for solving problems within computational geometry and practical experience with implementation issues involved in converting computation geometry algorithms into running programs.

Course Outcomes: On completion of the course it is expected to endow the students with skills to:

i) Construct algorithms for simple geometrical problems.

ii) Implement computational geometry algorithms.

UNIT-I **10 hrs**	**Introduction:** Historical perspective, geometric preliminaries. Convex hulls algorithms in 2d and 3d, lower bounds. Triangulations: polygon triangulations, representations, point-set triangulations.
UNIT-II **10 hrs**	**Voronoi diagrams:** Algorithms, closest pair problems. Delaunay triangulations: algorithms (divide-and-conquer, flip, incremental), duality of Voronoi diagrams, properties (min-max angle).
UNIT-III **15 hrs**	**Geometric searching:** point-location, 2d linear programming with prune and search. **Visibility:** algorithms for weak and strong visibility, visibility with reflections, art-gallery problems. **Arrangements of lines:** 2d arrangements, zone theorem, many-faces complexity, algorithms.
UNIT-IV **10 hrs**	**Sweep techniques:** plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, topological sweep for line arrangements. **Combinatorial geometry:** Ham-sandwich cuts, Helly's theorems, k-sets. **Rectilinear geometry:** intersection and union of rectangles, rectangle searching. Robust geometric computing. Applications

Text Books:

1. Mark de Berg, Otfried Schwarzkopf, Marc van Kreveld and Mark Overmars, Computational Geometry: Algorithms and Applications, Springer.
2. F. P. Preparata and Michael I. Shamos, Computational Geometry: An Introduction, Springer.
3. Joseph O' Rourke, Computational Geometry in C, Cambridge University Press.

Reference Books:

1. Joseph O'Rourke, Computational Geometry in C, Cambridge University Press, 2nd Edition, 1998.
2. Computational Geometry: An Introduction, F. P. Preparata and M.I. Shamos, Springer-Verlag, 1985.
3. Computational Geometry: Algorithms and Applications, M. de Berg, M. van Kreveld, M. Overmars, O. Schwarzkopf, Springer-Verlag, Revised Second Edition, 2000.

E11: QUEUING THEORY WITH APPLICATIONS TO COMPUTER SCIENCE

Course Objectives

1. Rigorous understanding of the theoretical background of queueing systems.
2. Understand and compute quantitative metrics of performance for queueing systems.
3. Apply and extend queueing models to analyze real world systems.

Learning outcomes: On completion of the course it is expected to endow the students with skills to:

i) The course is based on the application of probability and queueing theories which are branches of mathematics and simulation techniques for performance evaluation of queueing and telecommunications systems.

ii) In this course the students will learn to design resources such as buffer and link capacities to meet specified required quality of service of a queueing system.

iii) The students will develop ability to identify, evaluate, formulate and solve engineering problems related to resource allocation of queueing systems

UNIT-I **10 hrs**	**Review of probability,** random variables, distributions, generating functions; Poisson, Markov, renewal and semi-Markov processes; **Characteristics of queueing systems,** Little's law, Markovian and non-Markovian queueing systems
UNIT-II **15 hrs**	**Basic Queueing Theory:** M/M/-/- Type Queues. Departure Process from M/M/-/- Queue, Time Reversibility, Method of Stages, Queues with Bulk Arrivals. **M/G/1 Queue:** Equilibrium Analysis of the M/G/1 Queue. Analyzing the M/G/1 Queue using the Method of Supplementary Variables. M/G/1 Queue with Vacations. M[x]/G/1 Queue. Priority Operation of the M/G/1 Queue.
UNIT-III **10 hrs**	**M/M/n/K Queue:** M/M/n/K Queue with Multiple Priorities. M/G/1/K Queue. G/M/1, G/G/1 G/G/m, and M/G/m/m Queues, embedded Markov chain applications to M/G/1, G/M/1 and related queueing systems.
UNIT-IV **10 hrs**	**Networks of queues**, open and closed queueing networks; Queues with vacations, priority queues, queues with modulated arrival process, discrete time queues, introduction to matrix-geometric methods, applications in manufacturing, computer and communication networks.

Text Books:

1. D. Gross and C. Harris, Fundamentals of Queueing Theory, 3rd Edition, Wiley, 1998. (WSE Edition, 2004).
2. L. Kleinrock, Queueing Systems, Vol. 1: Theory, Wiley, 1975.
3. J. Medhi, Stochastic Models in Queueing Theory, 2nd Edition, Academic Press, 2003. (Elsevier India Edition, 2006).

Reference Books:

1. J.A. Buzacott and J.G. Shanthikumar, Stochastic Models of Manufacturing Systems, Prentice Hall, 1992.
2. R.B. Cooper, Introduction to Queueing Theory, 2nd Edition, North-Holland, 1981.

3. L. Kleinrock, Queueing Systems, Vol. 2: Computer Applications, Wiley, 1976.
4. R. Nelson, Probability, Stochastic Processes, and Queueing Theory: The Mathematics of Computer Performance Modelling, Springer, 1995.
5. E. Gelenbe and G. Pujolle, Introduction to Queueing Networks, 2nd Edition, Wiley, 1998.

E12: REAL TIME SYSTEMS

Course Objective:

- To study real-time computer control systems and their implementation techniques.
- Provide examples of real-time systems including functionality and implementation platforms.
- Describe and exemplify design parameters for real-time systems including execution time, implementation, communication & user interface.
- Study a range of methodologies for specifying and designing real time systems.
- Understand hardware and software design and implementation of real-time systems
- Describe and apply systems engineering methods and techniques in the design and analysis of real-time systems.

Course Outcome:

1. Clearly differentiate the different issues that arise in designing soft and hard real-time, concurrent, reactive, safety-critical and embedded systems.
2. Explain the various concepts of time that arise in real-time systems.
3. Describe the design and implementation of systems that support real-time applications. Justify and critique facilities provided by real-time operating systems and networks.
4. Design, construct and analyze a small, concurrent, reactive, real-time system.
5. Select and use appropriate engineering techniques, and explain the effect of your design decisions on the behavior of the system.

UNIT-I **10 hrs**	**Introduction:** Basic component Architecture, terminology, Real Time Design Issues, Other Devices Language Features, Survey of Commonly Used Programming Languages, Phases of software life cycle, Non-temporal Transition in the software life cycle.
UNIT-II **15 hrs**	**Real Time task scheduling:** Basics on RT task scheduling, RT task scheduling algorithms, Preemptive RT algorithms (Earliest deadline first, RMA), Static priority scheduling protocols, Resource sharing among RT Tasks, Priority inversion, Priority inheritance protocol (PIP), HLP, PCP, Different types of priority inversion under PCP, Scheduling RT tasks in multiprocessor and distributed systems**.**
UNIT-III **10 hrs**	**Queuing Models, Reliability, Testing, And Fault Tolerance, Multiprocessing Systems:** Basic Buffer size Calculation, Classical Queuing Theory, Little's Law, Faults, Failures ,bugs AND effects. Reliability, Testing, Fault Tolerence, Classification of Architectures, Distributed Systems, Non Von Neumann Architectures.
UNIT-IV **10 hrs**	H**ardware/ Software Integration, Real Time Applications:** Goals of Real Time System Integration, Tools, Methodology, The Software Hesisenberg Uncertainity Principle, Real Time Systems As Complex System, First Real Time Application Real Time Databases, Real time Image Processing Real Time UNIX, building Real Time Applications with Real Time Programming Languages.

Text Books :

1. Real Time System, Jane W.S.Liu

2. Real Time Systems Design and Analysis by Phillip A. Laplante,PHI.

3. Rajiv Mall, “Real Time Systems, Theory and Practice”, 2nd Edition, Pearson Education, 2007.

Reference Books:

1 Hard Real Time Computing Systems Predictable Scheduling Algorithms and applications by Giorgio C. Buttazzo

2 Real Time Design Patterns: Robust Scalable Architecture for Real Time System by BrucePowel Douglass

3. Real Time System: Scheduling, Analysis and Verification by Albert M.K. Change

E13: COMPUTER VISION

Course Objective:

1. Introduce the fundamental problems of computer vision.
2. Provide understanding of techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.
3. Provide pointers into the literature and exercise a project based on a literature search and one or more research papers.
4. Practice software implementation of different concepts and techniques covered in the course.
5. Utilize programming and scientific tools for relevant software implementation.

Course outcomes: On successful completion of this course, the learners will be able to

1. Understand the fundamental problems of computer vision.
2. Understand the techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.
3. Provide pointers into the literature and exercise a project based on a literature search and one or more research papers.
4. Practice software implementation of different concepts and techniques covered in the course.
5. Utilize programming and scientific tools for relevant software implementation.

UNIT-I **13 hrs**	**Introduction:** overview of computer vision, related areas, and applications; overview of software tools; overview of course objectives.; introduction to OpenCV. **Image formation and representation:** imaging geometry, radiometry, digitization, cameras and projections, rigid and affine transformations. **Filtering:** convolution, smoothing, differencing, and scale space.
UNIT-II **12 hrs**	**Feature detection:** edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors. **Model fitting:** Hough transform, line fitting, ellipse and conic sections fitting, algebraic and Euclidean distance measures. **Camera calibration:** camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.
UNIT-III **12 hrs**	**Epipolar geometry:** introduction to projective geometry; epipolar constraints; the essential and fundamental matrices; estimation of the essential/fundamental matrix. **Model reconstruction:** reconstruction by triangulation; Euclidean reconstruction; affine and projective reconstruction. **Motion analysis:** the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation; motion segmentation through EM.
UNIT-IV **8 hrs**	**Motion tracking:** statistical filtering; iterated estimation; observability and linear systems; the Kalman filter; the extended Kalman filter. **Object recognition and shape representation:** alignment, appearance-based methods, invariants, image eigenspaces, data-based

	techniques. **Final presentation:** students present selected topics and develop software implementation of related techniques based on the review of relevant literature. The work should be summarized in a concluding report which should include simulation results. A list of possible topics will be advertised prior to the project selection due date.

Text Books:

1. Computer Vision: Algorithms and Applications, R. Szeliski, Springer, 2011.
2. Computer Vision: A Modern Approach, D. Forsyth and J. Ponce, Prentice Hall, 2nd ed., 2011.
3. Introductory techniques for 3D computer vision, E. Trucco and A. Verri, Prentice Hall, 1998.

Reference Books:

1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

E14: HIGH PERFORMANCE COMPUTING

Objective: The overall goal is to acquaint students with how to improve the quality of the programs for execution on high performance computer systems. The course discusses the various activities that happen during program execution, and how they are managed by the hardware (architectural features) and system software (operating systems, run-time systems). The theoretical and practical mix of the HPC Software development programs has the following objectives:

1. To explore the fundamental concepts of Parallel programming and HPC Solutions and their applications.
2. To develop in-depth knowledge and understanding of HPC domain.
3. To understand the various search methods and visualization techniques.
4. To learn to use various HPC tools.

Course outcomes: On successful completion of this module students should be able to:

1. Understand key HPC concepts and how they are applied in scientific research.
2. Understand the efficiency of multicore systems and cluster systems
3. Devise parallel strategies to solve computational problems.
4. Write parallel programs for multicore processors and cluster systems with OpenMP and MPI.
5. Leverage numerical, I/O libraries for better performing code

UNIT-I **15 hrs**	**Program** execution: Program, Compilation, Object files, Function call and return, Address space, Data and its representation. **Computer organization:** Memory, Registers, Instruction set architecture, Instruction processing**, Pipelined processors**: Pipelining, Structural, data and control hazards, Impact on programming, **Virtual memory:** Use of memory by programs, Address translation, Paging. **Cache memory:** Organization, impact on programming, virtual caches. **Operating systems**: Processes and system calls, Process management. Program profiling, **File systems:** Disk management, Name management, **Protection Parallel architecture:** Inter-process communication, Synchronization, Mutual exclusion, Basics of parallel architecture.
UNIT-II **12 hrs**	**Programming using OpenMP:** Shared memory multiprocessing programming (OpenMP). OpenMP Programming Model, OpenMP API Overview, Compiling OpenMP Programs, OpenMP, Synchronization Constructs, Directives, Data Scope Attribute Clauses, Directive Binding and Nesting Rules, Run-Time Library Routines, Environment Variables, Thread Stack Size and Thread Binding, Monitoring, Debugging and Performance Analysis Tools for OpenMP.
UNIT-III **8**	**Programming using MPI:** Message Passing Interface (MPI) and approaches for the parallelization of programs: General Introduction, Point-to-Point Communication, Blocking vs. Non-blocking sends, Collective Communication, MPI hybrid models, profiling, and debugging.
UNIT-IV **10 hrs**	**Hybrid programming (OpenMP and MPI):** Numerical libraries & high performance I/O libraries, Introduction to multi-threading accelerators. **HPC tools:** Profiling and Debugging of codes tools: gprof, Vtune, **gdb**, Performance library like mkl, **lapack**, fft.

Text Books:

1. J. L. Hennessy and D. A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.

2. A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, John Wiley.

3. R. E. Bryant and D. R. O'Hallaron, Computer Systems: A Programmer's Perspective, Prentice Hall.

4. Michael J Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill Higher Education.

5. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar,"Introduction to Parallel Computing", Pearson Education India.

6. Rohit Chandra, Ramesh Menon, Leo Dagum, David Kohr,Dror Maydan,Jeff McDonald, "Parallel Programming in OpenMP", Morgan Kaufmann.

