M.Tech Programme

in

NETWORKING AND INTERNET ENGINEERING

SCHEME I TO IV SEMESTER: 2020-2021

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SYLLABUS I TO IV SEMESTER: 2020-2021

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for M. Tech

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for M. Tech (Networking and Internet Engineering)

SEMESTER	CREDITS
I	28
II	28
III	14
IV	18
TOTAL	88

SCHEME OF STUDY AND SYLLABUS FOR M. Tech in NETWORKING AND INTERNET ENGINEERING 2020

PG PROGRAM STRUCTURE (COMMON TO ALL PG PROGRAMS)

The following program structure shall be followed for all the PG Programs in the department.

Total credits		**88**
Semester 1:	2 mandatory courses (3+2 credits)	**= 05** credits
	2 core subjects (5 credits X 2)	= **10** credits (4:0:1 or 4:1:0)
	2 Electives (5 credits X 2)	= **10 (**4:0:1 or 4:1:0)
	1 Design Lab (1.5) + LAB (1.5)	= **03**
TOTAL		**28 credits**
Semester 2:		
	3 core subjects (5 credits X 3)	= **15** (4:0:1 or 4:1:0)
	1 Electives (5 credits X 1)	= **05** (4:0:1 or 4:1:0)
	1 Open Elective (5 credits X 1)	= **05** credits
	1 Design Lab (1.5) + LAB (1.5)	= **03**
TOTAL		**28 credits**
Semester 3:		
	Industrial training 8 weeks	**04 credits**
	Project Evaluation Phase I	**10 Credits**
Semester 4:		
	Project work and dissertation	**18 credits**
GRAND TOTAL		**88 credits**

Academic schedule:

Course work :(16 weeks + 1week preparation+ 2 weeks' exams+ 2 weeks' vacation) 21 X 2 = **42 weeks**

Training = **08 weeks**

PROJECT work and dissertation: **40 weeks**

Report preparation, submission, viva voce, result: **14 weeks**

TOTAL **104 weeks**

CONTINOUS EVALUATION SCHEDULE FOR PROJECT WORK

Event	Credits	Marks	Schedule
III SEM			
Industrial Training	04	100	Within 8th week
Synopsis Evaluation	02	50	Within 6th week
Mid-term Evaluation 1	02	50	Within 18th week
	Total	**200**	
IV SEM			
Mid-term Evaluation 2	02	50	Within 30th Week
Final internal seminar and demonstration	04	100	Within 40th Week
Report preparation	02	50	Within 44th Week
Evaluation of Project work External evaluation and Viva voce exam	28	200	Within 52nd Week
Declaration of results	**Total**	**400**	Within 54th Week

General guidelines:

1. Credit pattern of L: T: P means lectures, tutorials and practical's
2. 2 hours of tutorials/practical's is equal to 1 credit. 1 hour of lecture is 1 credit
3. Tutorials can be used for problem solving, assignments, interaction, simulations etc.
4. **CIE:** continuous internal assessment, 5 events to be conducted of which 2 have to be TESTS, remaining events can be used for lab work, mini project etc. **There shall be no choice in the question paper set for the test**.
5. The events have to be spread uniformly throughout the semester and are to be conducted according to the schedule fixed by the department.
6. Proper documentation is to maintained for all the events for the computation of CIE
7. The question paper for the **SEE** (Semester End evaluation) will be set by the faculty teaching the course. There will be no choice as for as the units are concerned for the student. Each of the 5 units will carry a weightage of 20 marks. However, within certain units, internal choice can be given. So, questions for 150 marks can be asked out of which student will attempt for 100 marks.
8. Based on the total marks obtained (CIE + SEE). Grades are awarded based on relative grading scheme.
9. A student who does not have a minimum of 25 out of 50 in CIE cannot appear for SEE.
10. A student should get a minimum of 40 percent in SEE for a pass.
11. A student failing in SEE has to repeat the course.
12. The syllabus can be split in to 5 units. For 3: x: y courses 40 hours of coverage is recommended. For 4: x: y courses, 50 hours of coverage is recommended

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JSS SCIENCE & TECHNOLOGY UNIVERSITY, MYSURU

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

M.Tech in Networking and Internet EngineeringSEMESTER I

SI No	Code	Course Title	L	T	P	Total credits	Contact hours	CIE	SEE	Total Marks	Exam duration
1	ECPG M1X	Mandatory Course 1	3	0	0	3	3	50	50	100	3 hours
2	ECPG M2X	Mandatory Course 2	2	0	0	2	2	50	-	50	-
3	LNI 130	Advanced Communication Networks	4	1	0	5	6	50	50	100	3 hours
4	LNI 140	Cryptography and Network security	4	1	0	5	6	50	50	100	3 hours
5	LNI 14X	Elective 1 Group A	4	1	0	5	6	50	50	100	3 hours
6	LNI 15X	Elective 2 Group B	4	1	0	5	6	50	50	100	3 hours
7	LNI 16L	Networking Lab-1	0	0	1.5	1.5	3	50	-	50	-
8	LNI 17L	Design and implementation -1	0	0	1.5	1.5	3	50	-	50	-
		TOTAL				**28**	**35**	**400**	**250**	**650**	

Mandatory Courses-1

Course code	Course title	Credit pattern
ECPGM11	Linear Algebra	3:0:0
ECPGM12	Graph Theory	3:0:0
ECPGM13	Data Analytics	3:0:0
ECPGM14	Transform Techniques	3:0:0
ECPGM15	Object Oriented Programming Using JAVA	3:0:0
ECPGM16	Advanced Microcontrollers and Applications	3:0:0
ECPGM17	Mathematical modeling and simulation	3:0:0

Mandatory Course - 2

Course code	Course title	Credit pattern
ECPGM21	Technical report writing and documentation	2:0:0
ECPGM22	Research Methodology	2:0:0
ECPGM23	Sustainable technologies	2:0:0
ECPGM24	Social implications of technology	2:0:0
ECPGM25	Entrepreneurship and Project Management	2:0:0
ECPGM26	Electronic waste management	2:0:0
ECPGM27	Internet and Society	2:0:0

PROGRAM CORE COURSES: (Two courses from among 1 to 5 will be offered)

SI No	Code	Course Title	Credit Pattern
1	LNI130	Advanced communication networks	4:1:0
2	LNI140	Cryptography and network security	4:1:0
3	LNI150	Storage area networks	4:1:0
4	LNI160	Wireless Networks	4:1:0
5	LNI170	Network Planning architecture and design	4:1:0
6	LNI 16L	Networking Lab-1	0:0:1.5
7	LNI 17L	Design and implementation -1	0:0:1.5

PROGRAM ELECTIVES FOR NETWORKING AND INTERNET ENGINEERING (LNI)

FIRST SEMESTER (Two electives to be chosen)

	SI No	Code	Course Title	Credit Pattern
Elective 1 Group A	1	LNI141	Network programming	4:1:0
	2	LNI142	Big data systems	4:1:0
	3	LNI143	Software defined Radio	4:1:0
	4	LNI144	Telecommunication management and regulation	4:1:0
Elective 1 Group B	1	LNI151	Cyber forensics and information security	4:1:0
	2	LNI152	Cloud computing and virtualization	4:1:0
	3	LNI153	Underwater Communication	4:1:0
	4	LNI154	Optical and DWDM networks	4:1:0
	5	LNI155	Quantum Computing and Communication	4:1:0

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M. Tech in Networking and Internet Engineering

SEMESTER II

SI No	Code	Course Title	L	T	P	Total credits	Contact hours	CIE	SEE	Total Marks	Exam duration
1.	LNI210	Mobile Computing	4	1	0	5	6	50	50	100	3 hours
2.	LNI220	Protocol Engineering	4	1	0	5	6	50	50	100	3 hours
3.	LNI230	Web Services	4	1	0	5	6	50	50	100	3 hours
4.	LNI 24X	Elective 1	4	1	0	5	6	50	50	100	3 hours
5.	ECPGOLX	Open Elective	4	1	0	5	6	50	50	100	3 hours
6.	LNI 16L	Networking Lab-2	0	0	1.5	1.5	3	50	-	50	-
7.	LNI 17L	Design and implementation -2	0	0	1.5	1.5	3	50	-	50	-
		TOTAL				**28**	**36**	**350**	**250**	**600**	