7. V. Rajaraman and C. Siva Ram Murthy, "Parallel Computers – Architecture and Programming", Prentice-Hall of India, 2003.

Reference Books:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.

2. Selim G. Akl, "The Design and Analysis of Parallel Algorithms", Prentice-Hall of India, 1999.

E15: AGILE SOFTWARE DEVELOPMENT

Objective: The main objectives of this course are to help one to understand the meaning of agile, its importance and when it is best suited in software industry. Software industry is going crazy on agile methods. It is rapidly becoming the choice for software development where requirements are unpredictable or is expected to change over time.

COURSE OUTCOMES:

Students will gain an understanding of the testing role within an agile project and be able to effectively apply practical skills associated with that role. At the end of the course, successful students will be able to:

- Understand the principles behind the agile approach to software development
- Differentiate between the testing role in agile projects compared with the role of testers in non-agile projects
- Positively contribute as an agile team member focused on testing
- Appreciate the challenges and difficulties associated with the non-testing activities performed in an agile team
- Demonstrate a range of soft skills required by agile team members

UNIT-I **10 hrs**	**Fundamentals of Agile:** The Genesis of Agile, Introduction and background, Agile Manifesto and principles, Overview of Scrum, Extreme Programming, Feature Driven development, Lean Software Development, Agile project management, Design and development practices in Agile projects, Test Driven Development, Continuous Integration, Refactoring, Pair Programming, Simple Design, User Stories, Agile Testing, Agile Tools
UNIT-II **10 hrs**	**Agile Scrum Framework: I**ntroduction to Scrum, Project phases, Agile Estimation, Planning game, Product backlog, Sprint backlog, Iteration planning, User story definition, Characteristics and content of user stories, Acceptance tests and Verifying stories, Project velocity, Burn down chart, Sprint planning and retrospective, Daily scrum, Scrum roles–Product Owner, Scrum Master, Scrum Team, Scrum case study, Tools for Agile project management
UNIT-III **10 hrs**	**Agile Testing:** The Agile lifecycle and its impact on testing, Test-Driven Development (TDD), xUnit framework and tools for TDD, Testing user stories -acceptance tests and scenarios, Planning and managing testing cycle, Exploratory testing, Risk based testing, Regression tests, Test Automation, Tools to support the Agile tester
UNIT-IV **15 hrs**	**Agile Software Design and Development:** Agile design practices, Role of design Principles including Single Responsibility Principle, Open Closed Principle, Liskov Substitution Principle, Interface Segregation Principles, Dependency Inversion Principle in Agile Design, Need and significance of Refactoring, Refactoring Techniques, Continuous Integration, Automated build tools, Version control. **Industry Trends:** Market scenario and adoption of Agile, Agile ALM, Roles in an Agile project, Agile applicability, Agile in Distributed teams, Business benefits, Challenges in Agile, Risks and Mitigation, Agile projects on Cloud, Balancing Agility with Discipline, Agile rapid development technologies

Text Books:

1. Agile Software Development with Scrum By Ken Schawber, Mike Beedle, Pearson.
2. Agile Software Development, Principles, Patterns and Practices By Robert C. Martin, Prentice Hall.
3. Agile Testing: A Practical Guide for Testers and Agile Teams By Lisa Crispin, Janet Gregory, Addison Wesley.
4. Agile Software Development: The Cooperative Game By Alistair Cockburn, Addison Wesley

Reference Books:

1. Rajib Mall, “Fundamentals of Software Engineering”, PHI
2. Marcus Ries, “Agile project management”, Kindle edition

E16: AUGMENTED REALITY AND VIRTUAL REALITY (AR &VR)

OBJECTIVE: This course provides students with an opportunity to explore the research issues in Augmented Reality and Virtual Reality (AR &VR). It also makes the students know the basic concept and framework of virtual reality.

Learning outcomes:

When students have successfully completed this module they should be able to:

1. Understand how using technology as «VR/AR» can help us in our life.
2. Develop interactive augmented and virtual reality applications for both PC based mobile devices using a variety of novel input devices
3. Demonstrate a knowledge of the research literature in Augmented and Virtual Reality for both compositing and interactive applications.

UNIT-I **10 hrs**	**Introduction of Virtual Reality:** Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. **Multiple Models of Input and Output Interface in Virtual Reality:** Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices
UNIT-II **10 hrs**	**Visual Computation in Virtual Reality:** Fundamentals of Computer Graphics. Software and Hardware Technology on Stereoscopic Display. Advanced Techniques in CG: Management of Large Scale Environments & Real Time Rendering. **Interactive Techniques in Virtual Reality:** Body Track, Hand Gesture, 3D Manus, Object Grasp
UNIT-III **10 hrs**	**Development Tools and Frameworks in Virtual Reality:** Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc. **Application of VR in Digital Entertainment:** VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.
UNIT-IV **15 hrs**	**Augmented and Mixed Reality:** Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Text Books:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

References Books:

1. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.

E17: MOBILE ROBOTICS

Couse Objective: This course will present various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems. The focus of the course is distributed equally on the computational aspects and practical implementation issues and thereby leads to a well-rounded training.

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

1. Understand the various aspects of design, fabrication, motion planning, and control of intelligent mobile robotic systems.
2. Map human intelligence and behavior to develop intelligent robot.
3. Apply computational intelligence algorithms for programming robot's behaviour.
4. Explore current trends in robotics research.

UNIT-I **15 hrs**	**Robot locomotion:** Types of locomotion, hopping robots, legged robots, wheeled robots, stability, maneuverability, controllability; **Mobile robot kinematics and dynamics:** Forward and inverse kinematics, holonomic and nonholonomic constraints, kinematic models of simple car and legged robots, dynamics simulation of mobile robots.
UNIT-II **10 hrs**	**Perception:** Proprioceptive/Exteroceptive and passive/active sensors, performance measures of sensors, sensors for mobile robots like global positioning system (GPS), Doppler effect-based sensors, vision based sensors, uncertainty zxsin sensing, filtering.
UNIT-III **5 hrs**	**Localization:** Odometric position estimation, belief representation, probabilistic mapping, Markov localization, Bayesian localization, Kalman localization, positioning beacon systems.
UNIT-IV **15 hrs**	**Introduction to planning and navigation:** path planning algorithms based on A-star, Dijkstra, Voronoi diagrams, probabilistic roadmaps (PRM), rapidly exploring random trees (RRT), Markov Decision Processes (MDP), stochastic dynamic programming (SDP).

Text Books:

1. R. Siegwart, I. R. Nourbakhsh, "Introduction to Autonomous Mobile Robots", The MIT Press, 2011.
2. Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011.
3. S. M. LaValle, "Planning Algorithms", Cambridge University Press, 2006
4. Thrun, S., Burgard,W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA, 2005.

Reference Books

1. Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds, 2012.
2. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005.

E18: BLOCKCHAIN TECHNOLOGY AND APPLICATIONS

CourseObjectives: The syllabus is aimed at giving a basic understanding of cryptocurrency, its importance and the use of blockchain technology. It is focused on defining the technological backbone of Bitcoin fundamentals and expands the concepts to building the blockchain technology. It guides us to understand the history of digital currency, the polices involving laws and organizations, the latest trends, and the communities involved; which facilitates us to construct, visualize and understand the ecosystem of blockchain technology and its environment on which it is deployed.

Learning outcomes:

The students will be able to understand the following:

1. Basic Cryptographic primitives used in Blockchain
2. Basic Blockchain (Blockchain 1.0) – concepts germane to Bitcoin and contemporary proof-of-work based consensus mechanisms, operations of Bitcoin blockchain, crypto-currency as application of blockchain technology
3. Blockchain 2.0 – Blockchains with smart contracts and Turing complete blockchain scripting – issues of correctness and verifiability, Ethereum platform and its smart contract mechanism
4. Blockchain 3.0 – Plug-and-play mechanisms for consensus and smart contract evaluation engines, Hyperledger fabric platform
5. applications of blockchain in cyber security, integrity of information, E-Governance and other contract enforcement mechanisms
6. Limitations of blockchain as a technology, and myths vs. reality of blockchain technology

UNIT-I **15 hrs**	**Introduction:** Need for Distributed Record Keeping, Modeling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Why Nakamoto Came up with Blockchain based cryptocurrency? Technologies Borrowed in Blockchain – hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash etc. **Basic Distributed Computing:** Atomic Broadcast, Consensus, Byzantine Models of fault tolerance.
UNIT-II **13 hrs**	**Basic Crypto primitives:** Hash functions, Puzzle friendly Hash, Collison resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems. **Blockchain 1.0:** Bitcoin blockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use
UNIT-III **12 hrs**	**Blockchain 2.0:** Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts, **Blockchain 3.0:** Hyperledger fabric, the plug and play platform and mechanisms in permissioned blockchain
UNIT-IV **5 hrs**	**Privacy, Security issues in Blockchain:** Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - -advent of algorand, and Sharding based consensus algorithms.

Text Books:

1. Draft version of “S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, ‘Blockchain Technology: Cryptocurrency and Applications’, Oxford University Press, 2019.
2. Josh Thompson, ‘Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming’, Create Space Independent Publishing Platform, 2017.

Reference Books:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction”, Kindle Edition.

2. Andreas M. Antonopoulo,”Mastering Bitcoin: Programming the Open Blockchain”,2nd Edition, Kindle Edition.

E19: DATA ANALYTICS

Course Objective: This course will cover fundamental algorithms and techniques used in Data Analytics. The statistical foundations will be covered first, followed by various machine learning and data mining algorithms. Technological aspects like data management (Hadoop), scalable computation (MapReduce) and visualization will also be covered. In summary, this course will provide exposure to theory as well as practical systems and software used in data analytics.

Course Outcomes: After completing this course, students will learn how to:

- Find a meaningful pattern in data
- Graphically interpret data
- Implement the analytic algorithms
- Handle large scale analytics projects from various domains
- Develop intelligent decision support systems

UNIT-I **15 hrs**	**Data Definitions and Analysis Techniques:** Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning and R-Programming, **Descriptive Statistics:** Measures of central tendency, Measures of location of dispersions, Practice and analysis with R, Basic Analysis Techniques.
UNIT-II **14 hrs**	**Basic analysis techniques:** Statistical hypothesis generation and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Practice and analysis with R.
UNIT-III **8 hrs**	**Data analysis techniques:** Regression analysis, Classification techniques, Clustering, Association rules analysis, Practice and analysis with R
UNIT-IV **8 hrs**	**Case studies and projects:** Understanding business scenarios, Feature engineering and visualization, Scalable and parallel computing with Hadoop and Map-Reduce, Sensitivity Analysis

Text Books:

1. Probability & Statistics for Engineers & Scientists (9th Edn.), Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall Inc.
2. The Elements of Statistical Learning, Data Mining, Inference, and Prediction (2nd Edn.), Trevor Hastie Robert Tibshirani Jerome Friedman, Springer, 2014
3. An Introduction to Statistical Learning: with Applications in R, G James, D. Witten, T Hastie, and R. Tibshirani, Springer, 2013
4. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer
5. Mining Massive Data Sets, A. Rajaraman and J. Ullman, Cambridge University Press, 2012

Reference Books:

1. Advances in Complex Data Modeling and Computational Methods in Statistics, Anna Maria

Paganoni and Piercesare Secchi, Springer, 2013
2. Data Mining and Analysis, Mohammed J. Zaki, Wagner Meira, Cambridge, 2012
3. Hadoop: The Definitive Guide (2nd Edn.) by Tom White, O'Reilly, 2014
4. MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems, Donald Miner, Adam Shook, O'Reilly, 2014
5. Beginning R: The Statistical Programming Language, Mark Gardener, Wiley, 2013

E20: HUMAN-COMPUTER INTERACTION

Objectives: The course explores the design of computer interfaces that are based on the abilities, limitations and goals of the users. The students would be introduced to the underlying principles of useable interface design through a review of theories and current research in Human-Computer Interaction (HCI).

It is expected that the successful completion of this course will:

1. Provide the student with a solid background in basic concepts in human computer interaction.
2. Allow the student to apply these concepts to analyze interface design from the perspective of the user.
3. Prepare the student for more advanced study in human computer interaction.

Course outcomes: This course introduces the students to the basic issues of designing usable computer interfaces, the process of designing those interfaces and an overview of the background necessary to develop a usable interface.

By the end of this course the student will be able to:

1. Describe the process of interaction design.
2. Explain the principles and techniques used in creating user-centered interfaces.
3. Explain some issues related to related to particular topics in HCI in depth.
4. Specifically the students enrolled in the course will:
5. Understand the concept of usability and how it relates to computer interface design.