PROGRAM CORE COURSES: SECOND SEMESTER (Three courses from among 1 to 5 will be offered)

Sl. No	Code	Course Title	Credit Pattern
1	LNI210	Mobile computing	4:1:0
2	LNI220	Protocol engineering	4:1:0
3	LNI230	Web services	4:1:0
4	LNI240	Cognitive radio and Networks	4:1:0
5	LNI250	Ubiquitous Computing	4:1:0
6	LNI 26L	Networking Lab-2	0:0:1.5
7	LNI 27L	Design and implementation -2	0:0:1.5

PROGRAM ELECTIVES: SECOND SEMESTER (one elective to be chosen)

Sl No	Code	Course Title	Credit Pattern
1	LNI241	5G technologies	4:1:0
2	LNI242	Photonic systems and technologies	4:1:0
4	LNI243	Cyber Physical systems	4:1:0

LIST OF OPEN ELECTIVE COURSES:

Students from any specialization have to register for ONE course in the even semester among these courses depending on which course is offered by the department.

Course Code	Course Title	Credit pattern
ECPGOL1	IOT	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL5	Heuristics for optimization	4:1:0
ECPGOL6	Organizational Behavior and Financial Management	4:1:0
ECPGOL7	Deep learning	4:1:0
ECPGOL8	MEMS	4:1:0
ECPGOL9	Artificial Neural Networks	4:1:0

Department of Electronics and Communication Engineering, SJCE, Mysore

Subject Name & Code	**Linear Algebra ECPGM11**
No. of Teaching Hours – 40	**Credits : 3:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Solve systems of linear equations and homogeneous systems of linear equations by different methods
2. Obtain solutions for signal processing applications using vector space concepts
3. Explain the concept of a linear transformation as a mapping from one vector space to another.
4. Apply the concepts of factorization, SVD and Optimization to formulate and solve engineering problems.
5. Communicate and understand mathematical statements, ideas and results both verbally and in writing with correct use of mathematical definitions, terminology and symbolism by working collaboratively.

Unit 1

Linear equations: Fields; system of linear equations, and its solution sets; elementary row operations and echelon forms; matrix operations; invertible matrices, LU-factorization.

Vector spaces: Vector spaces; subspaces; bases and dimension; coordinates; summary of row-equivalence; computations concerning subspaces. **08 Hours**

Unit 2

Linear Transformations: Algebra of linear transformations; isomorphism; representation of transformations by matrices; linear functional; transpose of a linear transformation.

08 Hours

Unit 3

Canonical Forms: Characteristic values; annihilating polynomials; invariant subspaces; direct-sum decompositions; invariant direct sums; primary decomposition theorem; cyclic bases; Jordan canonical form. Iterative estimates of characteristic values. **08 Hours**

Unit 4

Inner Product Spaces: Inner products; inner product spaces; orthogonal sets and projections; Gram-Schmidt process; QR-factorization. **08 Hours**

Unit 5

Symmetric Matrices and Quadratic Forms: Digitalization; quadratic forms; singular value decomposition. **08 Hours**

References:

1. **Gilbert Strang,** "*Linear Algebra and its Applications*," 3rd edition, Thomson Learning Asia, 2003.
2. **Kenneth Hoffman and Ray Kunze**, "*Linear Algebra*," 2nd edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India, 2004.
3. **David C. Lay**, "*Linear Algebra and its Applications*," 3rd edition, Pearson Education (Asia) Pvt. Ltd, 2005.
4. **S. K. Jain and A. D. Gunawardena,** "*Linear Algebra, An Interactive Approach*", Thomson, Brooks/Cole, 2004.
5. **Bernard Kolman and David R. Hill**, "*Introductory Linear Algebra with Applications*," Pearson Education (Asia) Pvt. Ltd, 7th edition, 2003.