UNIT-I **5 hrs**	**Introduction to HCI,** A Brief History of HCI, User Interface Design: Models, Principles, Practices. Direct Manipulation: Overview, Scope, Applications.
UNIT-II **10 hrs**	**Cognitive Framework of HCI:** Limitations in memory and decision making and the implications they have on HCI design. Space Time and Temporal Methods, Effect of Response Time and Feedback on performance.
UNIT-III **15 hrs**	**Motor Control:** Basics of bio-mechanics of the human body. Fitt's Law, Interaction with Computer through motor activities like mouse movement, keyboard press etc. Command Language, Menus, Forms, Graphical user Interface, Interaction Devices, Natural Language
UNIT-IV **15 hrs**	**Perception & Representation**, Attention and Interface Design, Memory in Interface Design, Knowledge Representation, User Modeling, Interaction with Natural Languages, Next Generation Interface, **UI Evaluation:** Introduction,Cognitive Walkthrough. Heuristic Evaluation, Evaluation with Cognitive Models, Evaluation with Users, Model-based Evaluation

Text Book:

1. Alan Dix, Janet E. Finlay Gregory, D. Abowd, Russell Beale, Human Computer Interaction, Pearson.

Reference:

1. Don Norman, The Design of Everyday Things, Basic Books.
2. Steve Krug, Don't Make Me Think-A Common Sense Approach to Web Usability, New Riders, Berkeley, California.
3. ACM Sigchi Curriculla for Human Computer Interaction

E21: ADVANCED LINUX PROGRAMMING

Course Objectives:

1. To teach principles of operating system including File handling utilities, Security by file permissions, Process utilities, Disk utilities, Networking Commands, Basic Linux commands, Scripts and filters.
2. To familiarize fundamentals of the Bourne again shell (bash), shell programming, pipes, input and output redirection Control structures, arithmetic in shell interrupt processing, functions, debugging shell scripts.
3. To impart fundamentals of file concepts kernel support for file, File structure related system calls (file API's).
4. To facilitate students in understanding Inter process communication.
5. To facilitate students in understanding semaphore and shared memory.
6. To facilitate students in understanding process.

Course Outcomes:

1. Ability to use various Linux commands that are used to manipulate system operations at admin level and a prerequisite to pursue job as a Network administrator.
2. Ability to write Shell Programming using Linux commands.
3. Ability to design and write application to manipulate internal kernel level Linux File System.
4. Ability to develop IPC-API's that can be used to control various processes for synchronization.
5. Ability to develop Network Programming that allows applications to make efficient use of resources available on different machines in a network.

UNIT-I **15 hrs**	**Advanced UNIX Programming with Linux:** Getting Started with emacs, GDB,GCC, automation with GNU make, Writing Good GNU/Linux Software. Processes, Interprocess Communication, Devices, The /proc file System, Linux System Calls, Security, File system permission, authenticating users
UNIT-II **5 hrs**	**Python Programming:** Built-in Data Types, Simple Statements, Compound statement, Functions and Classes, Parsing, Applications and Recipes, Guidance on Packages and Modules.
UNIT-III **15 hrs**	**BashProgramming:**Bash and bash scripts, Writing and debugging scripts, The Bash environment, The GNU sed stream editor, Regular expressions, Grep, Pattern Matching, Conditional statements, I/O redirection, repetitive tasks, interactive editing, non- interactive editing, Writing interactive scripts
UNIT-IV **10 hrs**	**Functions**, Catching Signals, Inter Process Communications, Semaphores, Shared Memories, Sockets, ProgramingGNOMEusingGTK+.

Text Books:

1. Mark Mitchell, Jeffrey Oldham, and Alex Samuel, "ADVANCED Linux Programming", New Riders Publishing, 2001.
2. Dave Kuhlman, "A Python Book: Beginning Python, ADVANCED Python, and Python Exercises", Rexx Publishers, 2012.

Reference Books:

1. Machtelt Garrels, “Bash Guide for Beginners”, Fultus Corporation Publishers, 2004.
2. Daniel P. Bovet, Marco Cesati, “Understanding the Linux Kernel”,
(2e), O'Reilly Publication, 2002.
3. Niel Matthew, Rick Stone, “Beginning Linux Programming”, (4e), Wiley Publications, 2007.

E22: ARTIFICIAL NEURAL NETWORKS

Course Objective: The objective of this paper is to give the students an in-depth understanding of Artificial Neural Networks (ANN). Different models of ANN with their functionalities, architecture and algorithms are covered. The learner is exposed to ANN concepts from ground up, gradually moving to theoretical and mathematical proofs with applications.

Course Outcomes: Upon successful completion of this course, the student should be able to:

1. Understand key concepts of Artificial Neural Networks.
2. Use Artificial Neural Networks for problem solving.
3. Identify appropriate Artificial Neural Network Model to build solutions to problems.
4. Use Artificial Neural Networks as a tool for Machine Learning.
5. Apply Artificial Neural Networks for building Deep Learning machines.

UNIT-I **12 hrs**	**Introduction and ANN Structure:** Biological neurons and artificial neurons, Model of an ANN, Activation functions used in ANNs, Typical classes of network architectures. **Mathematical Foundations and Learning mechanisms:** Re-visiting vector and matrix algebra, State-space concepts, Concepts of optimization, Error-correction learning, Mem ory-based learning, Hebbian learning
UNIT-II **12 hrs**	**Single layer perceptrons:** Structure and learning of perceptrons, Pattern classifier - introduction and Bayes' classifiers, Perceptron as a pattern classifier, Perceptron convergence, Limitations of a perceptrons. **Feedforward ANN:** Structures of Multi-layer feedforward networks, Back propagation algorithm, Back propagation - training and convergence, Functional approximation with back propagation, Practical and design issues of back propagation learning
UNIT-III **11 hrs**	**Radial Basis Function Networks:** Pattern separability and interpolation , Regularization Theory, Regularization and RBF networks , RBF network design and training , Approximation properties of RBF. Support Vector machines. Linear separability and optimal hyperplane , Determination of optimal hyperplane , Optimal hyperplane for nonseparable patterns , Design of an SVM , Examples of SVM.
UNIT-IV **10 hrs**	**Competitive Learning and Self organizing ANN:** General clustering procedures , Learning Vector Quantization (LVQ) , Competitive learning algorithms and architectures , Self organizing feature maps , Properties of feature maps. **Fuzzy Neural Networks:** Neuro-fuzzy systems , Background of fuzzy sets and logic , Design of fuzzy stems , Design of fuzzy ANNs

Text Books:

1. Simon Haykin, "Neural Networks: A comprehensive foundation", SecondEdition, Pearson Education Asia.
2. Satish Kumar, "Neural Networks: A classroom approach", Tata McGrawHill, 2004.
3. Robert J. Schalkoff, "Artificial Neural Networks", McGraw-Hill InternationalEditions, 1997

Reference Books:

1. Neural Networks and Learning Machines – Simon Haykin, Pearson
2. Neuro-Fuzzy & Soft Computing – J.-S. R. Jang, C. -T. Sun, E. Mizutani, Pearson

E23: WIRELESS NETWORKS

Course Objective:

• Understand the architecture and applications of current and next generation wireless networks: Cellular, WLANs, sensor networks, mobile ad-hoc networks and intermittently connected mobile networks.

• Learn how to design and analyze various medium access and resource allocation techniques wireless networks.

• Learn to design and analyze transport layer protocols, with an emphasis on congestion control, including TCP over wireless, congestion sharing mechanisms, explicit and precise rate control, utility optimization based approaches, and backpressure-based utility optimization.

Course outcome:

• Have knowledge and understanding of basic mobile network architecture

• Have knowledge and understanding of some basic technologies that are in use

• Be able to make critical assessment of mobile systems

• Be able to analyze and propose broad solutions for a range of mobile scenarios

UNIT-I **10 hrs**	**Wireless Communication Standard**: First, Second and Third Generation Wireless Communication Network, Coverage Extension, Types; Characterization of Wireless Channels- multipath Propagation, Linear Time Variant, Channel Model, Channel Correlation Function, Large Scale Path Loss and Shadowing, Fading.
UNIT-II **10 hrs**	**Bandpass Transmission Technique for Mobile Radio:** Signal Space and Decision Region, **Digital Modulation**: MPSK, MSK, GMSK,OFDA, Power Spectral Density, Probability of Transmission Error; Receiver Technique for Fading Dispersive Channels.
UNIT-III **15 hrs**	**Cellular Communication:** Frequency reuse and mobility Management, Cell Cluster Concept, Co Channel and Adjacent Channel Interference, Call Blocking and Delay at Cell Site, Cell Splitting, Sectoring. **Multiple Access Technique:** Random Access, Carrier Sense Multiple Access(CSMA), Conflict Free Multiple Access Technology and Spectral Efficiency-FDMA, TDMA, CDMA
UNIT-IV **10 hrs**	**Mobility management and In wireless network**: CAC, Handoff Management, Location Management for Cellular Network and PCS network, Traffic calculation. **Wireless Internetworking**: Mobile IP, Internet Protocol (IP), Transmission Control Protocol (TCP), Network Performance, Wireless Application Protocol(WAP) , Mobile AD HOC Network.

Text Books:

1. WIRELESS Comunication &Networking by Mark & Zuang , PHI

2. Wireless Communications And Networks**,** William Stallings , PHI

Reference Books:

1. Wireless Network Performance Handbook , by Smith , McGraw- Hill

2. Principles Of Wireless Networks, By Pahlavan , PHI

E24: CRYPTOGRAPHY AND NETWORK SECURITY

Course Objective:

• To understand the principles and practices of cryptography and network security

• To understand the practical applications that have been implemented and are in use to provide network security

Course Outcome: after successful completion of this course, the students will be able to explain

• Conventional encryption algorithms for confidentiality and their design principles

• Public key encryption algorithms and their design principles

• Use of message authentication codes, hash functions , digital signature and public key certificates

• Network security tools and applications

• System-level security issues like threat of and countermeasures for intruders and viruses, and the use of firewalls and trusted systems.

UNIT-I **11 hrs**	**Overview:** Security trends, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. **Symmetric (Private Key) Ciphers: Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography. **Block Ciphers and the Data Encryption Standard:** Block Cipher Principles, The Data Encryption Standard (DES), The Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles.
UNIT-II **10 hrs**	**Symmetric Ciphers** (continued): **Basic Concepts in Number Theory and Finite Fields:** Groups, Rings, and Fields, Modular Arithmetic**,** the Euclidian algorithm, Finite Fields of the Form GF(p), Polynomial Arithmetic, Finite Fields of the Form GF(2*n*). **Advanced Encryption Standard:** The Origins AES, Evaluation criteria for AES, the AES Cipher. **Stream cipher**: Stream ciphers and RC4. **Confidentiality using symmetric encryption**: Placement of encryption function, traffic confidentiality, key distribution.
UNIT-III **12 hrs**	**Asymmetric (Public Key) Ciphers: Introduction to Number Theory:** Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Discrete Logarithms. **Public-Key Cryptography and RSA:** Principles of Public-Key Cryptosystems. **Key Management-Other Public-Key Cryptosystems:** Key management, Diffie-Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography. **Message Authentication and Hash functions**: Message authentication requirements, authentication functions, Message authentication codes, Hash functions, Security of Hash functions and MAC, SHA, HMAC, CMAC.
UNIT-IV **12 hrs**	**Digital Signatures and Authentication protocols**: Digital signature, Authentication protocols, Digital signature standards, **Network Security applications: Authentication applications:** Kerberos, X.509 Authentication services, Public key infrastructure. **Electronic mail security**: PGP, S/MIME. Overview of IP Security. **Web Security**: Web security considerations, SSL and TLS, Secure electronic transaction. **System Security:** Intruders, Intrusion detection, password management, viruses and related threats, virus counter measures, Firewall design principles, and trusted systems.

Text Book:

1. William Stallings, “Cryptography and Network Security, Principles and Practices”, Pearson Education,Prentice Hall, 4th Edition.
2. Cryptography and Network Security, Atul Kahate, McGraw Hill Education (India) Private Limited; Third edition.

Reference books:

1. Applied Cryptography: Protocols & Algorithms, Schneier & Bruce, MGH International.
2. Cryptography and Security **–** by Dr T R Padmanabhan N Harini , Wiley India Pvt Ltd, 2011.

BTCOM-UG-P703 & BTCOM-UG-P704: PROGRAMME ELECTIVE VI & VII (2L 1T 0P)

E1: SOFT COMPUTING

Course Objectives: It comprises of computational techniques like Genetic/ Evolutionary algorithms, Artificial Neural Networks, Fuzzy Systems, Machine learning and probabilistic reasoning etc. This course thoroughly discusses Genetic Algorithms, Artificial Neural Networks (major topologies and learning algorithms) and Fuzzy Logic

Course outcomes: After completing the course, the students:

1. Acquire knowledge of soft computing theories fundamentals and so they will be able to design program systems using approaches of these theories for solving various real-world problems.
2. Awake the importance of tolerance of imprecision and uncertainty for design of robust and low-cost intelligent machines.

UNIT-I **11 hrs**	**Introduction:** Definition, Conception, Importance, Development history; Neural networks: Neuron models, Activation functions, Network architectures. Types of learning: error-correction, memory based, Hebbian, competitive, and Boltzmann learning.
UNIT-II **12 hrs**	**Feed Forward Neural Network:**Single layer perceptron, Multi layer perceptron, Back propagation algorithm, Radial basis function network. Self-organizing map, Principal component analysis, Applications.
UNIT-III **12 hrs**	**Fuzzy Logic:** Fuzzy set theory: Fuzzy versus Crisp, Fuzzy set and Crisp set, Fuzzy relations and Crisp relations. Fuzzy systems: Crisp logic, Predicate logic, Fuzzy logic, Fuzzy rule based system, Defuzzification methods, Applications
UNIT-IV **10 hrs**	**Genetic algorithms:** Basic concepts, Working principle, Encoding, Fitness function, Reproduction, Crossover, Mutation operators, Applications; Hybrid Intelligent systems: Combination of Neural networks, Fuzzy logic and Genetic algorithms.

Text Books:

1. Eva Volna, “Introduction to Soft computing”, (1e), Bookboon.com, 2013.
2. S. Rajasekaran, G. A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications”, PHI, 2011.

Reference Books:

1. S. N. Sivanandam, S. N. Deepa, “Principles of Soft Computing”, Wiley Pub., 2010.
2. Simon S. Haykin, “Neural Networks- A ComprehensiVe Foundation”, Prentice Hall, 2005.
3. Timothy J Ross, “Fuzzy Logic with Engineering Applications”, (2e), McGrawHill, 2004.

E2: WIRELESS AD-HOC AND SENSOR NETWORKS

Course Objectives: This course aims to develop

- An understanding of the concept of wireless adhoc and wireless sensor network with its major challenges.
- An understanding of WSN architecture and its design principles.
- Fundamental understanding on MAC and routing protocols.
- An ability to evaluate Localization And Positioning techniques in wireless adhoc and wireless sensor network.
- An ability to design and provide solutions for practical low cost, energy efficient, reliable and secure wireless sensor network.

Course Outcomes

On the completion of this course, the students will be able to:

1. Have an ability to evaluate wireless adhoc & sensor network based on its performance as well as minimize the design challenges.
2. Have an ability to demonstrate several architectures of WSN and provide a new design solutions according to the required applications.
3. Have an ability to design several MAC, Routing and transport protocols for WSNs.
4. Have an ability to provide practical solutions and apply the subject expertise for the welfare of society.
5. Demonstrate several Localization & Positioning techniques in wireless adhoc & sensor network.

UNIT-I **12 hrs**	**Introduction To Wireless Ad Hoc And Sensor Networks:** Fundamentals of Wireless Communication Technology, The Electromagnetic Spectrum, Radio propagation Mechanisms, Characteristics of the Wireless Channel, mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs) :concepts and architectures, Applications of Ad Hoc and Sensor networks, Design Challenges in Ad hoc and Sensor Networks
UNIT-II **15 hrs**	**Single Node And Network Architecture:** single node architecture: hardware and software components of a sensor node , WSN Network Architecture: typical network architectures data relaying and aggregation strategies, Energy consumption of sensor nodes, Operating system and execution environments. **Medium Access Control:** Overview, wireless MAC Protocols - Carrier Sense Multiple Access, Multiple Access with Collision Avoidance (MACA) and MACAW , MACA By Invitation, IEEE 802.11, IEEE 802.15.4 and ZigBee; Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols
UNIT-III **9 hrs**	**Network Layer:** Overview, categories of routing protocol, routing metrics, flooding and gossiping, data-centric routing- sensor protocols for information via negotiation, directed diffusion, rumor routing, gradient-based routing; proactive routing-destination sequenced distance vector, optimized

	link state routing; on-demand routing-ad hoc on-demand distance vector, dynamic source routing; hierarchical routing, location-based routing
UNIT-IV **9 hrs**	Localization And Positioning: Properties of localization and positioning procedures, Possible approaches: Proximity, Trilateration and Triangulation. **Security:** Fundamentals of network security, challenges of security in wireless sensor networks, security attacks in sensor networks, protocols and mechanisms for security, IEEE 802.15.4 and ZigBee security

Text Books:

1. XiangYang Li, “Wireless Adhoc and Sensor Networks: Theory and Applications”, Cambridge university press, USA, 2008.

2. WaltenegusDargie&Christian Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice, Wiley Publication

3. Jun Zheng&Abbas Jamalipour, Wireless Sensor Networks: A Networking Perspective, Wiley Publication.

Reference Books:

1. 1. C. Siva Ram Murty and B. S. Manoj, “Ad Hoc Wireless Networks- Architectures and Protocols” ,Pearson.
2. Xiuzhen Cheng, Xiao H. Huang, Dingzhu Du, “Ad Hoc wireless networking”, Springer
3. Holger Karl &Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley Publication.
4. Robert Faludi, Building Wireless Sensor Networks, O’Reilly Publication.
5. ShahinFarahani, ZigBee Wireless Networks and Transceivers, 1st Edition, Elsevier Publication.
6. Feng Zhao &Leonidas Guibas, Wireless Sensor Networks: An Information Processing Approach, Elsevier Publication.

E3: MOBILE COMPUTING AND APPLICATION

Course Objective

• To introduce the fundamental design principles & issues in cellular & mobile communications.

• To enable the student to understand the basic features of cellular-mobile communication systems and digital radio system.

• To motivate students to understand the different technology for working of mobile devices, their advantages and disadvantages and emerging problems.

Course Outcome: After successful completion of the course students will be able to

• Understand the basic physical-layer architecture of a mobile communication system.

• Understand various multiple-access techniques for mobile communications, and their advantages and disadvantages.

• Students will be able to acknowledge about the working and development of mobile and wireless devices in detail, services provided by them and recent application development trends in this field.

UNIT-I **12 hrs**	**Introduction, Cell Coverage &, Frequency Management:** Mobile and wireless devices, Frequencies for radio transmission, A basic cellular system, Cell Size. Elements of cellular radio systems, Design and Interference, Concept of frequency reuse, cell splitting, Channels, Multiplexing, Access Techniques, Medium Access control, Spread spectrum, Specialized MAC, Cell Throughput,, Co-channel interference reduction factor, Frequency management, fixed channel assignment, non-fixed channel assignment, traffic & channel assignment, Why hand off, types of handoff and their characteristics, dropped call rates & their evaluation.
UNIT-II **10 hrs**	**GSM Architecture & Services:** GSM Services and Features, GSM System Architecture, GSM Radio Subsystem, GSM Channel Types, Example of a GSM Call, Signal Processing in OSM, Channel Coding for Data Channels, Channel Coding for Control Channels, Frequency and Channel Specifications. **New Data Services:** DECT Functional Concept, DECT Radio Link, Personal Access Communication Systems, PACS System Architecture, PACS Radio Interface, UMTS
UNIT-III **13 hrs**	**Wireless Networks:** Wireless LAN, Hidden Nodes in Wireless Networks, Ordered MAC Techniques and Wireless Networks, Deterministic MACs for Wireless Networks, Comparison Of MAC Techniques for Wireless Networks; Infrared V/S Radio Transmission; IEEE 802.11, Architecture, Layers, Management; HIPERLAN; Bluetooth; Wireless Broadband (WiMAX), RFiD, Java Card., WLL. **Mobile network and Transport layer:** Mobile Network Layer; Mobile IP, DHCP, ADHOC Networks; Mobile Transport Layer; Traditional TCP, Indirect TCP, Snooping TCP, Mobile TCP; Fast Transmit/Fast Recovery, Transmission/Time Out Freezing, Selective Retransmission, Transaction Oriented TCP.
UNIT-IV **10 hrs**	**Mobile System Development and Support:** Wireless Application Protocol (WAP) – WAP Model, WAP Gateway, WAP Protocols WAP User Agent Profile and Caching, Wireless Bearers for WAP, WAP Developer Toolkits, Mobile Station Application Execution Environment Third-Generation Mobile Services - Paradigm Shifts in Third-Generation Systems W-CDMA and cdma2000,

	Improvements on Core Network, Quality Service in 3G Wireless Operating System for 3G Handset, Third- Generation Systems and Field Trials, Other Trial Systems, Impact on Manufacture and Operator Technologies.

Text Books

1. Mobile Communications – Schiller, Jochen; 2nd Indian Reprint, Pearson Education Asia – Addison Wesley Longman PTE. Ltd.
2. Wireless Communication Principles and Practice, Theodore S Rappaport, 2nd Ed, Pearson Education.

Reference Books:

1. Mobile Data Wireless LAN Technologies – Dayem, Rifaat A.; Prentice Hall International.
2. The Essential Guide to Wireless Communication Applications – Dornan, A.; 1st Indian Reprint, Pearson Education Asia.
3. Sandeep Singhal, “The Wireless Application Protocol”, Pearson Education Asia,
4. P. Stavronlakis, “Third Generation Mobile Telecommunication systems”, Springer Publishers.

E4: FAULT TOLERANT COMPUTING SYSTEMS

Course Objectives: The purpose of the course is to solve and understand dependability problems; the need to design computer systems which are reliable, available and safe. Dependability concerns are integral parts of engineering design. The term dependability encompasses the concepts of reliability, availability, safety, security, maintainability, testability. Implementation of Fault Tolerance Designs through Redundancy is one way to improve the dependability parameters of the system.

Course outcomes: On completion of the course it is expected to endow the students with skills to:

i) Grasp the basic knowledge of fault tolerant computing and concerned not only about whether a system is working but also whether it is working correctly, particularly in safety critical cases.

ii) Students should be familiar with making system fault tolerant, modeling and testing, and benchmarking to evaluate and compare systems.

UNIT-I **10 hrs**	**Introduction to Fault-Tolerance:** Error, Faults and Failures; Reliability and Availability; Dependability Measures. **Mathematical Reliability Modeling:** Probability Basics; Reliability and Availability Modeling, Analysis using Markov Models.
UNIT-II **13 hrs**	**Hardware Fault-Tolerance:** Canonical and Resilient Structures; Reliability Evaluation Techniques and Models; Processor-level Fault Tolerance; Byzantine Failures and Agreements. **Information Redundancy:** Error Detection/Correction Codes (Hamming, Parity, Checksum, Berger, Cyclic, Arithmetic); Encoding/Decoding circuits; Resilient Disk Systems (RAID).
UNIT-III **12 hrs**	**Fault-Tolerant Networks:** Network Topologies and their Resilience; Fault-tolerant Routing. **Software Fault-Tolerance**: Single-Version Fault Tolerance; N-Version Programming; Recovery Approach; Exception and Conditional (Assert) Handling; Reliability Models.
UNIT-IV **10 hrs**	**Checkpointing:** Optimal Checkpointing; Checkpointing in Distributed and Shared-memory Systems**. Fault-Tolerant System Design/Applications:** Defect-tolerance in VLSI Designs; Fault Detection in Cryptographic Systems.

Text Books:

1. Israel Koren and C. Mani Krishna; Fault-Tolerant Systems; Morgan-Kaufman Publishers, 2007.
2. Elena Dubrova; Fault-Tolerant Design; Springer, 2013.
3. Michael R. Lyu; Handbook of Software Reliability Engineering; IEEE Computer Society Press (and McGraw-Hill), 1996.

Reference Books:

1. Martin L. Shooman; Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design; John Wiley & Sons Inc., 2002.
2. Kishor S. Trivedi; Probability and Statistics with Reliability, Queuing and Computer Science Applications; John Wiley & Sons Inc., 2016.

E5: MULTI-AGENT SYSTEMS

Course Objective:

This course describes: what are agents, muti-agent systems and what are their characteristics, reasoning about agents' knowledge and beliefs, distributed planning, high-level communication and automated negotiation, coordination mechanisms, MAS learning, organizational issues, and multi-agent systems architectures involved in building closed or open distributed systems.

Course Outcomes:

By the end of this course, students will know:

- what ideas, what new trends and what new possibilities are offered by intelligent agents and MAS;
- build multi-agent systems or select the right MAS framework for solving a real-world problem based on concepts such as distribution of tasks, communication, cooperation and coordination of actions;
- use the agent technology in areas such as Internet information gathering, electronic commerce and virtual markets, distributed decision making, workflow management, collaborative scientific work, and integration of legacy systems;
- what does the agent paradigm bring as compared to distributed processing or object oriented software development.

UNIT-I **13 hrs**	**Introduction:** Agents, agent definitions and classification, multi-agent systems (MAS),Is it an Agent, or just a Program?, The Belief-Desire-Intention, Models of agency, architectures and languages. Agent communication and interaction protocols, Terraforming Cyberspace, Plans and Resource-Bounded Practical Reasoning.
UNIT-II **10 hrs**	**Agent communication and interaction protocols**, UML diagrams, KQML as an agent communication language, Agent communication languages: Rethinking the principles, Knowledge representation.
UNIT-III **10 hrs**	**Distributed problem solving and planning**, Coordination mechanisms and strategies, Negotiation and coalition formation, Learning in MAS, Agent languages, Agent-oriented programming
UNIT-IV **12 hrs**	**Organizational theories**, Agent platforms, Agent-oriented software engineering, Industrial applications of MAS, MAS in electronic commerce and virtual markets, Adaptive information agents and information retrieval.

Textbook

1. "Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence." Gerhard Weiss (Ed.), MIT Press, 1999.
2. M. Wooldridge. An Introduction to Multiagent Systems. John Wiley and Sons Ltd, February 2002.

Reference Book:

1. Elaine Rich, Kevin Knight & Shivashankar B. Nair (2008). Artificial Intelligence (Third Edition) TMH.
2. Artificial Intelligence: A Modern Approach (Third edition) by Stuart Russell and Peter Norvig Russell, S. & Norvig, P. (2010).

E6: UBIQUITOUS COMPUTING

Course Objective: This course provides students with an opportunity to explore the research issues in ubiquitous computing and its close relative, pervasive and mobile computing. Many traditional areas of computer science and engineering are impacted by the constraints and demands of ubiquitous computing. A primary focus of this course is to explore the high level facilities, system architecture, and protocols of the ubiquitous system.

Course Outcomes: On completion of the course it is expected to endow the students with skills of

1. Fundamentals of ubiquitous computing and its close relative, pervasive and mobile computing.
2. Basics ofhigh level facilities, system architecture, and protocols of the ubiquitous system.

UNIT-I **10 hrs**	**Introduction:** Definition,scope, essential elements of ubiquitous, pervasive, and mobile computing. An introduction, overview, and challenges to research topics in ubiquitous computing, including sensors, ambient displays, tangibles, middleware, mobility, and location and context awareness.
UNIT-II **12 hrs**	**Architecture for ubiquitous computing:** New devices and communications; and software architectures. Wireless standards & protocols for ubiquitous networks : Near field communication (NFC), Bluetooth classic, Bluetooth Low Energy (BLE), WiFi, and WiFi Direct. **Location in ubiquitous computing:** Personal assistants, Location aware computing, Location tracking, Architecture, Location based service and applications (Indoor Positioning Techniques).
UNIT-III **12 hrs**	**Integrating the physical and the virtual worlds**: sensing and actuation; awareness and perception. Context-aware Computing, Issues and Challenges, Developing Context-aware Applications, System Architecture. **Ubiquitous applications:** the appropriate design; mixed reality and sensible design. Wearable computing, Glass and Augmented Reality, Eye-Tracking, Digital Pen and Paper Mobile social networking & crowd sensing, Event based social network.
UNIT-IV **11 hrs**	**Application domains for ubiquitous computing:** Illustration of some existing application domains for ubiquitous computing in such areas as gaming, workplaces, domestic spaces, museums and educational communities. Human Activity and Emotion Sensing, Health Apps Mobile peer-to-peer (p2p) computing Smart Homes and Intelligent Buildings, Mobile HCI, and Internet of Thinking IoT.

Text Books:

1. Ubiquitous Computing Fundamentals. Ed. John Krumm. ISBN: 1420093606. Chapman & Hall/CRC 2009.
2. Pervasive Computing and Networking, Mohammad S. Obaidat and et al., ISBN: 978-0-470-74772-8, Wiley 2011.

Reference Book:

1. Wireless Sensor Networks: An Information Processing Approach - Feng Zhao and Leonidas Guibas, Morgan Kaufmann Publishers, 2004 (Indian Edition)

E7: PARALLEL AND DISTRIBUTED ALGORITHMS

Course Objectives:

This course provides a detailed study of how to design, analyze, and implement parallel algorithms for computers that have multiple processors. It essentially tries to comprehend how to choose a parallel algorithm that makes good use of the target architecture.

Course Outcomes:

Course outcomes: On completion of the course it is expected to endow the students with skills to

i) This course attempt to provide an in depth discourse on how to think about algorithms in a parallelized manner. Essentially, detailed study of how to design, analyze, and implement parallel algorithms for computers that have multiple processors.

ii) These steps are not always easy. Some algorithms suitable for conventional, single-processor computers are not appropriate for parallel architectures.

iii) Many algorithms with inherent parallelism have a higher computational complexity than the best sequential counterpart.

iv) In either case, implementing an inappropriate algorithm wastes a parallel computer's resources.

UNIT-I **12 hrs**	**The Idea of Parallelism:** A Parallelised version of the Sieve of Eratosthenes, PRAM Model of Parallel Computation, Pointer Jumping and Divide & Conquer: Useful Techniques for Parallelization, **PRAM Algorithms**: Parallel Reduction, Prefix Sums, List Ranking, Preorder Tree Traversal, Merging Two Sorted Lists, Graph Coloring, Reducing the Number of Processors and Brent's Theorem, Dichotomoy of Parallel Computing Platforms, Cost of Communication
UNIT-II **10 hrs**	**Programmer's view of modern multi-core processors,** The role of compilers and writing efficient serial programs, **Parallel Programming Languages**: Shared Memory Parallel Programming using OpenMP, **Parallel Complexity**: The P-Complete Class, Mapping and Scheduling, Elementary Parallel Algorithms, Matrix Multiplication
UNIT-III **11 hrs**	**Writing efficient openMP programs**, Sorting, **Dictionary Operations**: Parallel Search, Graph Algorithms, **Industrial Strength programming 1**: Programming for performance; Dense Matrix-matrix multiplication through various stages: data access optimization, loop interchange, blocking and tiling, Analyse BLAS (Basic Linear Algebra System), ATLAS (Automatically Tuned Linear Algebra System) code
UNIT-IV **12 hrs**	**Distributed Algorithms:** models and complexity measures. Safety, liveness, termination, logical time and event ordering, Global state and snapshot algorithms, Mutual exclusion and Clock Synchronization, Distributed Graph algorithms, **Distributed Memory Parallel Programming:** Cover MPI programming basics with simple programs and most useful directives; Demonstrate Parallel Monte Carlo, Industrial strength programming 2: Scalable programming for capacity, Distributed sorting of massive arrays, Distributed Breadth-First Search of huge graphs and finding Connected Components

Text Books:

1. Michael J Quinn, Parallel Computing, TMH
2. Joseph Jaja, An Introduction to Parallel Algorithms, Addison Wesley

Reference Books:

1. Mukesh Singhal and Niranjan G. Shivaratri, Advanced Concepts in Operating Systems, TMH
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Introduction to Parallel Computing, Pearson

E8: FUTURE INTERNET ARCHITECTURE

Course Objective:

This course is an advanced networking course focusing on present and future Internet architecture, particularly targeted for the students who want to take their professional or research career in network development, administration and service management. The course will introduce working structures and protocols for today's Internet architecture, with a focus on how different network management and administrative tasks, like service differentiation, availability, capacity planning, monitoring etc., are done today with discussions on their limitations in terms of network scalability, quality of service provisioning and reliability point of view. With this target to motivate students towards the development of a new Internet architecture, the course will cover present developments towards the future Internet architecture, like software defined networking, mobile Internet, content centric networking, named data networking, different future Internet architecture proposals and context aware computing.

Learning Outcomes: After completing the course, the students will understand:

1. working structures and protocols for today's Internet architecture
2. on how different network management and administrative tasks works
3. the state of the art in network protocols, network architecture, and networked systems.
4. how to develop new Internet architecture.

UNIT-I **10 hrs**	**Architectural Principles:** The Design of DARPA Internet Architecture **Internet Backbone Architecture:** Switches, Bridges, Routers, Network access points and Internet Exchange Points, Physical characteristics of long haul backbone links, Internet Service Providers (ISP) and ISP connectivity, Economy of the backbone. Backbone routing (BGP) and routing table optimizations.
UNIT-II **10 hrs**	**Recent trends in Internet Applications:** Bitcoin and Cryptocurrencies: The Blockchain Storm, Adaptive streaming over HTTP, **Software Defined Networking (SDN):** Management issues in present network architecture, Network Virtualization and evolution of SDN, SDN architecture - data plane vs control plane, Examples of SDN controllers - OpenFlow architecture, SDN Programming
UNIT-III **15 hrs**	**Modern Transport Protocols in the Internet:** Basics of TCP and its limitations SPDY and QUIC, Multipath TCP (MPTCP), **Quality of Service (QoS) in the Internet:** QoS architecture - DiffServ and IntServ architecture, application QoS requirements, Queue management protocols and traffic shaping - priority queuing, custom queuing, weighted fair queuing, Flow based weighted fair queuing Random early detection, IntSev - Resource reservation protocol (RSVP), DiffServ - Assured Forwarding and Expedited Forwarding, **Virtualization**: Data Center Virtualization, Hyperconvergence Architecture, Virtual Network managenemt and QoS, Replica Management and Geo-load balancing
UNIT-IV	**Next Generation Internet Architecture:** Design Requirements for Future Internet

10 hrs	Architecture, Internet Hourglass Model, Content Delivery Network (CDN) Named Data Networking (NDN), Context Aware Computing, Mobile Internet - MobilityFirst Architecture - End-point mobility, device mobility, global name resolution, ChoiceNet and Nebula architecture

Text Books:

1. Thomas D. Nadeau, Ken Gray “SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies”, - O'Reilly Media
2. Andrew S. Tanenbaum, “Computer Networks”, PHI.

Reference Books:

3. Kurose Ross, “Computer Networks – A Top-Down Approach featuring the Internet”, Pearson.
4. Patricia A Morreale and James M. Anderson"Software Defined Networking: Design and Deployment"-CRC Press.

E9: DEEP LEARNING AND APPLICATIONS

Course Objectives: This course is an introduction to deep learning, a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task.

Course outcomes: After completing the course, the students will:

1. Understand how to solve a wide range of problems in Computer Vision and Natural Language Processing.
2. Learn about the building blocks used in these Deep Learning based solutions.
3. Learn about feedforward neural networks, convolutional neural networks, recurrent neural networks and attention mechanisms.
4. Look at various optimization algorithms such as Gradient Descent which is used for training such deep neural networks.
5. Have knowledge of deep architectures used for solving various Vision and NLP tasks.

UNIT-I **11 hrs**	**Introduction:** Feedforward Neural networks, Gradient descentand the backpropagation algorithm, Unit saturation aka the vanishing gradient problem, RelU Heuristics for avoiding bad local minima. Heuristics for faster training, Nestors accelerated gradient descent, Regularization, Dropout.
UNIT-II **12 hrs**	**Convolutional Neural Networks**: Architectures, convolution / pooling layers. Recurrent Neural Networks: LSTM, GRU, Encoder Decoder architectures. **Deep Unsupervised Learning:** Autoencoders (standard, sparse, denoising, contractive, etc), Variational Autoencoders, Adversarial Generative Networks, Autoencoder and DBM, Attention and memory models, Dynamic memory networks
UNIT-III **10 hrs**	**Applications of Deep Learning to Computer Vision:** Image segmentation, object detection, automatic image captioning, Image generation with Generative adversarial networks, video to text with LSTM models. Attention models for computer vision tasks.
UNIT-IV **12 hrs**	**Applications of Deep Learning to NLP:** Introduction to NLP and Vector Space Model of Semantics, Word Vector Representations: Continuous Skip-Gram Model, Continuous Bag-of Words model (CBOW), Glove, Evaluations and Applications in word similarity, analogy reasoning. Named Entity Recognition, Opinion Mining using Recurrent Neural Networks, Parsing and Sentiment Analysis.

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. “Deep Learning”.
2. Duda, R.O., Hart, P.E., and Stork, D.G. “Pattern Classification”. Wiley-Interscience. 2nd Edition. 2001.
3. Laurene Fausett , “Fundamentals of Neural Networks”.

Reference Books:

1. Theodoridis, S. and Koutroumbas, K. “Pattern Recognition”. Edition 4. Academic Press, 2008.

2. Francois Chollet , “Deep Learning with Python”
3. Bishop, C. M. “Neural Networks for Pattern Recognition”. Oxford University Press. 1995.
4. Hastie, T., Tibshirani, R. and Friedman, J. T”he Elements of Statistical Learning”. Springer. 2001.

E10: CYBER SECURITY

Course objective: The objectives of this course is to familiarize students with the following:

- To Create cyber security awareness and to understand principles of web security
- To understand key terms and concepts in cyber law, intellectual property and cyber-crimes, trademarks and domain theft.
- To make attentive to students about possible hacking and threats in this communication era.
- Discuss Issues for creating Security Policy for a Large Organization.

Course Outcome: After completing the course, the students will

1. Be able to acknowledge about the cybercrime, cyber-criminal, and intellectual property rights.
2. Understand Open Standards.
3. Understand Protection and resilience of Critical Information Infrastructure.
4. Enable effective prevention, investigation and prosecution of cybercrime and enhancement of law enforcement capabilities through appropriate legislative intervention.

UNIT-I **7 hrs**	**Cyber Security Fundamentals:** Security Concepts: Authentication, Authorization, Non-repudiation, Confidentiality, Integrity, availability. Cyber Crimes and Criminals: Definition of cyber-crime, types of cyber-crimes and types of cyber-criminals.
UNIT-II **8 hrs**	**Cyber attacker Techniques and Motivations:** Anti-forensics: Use of proxies, use of tunneling techniques. Fraud techniques: Phishing and malicious mobile code, Rogue antivirus, Click fraud. Threat Infrastructure: Botnets, Fast Flux and advanced fast flux.
UNIT-III **15 hrs**	**Exploitation:** Techniques to gain foothold: Shellcode, Buffer overflows, SQL Injection, Race Conditions, DoS Conditions, Brute force and dictionary attacks. Misdirection, Reconnaissance, and Disruption Methods: Cross-Site Scripting (XSS), Social Engineering, WarXing, DNS Amplification Attacks. **Information Technology Act 2000:** Overview of IT Act 2000, Amendments and Limitations of IT Act, Electronic Governance, Legal Recognition of Electronic Records, Legal Recognition of Digital Signature, Certifying Authorities, Cyber Crime and Offenses, Network Service Providers Liability, Cyber Regulations Appellate Tribunal, Penalties and Adjudication.
UNIT-IV **15 hrs**	**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).

Text Books

1. Cyber Security Essentials, James Graham et al. CRC Press
2. Cyber Laws: Intellectual property & E Commerce Security, Kumar K. Dominant Publisher

Reference Books

1. Cyber Law Text & Cases, Gerald R. Ferrera, Margo E. K. Reder, CENGAGE LEARNING Publication.

2. Ethics in Information Technology, George W. Reynolds, CENGAGE LEARNING Publication.

3. Cyber Laws & IT Protection, Harish Chander, PHI Publication.

4. Ross J. Anderson. Security Engineering: A Guide to Building Dependable Distributed Systems. John Wiley, New York, NY, 2001.

5. Matt Bishop. Computer Security: Art and Science. Addison Wesley, Boston, MA, 2003.

6. Frank Stajano. Security for Ubiquitous Computing. John Wiley, 2002.

E11: R PROGRAMMING

Course Objectives: This course will teach how to program in R and how to use R for effective data analysis. The students will learn how to install and configure R necessary for an analytics programming environment and gain basic analytic skills via this high-level analytical language. It also covers fundamental knowledge in R programming and popular R packages for data science will be introduced as working examples.

Course Outcomes:

Upon completion of this course participants should be able to:

1. establish an efficient scientific computing environment
2. identify and use available R packages and associated Open Source software to meet given scientific objectives
3. design and write efficient programs using R (and similar high-level languages) to perform routine and specialized data manipulation/management and analysis tasks
4. document, share, and collaborate on code development using a suite of Open Source standards and tools
5. document analytical workflow using R, markdown languages, and version control

UNIT-I **10 hrs**	**History and overview of R:** Introduction to R,History of R Programming, Features of R, Useful R Packages. Advantages of using R programming, Character , Numeric (Real Numbers), Integer (Whole Numbers) , Complex , Logical (True / False), R Basic Syntax , R Script File. **Install and configuration of R programming environment:** installing R, commands & syntax, packages and libraries, workspace in R.
UNIT-II **15 hrs**	**Basic language elements and data structures:** Vector ,Matrices, Arrays, List, Factors, Data frames, Data import & export & data types, Continuous and Categorical variables, Variable Assignment, Finding Variables, Deleting Variables. Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Miscellaneous Operators. Matrix syntax, Accessing Elements of a Matrix, Matrix Computations, Array Operations. **R Functions , R Strings and Vectors:** Function Definition, Function Components, Built-in Function, User-defined Function, Lazy Evaluation of Function. Rules Applied in String Construction, String Manipulation, Formatting numbers & strings - format function, Counting number of characters in a string - nchar function, Changing the case
UNIT-III **12 hrs**	**R Factors and Data Frames:** Factor function, Factors in Data Frame, Create Data Frame, Get the Structure of the Data Frame, Summary of Data in Data Frame, Extract Data from Data Frame, Expand Data Frame. R Data Reshaping :Joining Columns and Rows in a Data Frame, Merging Data Frames R CSV files. **Statistical measures in R:** Descriptive and inferential statistics, R Mean, Median Mode, R Regression, Steps to Establish a Regression, Simple linear regression, Multiple linear regression, lm Function predict Function,T rees Decision tree Random Forests, R Normal Distribution, Analysis of Covariance
UNIT-IV	**Time Series:** Different Time Intervals, Multiple Time Series, Missing data imputation using

8 hrs	Amelia package in R. **Data analysis:** Data analysis using rattle(),acf(),pacf(),Building C5 ,Building CART decision tree,The k-Means Clustering. **Building Neural network using R, Predictive analysis using R. Introductin of R Databases.**

Text Books:

1. Hands-On Programming with R: Write Your Own Functions and Simulations by By Garrett Grolemund, O 'Reily publishers
2. R Packages: Organize, Test, Document, and Share Your Code,by Book by Hadley Wickham, O 'Reily publishers

Reference Books:

1. R PROGRAMMING FOR BEGINNERS , by Sandip Rakshit, publisher Mc Graw Hill
2. Beginning R : The Statistical Programming Language 1 Edition (English, Paperback, Dr. Mark Gardener)
3. Efficient R Programming : A Practical Guide to Smarter Programming, by Colin Gillespie, Robin Lovelace) , O 'Reily publishers

E12: INTERNET OF THINGS

Objective: This course highlights the concepts of Internet of Things and facilitates students to build IoT applications.

Learning outcomes: On successful completion of this course,

1. Students will show the understanding of impact of information technology solutions on the society.
2. Students will be able to understand the application areas of IOT.
3. Able to understand building blocks of Internet of Things and characteristics.
4. Students will be explored to the interconnection and integration of the physical world and the cyber space.
5. Students will be able to design & develop IOT Devices.

UNIT-I **10 hrs**	**Introduction to IoT:** Defining IoT, Characteristics of IoT, Sensing, Actuation, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.
UNIT-II **10 hrs**	**Domain specific applications of IoT:** Home automation, Industry applications, Surveillance applications, Other IoT applications**. Basics of Networking:** Communication Protocols, Sensor Networks, Machine-to-Machine (M2M) Communications.
UNIT-III **10 hrs**	**Challenges in IoT:** Design challenges, Development challenges, Security challenges, Other challenges. **Interoperability in IoT:** Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.
UNIT-IV **15 hrs**	**Developing IoTs:** Introduction to Python programming, Introduction to Raspberry. Implementation of IoT with Raspberry Pi. **Introduction to SDN:** SDN for IoT, Data Handling and Analytics. **Cloud Computing, Sensor-Cloud, Fog Computing.** **Case Study:** Agriculture, Healthcare, Activity Monitoring.

Text Books:

1. Ovidiu Vermesan,Peter Friess"Internet of Things –From Research and Innovation to market Deployment",River Publishers.
2. Jan Ho¨ ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle "From Machine-to-Machine to the Internet of Things Introduction to a New Age of Intelligence",Academic Press Elsevier.
3. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-onApproach)”, 1 st Edition, VPT, 2014.

Reference Books:

1. Tim O’Reilly & Cory Doctorow "Opportunities and Challenges in the IoT",O’Reilly publication.
2. Pethuru Raj , Anupama C.Raman,"The Internet of Things, Enabling Technologies,platforms and use cases", CRC Press.

E13: PARALLEL AND DISTRIBUTED DATABASE SYSTEMS

Course Objectives: This course envisages the principles of parallel anddistributed database systems including design and architecture, security, integrity, query processing and optimization, transaction management, concurrency control, and fault tolerance. Fundamental issues in parallel anddistributed database systems that are motivated by the computer networking and distribution of processors and databases will also be addressed

Course Outcomes: At the conclusion of this course students will

1. Explore and critically evaluate a range of data models, database architectures and features supported by different database management systems.
2. Design, implement and evaluate various types of client-side interfaces to databases using selected modern tools appropriate for the task.
3. Analyse, design and practically implement a solution using current data management technologies using selected & modern tools appropriate for the task.
4. Discuss issues underpinning database administration, security and performance.
5. Be familiar with the currently available models, technologies for and approaches to building distributed database systems
6. Be aware of the current research directions in the field and their possible outcomes

UNIT-I **12 hrs**	**Concepts of Parallel and Distributed DBMS:** information systems, overview of traditional DBMS structure, distributed and parellel data processing, concept of distributed DBMS, architectural models for DDBMS, types of parallelism id database systems. **Client-Server Architecture:** structure of client-server systems, client-server standards, database middleware, transaction monitors, API for TM. **Heterogeneous Database Servers:** Interface Standards for Relational Database, ODBC, ODBC architecture, functionality and usage of ODBC.
UNIT-II **12 hrs**	**Architecture of Distributed DBMS:** transparences in DDBMS, architecture of DDBMS, types and role of fragmentation, types and role of replication, allocation problem**. Optimization of Distributed Query:** problem of query processing, distributed query, query decomposition, load balancing. **Parallel Query Processing:** muliprocessor architectures, parallel relational operators, parallel query processing parallelism in main-memory DBMS, **Parallel Query Optimization**
UNIT-III **10 hrs**	**Transaction Model of the DDBMS:** concept of transaction and history, concurrency control models, serializability, multilevel atomicity, locking methods. **Concurrency Control Algorithms:** multiversion locking methods, multiversion timestamp ordering methods, validation methods, optimistic methods, deadlock management. Reliability Issues of DDBMS's, Security Aspects in DDBMS
UNIT-IV **11 hrs**	**Design of Distributed Databases:** design methodologies, design strategies, distribution design issues, fragmentation issues. **WEB -based interface for DDBMS:** structure of WEB

	based user interface, cgi interface, database web servers. **DDBMS and Object Oriented Systems:** OO concepts in DDBMS, implementation level of OO concepts, management of OO data elements, COBRA architecture

Text Books:

1. M. Tamer Oezsu, Patrick Valduriez “Principles of Distributed Database Systems", Prentice Hall
2. Bell and J. Grimson, “Distributed Database Systems”, Addison-Wesley.

Reference Books:

1. Coulouris, Dollimore and Kindberg, “Distributed Systems: Concepts and Designs”, Addisson-Wesley
2. Ceri, Pellagati, “Distributed Database Systems”, McGraw Hill
3. M. Stonebraker, “Readings in Database Systems”, San Mateo, California: Morgan Kaufmann.

E14: MULTIMEDIA APPLICATIONS

Course Objectives: Multimedia has become an indispensable part of modern computer technology. In this course, students will be introduced to principles and current technologies of multimedia systems. Issues in effectively representing, processing, and retrieving multimedia data such as sound and music, graphics, image and video will be addressed. The students will gain hands-on experience in those areas by implementing some components of a multimedia streaming system as their term project. Latest Web technologies and some advanced topics in current multimedia research will also be discussed.

Course Outcomes: Upon completion of this course participants will be able to understand:

- Principles and current technologies of multimedia systems.
- Issues in effectively representing, processing, and retrieving multimedia data
- Latest Web technologies
- Advanced topics in current multimedia research will also be discussed.

UNIT-I **10 hrs**	**Introduction to Multimedia:** Multimedia information representation, Multimedia networks, Application and networking Terminology, Multimedia information representation. **Data compression**: coding requirements, source, entropy, and hybrid coding, JPEG, H.261 (px64), MPEG, MP3.
UNIT-II **8 hrs**	**Digitization Principles:** Compression Principles, Text Compression, Image Compression, Audio Compression, Video Compression. **Multimedia operating system issues, Multimedia synchronization.**
UNIT-III **15 hrs**	**Notion of Stream-Management System:** Sampling Data in a Stream, Filtering Streams, Distinct Elements in a Stream. **Multimedia applications:** digital libraries, system software, toolkits, conferencing paradigms, structured interaction support, and examples from video/audio/graphics conferencing.
UNIT-IV **12 hrs**	**Databases:** NOSQL Models, Understanding Storage Architecture, Performing CURD operations, Querying NOSQL Stores**. Latest Web technologies**: XML, X3D and Semantic Web.

Text Books:

1. Anand Rajaraman and Jeffrey David Ullman, “Mining of MASSIVE Datasets”, Cambridge University Press, 2011.

2. Tom White, “Hadoop: The DEFINITIVE guide”, (3e), O'reilly, Yahoo Press, 2012.

Reference Books:

1. Shashank Tiwari, “Professional NOSQL”, Wiley India Pvt. Ltd., 2012

2. Jimmy Lin, Chris Dyer, “Data INTENSIVE Text Processing with MapReduce”, (1e), Morgan & Claypool Publishers, 2010.

3. Paul C Zikopoulos, Chris Eaton, Dirk Deroos, Thomas Deutch, George Lapis, “Understanding Big Data”, McGraw Hill, 2012.

E15: GAME THEORY WITH ENGINEERING APPLICATIONS

Course Objective: This course is an introduction to the fundamentals of game theory and mechanism design. Motivations are drawn from engineered/networked systems (including distributed control of wireline and wireless communication networks, incentive-compatible/dynamic resource allocation, multi-agent systems, pricing and investment decisions in the Internet), and social models (including social and economic networks). The course emphasizes theoretical foundations, mathematical tools, modeling, and equilibrium notions in different environments

Course Outcomes:

Upon completion of this course participants should be able to understand:

- theoretical foundations,
- mathematical tools,
- modeling, and
- equilibrium notions in different environments

UNIT-I **8 hrs**	**Introduction to game theory:** Games and solutions. Game theory and mechanism design. Examples from networks.**Strategic form games:** Matrix and continuous games. Iterated strict dominance. Rationalizability. Nash Equilibrium; existence and uniqueness. Mixed and correlated equilibrium. Supermodular games. Potential/congestion games.
UNIT-II **8 hrs**	**Learning, evolution, and computation:** Myopic learning; fictitious play. Bayesian learning. Evolutionarily stable strategies. Computation of Nash equilibrium in matrix games. **Extensive games with perfect information:** Backward induction and subgame perfect equilibrium. Applications in bargaining games. Nash bargaining solution.
UNIT-III **14 hrs**	**Repeated games:** Infinitely/finitely repeated games. Trigger strategies. Folk theorems. Imperfect monitoring and perfect public equilibrium. **Games with incomplete information:** Mixed and behavioral strategies. Bayesian Nash equilibrium. Applications in auctions. Different auction formats. Revenue and efficiency properties of different auctions.
UNIT-IV **15 hrs**	**Mechanism design**: Optimal auctions; revenue-equivalence theorem. Social choice viewpoint. Impossibility results. Revelation principle. Incentive compatibility. VCG mechanisms. Mechanisms in networking, decentralized mechanisms. **Network effects and games over networks:** Positive and negative externalities. Utility-based resource allocation. Selfish routing. Wardrop and Nash equilibrium. Partially optimal routing. Network pricing. Competition and implications on network performance. Strategic network formation. Price of anarchy.

Text Books:

1. Fudenberg, Drew, and Jean Tirole. Game Theory. Cambridge, MA: MIT Press, 1991.
2. Nisan, Noam, Tim Roughgarden, Eva Tardos, and Vijay V. Vazirani. Algorithmic Game Theory. Cambridge, UK: Cambridge University Press, 2007.

Reference Books:

1. Fudenberg, Drew, and David Levine. The Theory of Learning in Games. Cambridge, MA: MIT Press, 1998.
2. Mas-Colell, Andreu, Michael D. Whinston, and Jerry R. Green. Microeconomic Theory. New York, NY: Oxford University Press, 1995.
3. Osborne, Martin J., and Ariel Rubinstein. A Course in Game Theory. Cambridge, MA: MIT Press, 1994.

BTCOM-UG-O705: OPEN ELECTIVE II (2L 1T 0P)

E1: DECISION SUPPORT SYSTEM

Course Objective:

- To review and clarify the fundamental terms, concepts and theories associated with Decision Support Systems, computerized decision aids, expert systems, group support systems and executive information systems.
- To examine examples and case studies documenting computer support for organizational decision making, and various planning, analysis and control tasks.
- To discuss and develop skills in the analysis, design and implementation of computerized Decision Support Systems.
- To understand that most Decision Support Systems are designed to support rather than replace decision makers and the consequences of this perspective for designing DSS.
- To discuss organizational and social implications of Decision Support Systems.

Course outcome: At the end of the course students will

1. Recognize the relationship between business information needs and decision making
2. Appraise the general nature and range of decision support systems
3. Appraise issues related to the analyze, design, development and implement a DSS
4. Select appropriate modeling techniques

UNIT-I **12 hrs**	**Overview of different types of decision-making:** Strategic, tactical and operational. Consideration of organizational structures. Mapping of databases, MIS, EIS, KBS, expert systems OR modeling systems and simulation, decision analytic systems onto activities within an organization. Extension to other 'non organizational' areas of decision making. Relationship with knowledge management systems
UNIT-II **12 hrs**	Studies of human cognition in relation to decision making and the assimilation of information. Cultural issues. Implications for design of decision-making support. Communication issues. Normative, descriptive and prescriptive analysis: requisite modeling. Contrast with recognition primed decision tools.
UNIT-III **12 hrs**	Database, MIS, EIS, KBS, Belief nets, data mining. OR modeling tools: simulation and optimization. History, design, implementation: benefits and pitfalls. Risk assessment. Decision analysis and strategic decision support.
UNIT-IV **9 hrs**	Group decision support systems and decision conferencing. Intelligent decision support systems: tools and applications. Cutting-edge decision support technologies. History, design, implementation: benefits and pitfalls. Deliberative e-democracy and e-participation

Text Books

1. P.R. Kleindorfer, H.C. Kunreuther, P.J.H. Schoemaker , “Decision Sciences: an integration Perspective”, Cambridge University Press 1993

2. G.M. Marakas, Decision support Systems in the 21st Century, Prentice Hall.

Reference Books

1. E. Turban and J.E. Aronson, Decision support Systems and Intelligent Systems. Prentice Hall

2. V.S.Janakiraman and K.Sarukesi, Decision Support Systems, PHI

3. Efrem G. Mallach, Decision Support and Data Warehouse Systems, tata McGraw-Hill.

E2: EMBEDDED SYSTEMS

Course Objective: The objective of the course is to introduce students to the modern embedded systems and to show how to understand and program such systems using a concrete platform built around A modern embedded processor like the Intel ATOM.

Course outcome:

- Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems..
- Become aware of the architecture of the ATOM processor and its programming aspects (assembly Level)
- Become aware of interrupts, hyper threading and software optimization.
- Design real time embedded systems using the concepts of RTOS.
- Analyze various examples of embedded systems based on ATOM processor

UNIT-I **6 hrs**	**EMBEDDED COMPUTING:** Challenges of Embedded Systems, Embedded system design process. Embedded processors, ARM processor: Architecture, ARM and Thumb Instruction sets.
UNIT-II **15 hrs**	**EMBEDDED C PROGRAMMING:** C-looping structures, Register allocation, Function calls, Pointer aliasing, structure arrangement, bit fields, unaligned data and endianness, inline functions and inline assembly, portability issues. **OPTIMIZING ASSEMBLY CODE:** Profiling and cycle counting, instruction scheduling, Register allocation, conditional execution, looping constructs, bit manipulation, efficient switches, optimized primitives.
UNIT-III **12 hrs**	**PROCESSES AND OPERATING SYSTEMS:** Multiple tasks and processes, Context switching, Scheduling policies, Inter-process communication mechanisms, Exception and interrupt handling, Performance issues.
UNIT-IV **12 hrs**	**EMBEDDED SYSTEM DEVELOPMENT:** Meeting real time constraints, Multi-state systems and function sequences. Embedded software development tools, Emulators and debuggers. Design methodologies, Case studies, Complete design of example embedded systems.

Text Books:

1. Andrew N Sloss, D. Symes, C. Wright, “ARM System Developers Guide”, Morgan Kaufmann / Elsevier, 2006.
2. Michael J. Pont, “Embedded C”, Pearson Education , 2007.

Reference Books

1. Wayne Wolf, “Computers as Components: Principles of Embedded Computer System Design”, Morgan Kaufmann / Elsevier, 2nd. edition, 2008.
2. Steve Heath, “Embedded System Design”, Elsevier, 2nd edition, 2003.

E3: VLSI DESIGN, VERIFICATION AND TEST

Course Objective: This course aims at covering the important problems/algorithms/tools so that students get a comprehensive idea of the whole digital VLSI design flow.

Learning outcomes: At the end of the course, the student is able to

1. Concepts of circuit design for digital VLSI components in state of the art MOS technologies.
2. High level Synthesis, Verilog RTL Design, Combinational and Sequential Synthesis Logic Synthesis (for large circuits)
3. Hardware Verification and methodologies, Binary Decision Diagrams(BDDs) and algorithms over BDDs
4. Fault models, Fault Simulation, Test generation for combinational circuits, Test generation algorithms for sequential circuits and Built in Self-Test.

UNIT-I **10 hrs**	**Introduction to Digital VLSI Design Flow:** Specification, High level Synthesis, RTL Design, Logic Optimization, Verification and Test Planning, Scheduling, Allocation and Binding: Problem Specification: Scheduling, Allocation and Binding , Basic Scheduling Algorithms, Allocation Steps: Unit Selection, Functional Unit Binding, Storage Binding, Interconnect Binding , Allocation Techniques: Clique Partitioning, Left-Edge Algorithm, Iterative Refinement.
UNIT-II **12 hrs**	**Logic Optimization and Synthesis:** Heuristic Minimization of Two-Level Circuits: Espresso, Finite State Machine Synthesis, Multi-Level Logic Synthesis , Multi-Level Minimization. Binary Decision Diagram : Reduction rules and Algorithms, ROBDDs , Operation on BDDs and its Algorithms. Temporal Logic: Basic Operators , Syntax and Semantics of LTL, CTL and CLT* , Equivalence and Expressive Power, Model Checking: Verification, Specification and Modelling, Model Checking Algorithm.
UNIT-III **15 hrs**	**Test:** Introduction to Digital Testing, est process and Test economics, Functional vs. Structural Testing Defects, Errors, Faults and Fault Modeling, Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem. Fault Simulation and Testability Measures: Circuit Modeling and Algorithms for Fault Simulation, Combinational SCOAP Measures and Sequential SCOAP Measures. Combinational Circuit Test Pattern Generation: Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras, D-Calculus and D-Algorithm, Basics of PODEM and FAN.
UNIT-IV **8 hrs**	**Built in Self-Test (BIST)**: Introduction to BIST architecture BIST Test Pattern Generation, Response Compaction and Response Analysis, Memory BIST: March Test, BIST with MISR, Neighborhood Pattern Sensitive Fault Test, Transparent Memory BIST.

Text Books:

1. D. D. Gajski, N. D. Dutt, A.C.-H. Wu and S.Y.-L. Lin, High-Level Synthesis: Introduction to Chip and System Design, Springer, 1st edition, 1992.
2. S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Prentice Hall, 2nd edition, 2003.
3. G. De Micheli. Synthesis and optimization of digital circuits, 1st edition, 1994.

Reference Books:

4. M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning about systems, Cambridge University Press, 2nd Edition, 2004.

5. Bushnell and Agrawal, Essentials of Electronic Testing for Digital, Memory & Mixed-Signal Circuits, Kluwer Academic Publishers, 2000.

E4: HUMAN RESOURCE DEVELOPMENT AND ORGANIZATIONAL BEHAVIOR

Course Objectives: The objective of the course is to familiarise the students about the different aspects of managing people in the organisations from the stage of acquisition to development and retention. In order to be successful, today's organizations must integrate organizational behavior and HRD. Organizations are dependent upon their employees to obtain the goals of the organization. It is through the employees that organizations can overcome the challenges with which organizations are faced today. Employees have to be motivated as a way of making them increase their productivity which is accomplished through the examination of organizational behavior and implementation of human resource development initiatives.

Learning outcomes: On completion of the course it is expected to endow the students with skills of

- List and define basic organizational behavior principles, and analyze how these influence behavior in the workplace.
- Analyze individual human behavior in the workplace as influenced by personality, values, perceptions, and motivations.
- Outline the elements of group behavior including group dynamics, communication, leadership, power & politics and conflict & negotiation.
- Understand your own management style as it relates to influencing and managing behavior in the organization systems.
- Enhance critical thinking and analysis skills through the use of management case studies, personal application papers and small group exercises.
- Strengthen research, writing and presentation skills.

UNIT-I **13 hrs**	**Human Resource Development:** Definition & Background, Economic Development, HRD and Organizational Socialization, Development of Individual through Training: Designing Training Programs: On –the Job, Off the Job, Methods, Other methods of HRD: Suggestion schemes, Counselling, career planning, 17 talent management, Competency mapping, Strategic Interventions: HRD in Service and Information Technology Sectors, HRD for Women and Workers, Mentoring, HR Audit: Audit Methodology, Writing the HRD Report, Designing and using HRD Audit for Business Improvement, Training need analysis, HRD in India: Cases in PSUs and Private Sector Enterprises.
UNIT-II **12 hrs**	**Fundamentals of Organizational Behaviour**: Understanding Organizational Behaviour - Fundamental Concepts, Organizational processes, Organizational structure, Organizational Change and Innovation processes. Effectiveness in organizations - Models of Organizational Behaviour, Systems theory and time dimension of effectiveness, Developing competencies, Limitations of Organizational Behaviour, Continuing challenges. Social systems and organizational culture - Understanding a Social System, Social Culture, Role, Status, Organizational culture, Influencing culture change, Sustaining the culture, Characteristics of effective socialization.

UNIT-III **10 hrs**	**Understanding and Managing Individual Behaviour:** Individual differences and work behavior, Personality, Attitudes, Perceptions, Attributions and Emotions, Motivation, Job Design, Work and Motivation, Evaluation, Feedback and Rewards, Managing misbehavior, Stress and Counseling.
UNIT-IV **10 hrs**	**Group Behaviour and Interpersonal Influence:** Informal and Formal Groups, Teams and Team Building, Managing Conflict and Negotiation, Power and Politics, Empowerment and Participation, Assertive Behaviour. **Organizational Processes**: Communication, Decision Making, Leadership. Organizational Structure and Design, Managing Change and Innovation.

Text Books:

1. Swati Sharma, Handbook of Organizational Behaviour and Human Resources 1 Edition
2. Mirza Saiyadain, Jag Sodhi, Cases in Organisational Behaviour and Human Resource Management Paperback – 18 Mar 2009
3. Organizational Behaviour-Robbins, Judge & Sanghi, Pearson Education Publication.
4. Organizational Behaviour-McShane & Glinow, McGraw Hill Publication.

Reference Books:

1. Sanjeev Kumar Singh, Human Resource Development : HRD—IR Interface Approach
2. G G Jadhav, Human Resource Management And Organisational Behaviour

E5: ENTERPRISE RESOURCE PLANNING

Course Objectives:

- To understand the business process of an enterprise
- To grasp the activities of ERP project management cycle
- To understand the emerging trends in ERP developments

Course Outcomes:

- Comprehend the technical aspects of ERP systems;
- Understand concepts of reengineering and how they relate to ERP system implementations;
- Map business processes using process mapping techniques;
- Understand the steps and activities in the ERP life cycle;
- Identify and describe typical functionality in an ERP system;
- Practical hands-on experience with one of the COTS ERP Software e.g. SAP, Oracle

UNIT-I **10 hrs**	**Introduction:** ERP: An Overview, Enterprise – An Overview, Origin, Evolution and Structure: Conceptual Model of ERP, The Benefits of ERP, ERP and Related Technologies, Business Process Reengineering (BPR), Data Warehousing, Data Mining, OLAP, Product Life Cycle Management(PLM), Supply chain Management(SCM)
UNIT-II **10 hrs**	**ERP implementation:** ERP Implementation Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Role of SDLC/SSAD, Object Oriented Architecture Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring
UNIT-III **15 hrs**	**Business modules:** Business modules in an ERP Package, Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution, **the ERP market:** ERP Marketplace and Marketplace Dynamics: Market Overview, Marketplace Dynamics, The Changing ERP Market. ERP- Functional Modules: Introduction, Functional Modules of ERP Software, Integration of ERP, Supply chain and Customer Relationship Applications
UNIT-IV **10 hrs**	**ERP – present and future:**ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture Using ERP tool: ERP Market Place, SAP AG, PeopleSoft, Baan, JD Edwards, Oracle, QAD, SSA. Turbo Charge the ERP System, EIA, ERP and e-Commerce, ERP and Internet, Future Directions.

Textbook:

1. Alexis Leon, “ERP Demystified”, Tata McGraw Hill, New Delhi, 2000

Reference Books:

1. Joseph A Brady, Ellen F Monk, Bret Wagner, “Concepts in Enterprise Resource Planning”, Thompson Course Technology, USA, 2001.

2. Vinod Kumar Garg and Venkitakrishnan N K, “Enterprise Resource Planning – Concepts and Practice”, PHI,

E6: PRINCIPLE OF PROGRAMMING LANGUAGES

Course Objectives: The objective of this course is to identify the conceptual building blocks from which languages are assembled and specify the semantics, including common type systems, of programming languages.

Course outcomes: After the completion of the course students will be capable of

1. Visualizing the problems for software requirements and decomposing into various modules for clarity and efficiency.
2. Preparing initial documents like SRS etc. effectively.
3. Incorporating OOD approach for developing software.
4. Develop programs using special procedural language: SCHEME.
5. Creating effective design like DFD, ERD and Data dictionaries for any software.

UNIT-I **10 hrs**	**Names, Scopes, and Bindings:** Names, Scopes, and Bindings: The art of language design; Programming language spectrum; Why study programming languages? Evolution of programming languages – describing syntax – context-free grammars – attribute grammars – describing semantics – lexical analysis – parsing – recursive-decent – bottom up parsing. Syntactic Structure - Language representation, Abstract Syntax tree, Lexical syntax, Context Free Grammars, Variants of CFG, Issues involved and Normal Forms for CFG. Compilation and interpretation; Programming environments. Names, scope, and bindings: The notion of binding time; Object lifetime and storage management; Scope rules; Implementing scope; The meaning of names within a scope; The binding of referencing environments; Macro expansion. High Level Languages, Issues in Programming - Case studies, Programming paradigms, Language implementation.
UNIT-II **12 hrs**	**Data Types & Control Structures:** Type systems; Type checking; Records and variants; Arrays; Strings; Sets; Pointers and recursive types; Lists; Files and Input/Output; Equality testing and assignment. Names – variables – binding – type checking – scope – scope rules – lifetime and garbage collection – primitive data types – strings – array types – associative arrays – record types –union types – pointers and references – Arithmetic expressions – overloaded operators –type conversions – relational and boolean expressions – assignment statements – mixed mode assignments . Control structures – selection – iterations – branching – guarded statements.
UNIT- III **11 hrs**	**Subroutines and Control Abstraction:** Review of stack layout; Calling sequences; Parameter passing; Generic subroutines and modules; Exception handling; Coroutines; Events, **Imperative languages:** Control Flow: Expression evaluation; Structured and unstructured flow; Sequencing; Selection; Iteration; Recursion; Non-determinacy, Structured Programming - Need and Design issues. Block Structures (Pascal), types arrays, records, sets, pointers, procedures, parameter passing, scope rules (in C). **Object oriented languages:** Grouping of data and Operations - Constructs for Programming Structures,

	abstraction Information Hiding, Program Design with Modules, Defined types, Object oriented programming - concept of Object, inheritance, Derived classes and Information hiding - Templates- Exception handling (Using C++ and Java as example language).
UNIT-IV **12 hrs**	**Functional Programming:** Features, Implementation, Types - values and operations, Introduction to lambda calculus Product of types.Introduction to lambda calculus. Lists and Operations on Lists, Functions from a domain to a range, Function Application, Lexical Scope. Bindings of values and functions (Using Haskell/ Lisp as example language).Reactive programming and its concepts, **Logic programming:** Formal Logic Systems, Working with relations and their implementation (Using Prolog as example). Database query Languages, Exception handling (Using SQL as example), **Concurrency:** Background and motivation; Concurrency programming fundamentals; Implementing synchronization; Language-level mechanisms; Message passing. Run-Time Program Management: Virtual machines; late binding of machine code; Inspection/introspection.

Text Books:

1. Michael L. Scott: Programming Language Pragmatics, 3rd Edition, Elsevier, 2009.
2. Programming Language Design Concepts by David A. Watt, Wiley publications

Reference Books:

1. Ravi Sethi: Programming languages Concepts and Constructs, 2nd Edition, Pearson Education, 1996.
2. R Sebesta: Concepts of Programming Languages, 8th Edition, Pearson Education, 2008.
3. Allen Tucker, Robert Nonan: Programming Languages, Principles and Paradigms, 2nd Edition, Tata McGraw-Hill, 2007.
4. Programming Languages: Principles and Practice (English) 1st Edition (Paperback) by Kenneth C. Louden.

E7: ETHICAL HACKING AND DIGITAL FORENSICS

Course Objectives:

- To learn various hacking techniques and attacks.
- To know how to protect data assets against attacks from the Internet.
- To assess and measure threats to information assets.
- To understand the benefits of strategic planning process.
- To evaluate where information networks are most vulnerable.
- To perform penetration tests into secure networks for evaluation purposes.
- To enable students to understand issues associated with the nature of forensics.

Course Outcomes: On completion of this course, a student should be able to:

- Defend hacking attacks and protect data assets.
- Defend a computer against a variety of different types of security attacks using a number of hands-on techniques.
- Defend a LAN against a variety of different types of security attacks using a number of hands on techniques.
- Practice and use safe techniques on the World Wide Web.
- Understand computer Digital forensics.

UNIT-I **6 hrs**	**Hacking Windows:** Hacking windows, Network hacking, Web hacking, Password hacking. A study on various attacks, Input validation attacks, SQL injection attacks, Buffer overflow attacks, Privacy attacks.
UNIT-II **11 hrs**	**TCP/IP:** TCP / IP – Checksums – IP Spoofing port scanning, DNS Spoofing. Dos attacks – SYN attacks, Smurf attacks, UDP flooding, DDOS – Models. Firewalls – Packet filter firewalls, Packet Inspection firewalls – Application Proxy Firewalls. Batch File Programming. **Fundamentals of Computer Fraud:** Fundamentals of Computer Fraud – Threat concepts – Framework for predicting inside attacks – Managing the threat – Strategic Planning Process.
UNIT-III **17 hrs**	**Wireless & Web Hacking:** Wireless Hacking : Requirements , Aircracking , Hidden SSIDs , Monitor Mode , Monitoring Tool- Beacon Frames on Wireshark ,Airodump-ng , Wireless Adapter in Monitor Mode , Determining the Target , Cracking a WPA/WPA2 Wireless Network Using Aircrack-ng , Capturing Packets and Four-Way Handshake , Web Hacking : Attacking the Authentication , Brute Force and Dictionary Attacks. Attacking Authentication: Attacking Session Management, Design Flaws in Authentication Mechanisms Attacking Forgotten Password Functionality, attacking Password change functions. Countermeasures to authentication attacks. SQL Injection: Attacking SQL Servers, Sniffing, Brute Forcing and finding Application Configuration Files, Input validation attacks. Preventive Measures. Web Application Threats, Web Application Hacking, Cross Site Scripting / XSS Flaws / Countermeasures Correct Web Application Set-up.

UNIT-IV **11 hrs**	**Architecture:** Architecture strategies for computer fraud prevention – Protection of Web sites – Intrusion detection system – NIDS, HIDS – Penetrating testing process – Web Services– Reducing transaction risks. **Key Fraud Indicator Selection Process Customized:** Forensics – Computer Forensics – Journaling and it requirements – Standardized logging criteria – Journal risk and control matrix – Neural networks – Misuse detection and Novelty detection.

Text Books:

1. Kenneth C.Brancik "Insider Computer Fraud" Auerbach Publications Taylor & Francis Group– 2008.
2. Ankit Fadia " Ethical Hacking" second edition Macmillan India Ltd, 2006

Reference Books:

1. Michael T. Simpson, Kent Backman, James E. Corley, "Hands On Ethical Hacking and Network Defense", Cengage Learning, 2012.
2. Ankit Fadia, Manu Zacharia, "Network intrusion alert: an ethical hacking guide to intrusion detection", Thomson Course Technology PTR- 2007.
3. Thomas Mathew, "Ethical Hacking", OSB Publisher, 2003.
4. Stuart McClure, Joel Scambray and George Kurtz, "Hacking Exposed: Network Security Secrets & Solutions", McGraw-Hill, 2005.

E8: OPERATION RESEARCH

Course Objective

- To introduce use quantitive methods and techniques for effective decisions–making; model formulation and applications those are used in solving business decision problems.
- To model decision making problems using major modeling formalisms of artificial intelligence and operations research, including propositional logic, constraints, linear programs and Markov processes,
- To evaluate the computational performance of search, satisfaction, optimization and learning algorithms.
- To apply search, satisfaction, optimization and learning algorithms to real world problems.

Course Outcome:

- Identify and develop operational research models from the verbal description of the real system.
- Understand the mathematical tools that are needed to solve optimization problems.
- Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

UNIT-I **8 hrs**	**Linear Programming:** LP formulations, Graphical method for solving LP with 2 variables, Simplex method, Application of simplex method for maximization and minimization of LP problems, Artificial variable technique for finding the initial basic feasible solution, The Big-M method, Degeneracy in simplex method, Duality theory in LP, Dual simplex method.
UNIT-II **14 hrs**	**Transportation Model:** North – West comer rule, Least cost method, Vogel's Approximation method, Modi Method, Assignment problem, Dynamic Programming: Basic concepts, Bellman's optimality principle, Dynamic programming approach in decision making, Optimal subdivision problem. **Inventory Model:** Introduction to the inventory problem, Deterministic models, The classical EOQ (Economic order quantity) model, Purchasing model with no shortage, Manufacturing model with no shortage, purchasing model with shortage, Manufacturing model with shortage, Inventory models with probabilistic demand.
UNIT-III **11 hrs**	**Sequencing and Queuing Theory:** Sequencing problem, Johnson's algorithm for processing N-jobs through 2 machine problem, N-jobs through 3 machine problem, 2- job through N machine by graphical method, Characteristics of queuing system- steady state M/M/1, M/M/1K and M/M/C queuing models.
UNIT-IV **12 hrs**	**CPM and PERT:** Arrow network, Time estimates – Earliest expected time, Latest allowable occurrence time and slack, Critical path, Probability of meeting scheduled date of completion of project, Calculation on CPM network, Various floats for activities, Critical Path, Updating project, Operation time cost trade off curve & project time cost trade off curve, selection of schedule based on cost analysis.

Text Books:-

1. Operation Research, Panneerselvam, Prentice Hall of India
2. Operation Research: An Introduction - Hamdy a. Taha, Prentice Hall of India

Reference Books:-

1. Gillett B.E, Introduction to Operation Research- A Computer Oriented algorithmic approach, Mc Graw Hill.
2. Kanti Swarup, Gupta.P.K.,Man Mohan, Operations Research, Sultan Chand & Sons.
3. Vohra N.D., Quantitative Techniques in Managemental, T.M.H.
4. Zoints. S.,Linear & Integer Programming,Prentice Hall.

E9: ENGINEERING RESEARCH METHODOLOGY

Course Objective: This course covers the various stages of research work in engineering sciences and highlights the importance, scope, functioning and procedures to be followed for successful research outcomes and its documentation and presentation. It also intends to give students the tools to conceptualize their theses in terms of research questions and design, methodology, data collection and qualitative as well as quantitative analysis.

Course outcomes: At the end of this course, the students will demonstrate their ability to

1. Understand the research method as a major component leading to the learning and completion of Dissertation.
2. Produce a dissertation research proposal with researchable topic related to the field of engineering and applied science, appropriate research method, and a display of literature review.
3. Complete a research leading to a dissertation.

UNIT-I **12 hrs**	**Research Methodology:** Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.
UNIT-II **12 hrs**	**Literature Survey:** Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Literature Review: Need of Review, Guidelines for Review, Record of Research Review. **Research Design:** Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.
UNIT-III **12 hrs**	Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software. Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chisquare, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.
UNIT-IV **9 hrs**	**Research Report Writing:** Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Text Books:

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y. P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009

Reference Books:

1. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.
2. Naval Bajjai “Business Research Methods” Pearson 2011.
3. Prahalad Mishra “ Business Research Methods “ Oxford 2016

E10: QUANTUM COMPUTING

Course Objective: The objective of this course is to provide the students an introduction to quantum computation. Much of the background material related to the algebra of complex vector spaces and quantum mechanics is covered within the course.

Learning outcomes: On completion of the course it is expected to endow the students with skills of

1. fundamentals of quantum information processing, including quantum computation, quantum cryptography, and quantum information theory
2. the quantum circuit model, qubits, unitary operators, measurement, entanglement, quantum algorithms for factoring and search, quantum cryptographic key distribution, error-correction and fault-tolerance, information capacity of quantum channels, complexity of quantum computation.

UNIT-I **12 hrs**	**Introduction to Quantum Computation:** Quantum bits, Bloch sphere representation of a qubit, multiple qubits. **Background Mathematics and Physics:** Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.
UNIT-II **12 hrs**	**Quantum Circuits:** single qubit gates, multiple qubit gates, design of quantum circuits. **Quantum Information and Cryptography:** Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem.
UNIT-III **12 hrs**	**Quantum Algorithms:** Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Deutsch's algorithm, Deutsch's Jozsa algorithm, Shor factorization, Grover search.
UNIT-IV **9 hrs**	**Noise and error correction:** Graph states and codes, Quantum error correction, fault-tolerant computation.

Text Books:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press, 2002.
2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II:Basic Tools and Special Topics, World Scientific,2004.

Reference Books:

1. P. Kaye, R. Laflamme, and M. Mosca. An Introduction to Quantum Computing. Oxford, 2007.
2. Pittenger A. O., An Introduction to Quantum Computing Algorithms, 2000.