Subject Name & Code	Graph Theory ECPGM12
No. of Teaching Hours – 40	Credits : 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Understand the basic of Graph and trees and mathematical enumeration of trees using various formulations.
2. Understand the basic of Tree as data structure, types of trees,
3. Applications of bipartite graph, Euler's graph, Hamiltonian graphs.
4. Understand applications of k-connected networks, k-connected graphs, maximum flow networks, stable matching.
5. Implementation of various Vertex coloring, theorems and its application.

Unit 1: Introduction

Discovery of graphs, Definitions, Subgraphs, Isomorphic graphs, Matrix representations of graphs, Degree of a vertex, Directed walks, paths and cycles, Connectivity in digraphs, Eulerian and Hamilton digraphs, Eulerian digraphs, Hamilton digraphs, Special graphs, Complements, Larger graphs from smaller graphs, Union, Sum, Cartesian Product, Composition, Graphic sequences, Graph theoretic model of the LAN problem, Havel-Hakimi criterion, Realization of a graphic sequence. **08 Hours**

Unit 2: Connected graphs and shortest paths

Walks, trails, paths, cycles, connected graphs, Distance, Cut-vertices and cut-edges, Blocks, Connectivity, Weighted graphs and shortest paths, Weighted graphs, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm. **08 Hours**

Unit 3: Trees

Definitions and characterizations, Number of trees, Cayley's formula, Kircho-matrix-tree theorem, Minimum spanning trees, Kruskal's algorithm, Prim's algorithm, Special classes of graphs, Bipartite Graphs, Line Graphs, Chordal Graphs, Eulerian Graphs, Fleury's algorithm,

Chinese Postman problem, Hamilton Graphs, Introduction, Necessary conditions and sufficient conditions. **08 Hours**

Unit 4: Independent sets coverings and matchings

Introduction, Independent sets and coverings: basic equations, Matchings in bipartite graphs, Hall's Theorem, K¨onig's Theorem, Perfect matchings in graphs, Greedy and approximation algorithms. **08 Hours**

Unit 5: Vertex Colorings

Basic definitions, Cliques and chromatic number, Mycielski's theorem, Greedy coloring algorithm, Coloring of chordal graphs, Brooks theorem, Edge Colorings, Introduction and Basics, Gupta-Vizing theorem, Class-1 and Class-2 graphs, Edge-coloring of bipartite graphs, Class-2 graphs, Hajos union and Class-2 graphs, A scheduling problem and equitable edge-coloring. **08 Hours**

References:

1. **J. A. Bondy and U. S. R. Murty**. "*Graph Theory*", volume 244 of Graduate Texts in Mathematics. Springer, 1st edition, 2008.
2. **J. A. Bondy and U.S.R. Murty,** "*Graph Theory with Applications*" https://www.iro.umontreal.ca/~hahn/IFT3545/GTWA.pdf
3. **West. D. B**, "*Introduction to Graph Theory*", Prentice Hall, Upper Saddle River, NJ.
4. **Narasingh Deo, "***Graph Theory with application to engineering and computer science***",** Prentice-Hall. (E-book is available).
5. Lecture Videos: http://nptel.ac.in/courses/111106050/13.

Subject Name & Code	**Data Analytics ECPGM13**
No. of Teaching Hours – 40	**Credits : 3:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Unit 1: Data Analysis

Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics – Rule induction – Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods. **08 Hours**

Unit 2: Mining Data Streams

Introduction to Streams Concepts – Stream data model and architecture – Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window – Realtime Analytics Platform(RTAP) applications – case studies – real time sentiment analysis, stock market predictions. **08 Hours**

Unit 3: Frequent Item Sets and Clustering

Mining Frequent item sets – Market based model – A priori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent item sets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern based clustering methods – Clustering in non-Euclidean space – Clustering for streams and Parallelism. **08 Hours**

Unit 4: Frameworks and Visualization

Map Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – S3 – Hadoop Distributed file systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications. **08 Hours**

References:

1. **Michael Berthold, David J. Hand,** "*Intelligent Data Analysis*", Springer, 2007.
2. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
3. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O'Reilly, 2011.
4. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.

Subject Name & Code	Transform Techniques ECPGM14
No. of Teaching Hours – 40	Credits : 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Unit 1:

Fourier Transform: The direct and inverse FT, existence of FT, Properties of FT, The Frequency Spectrum.

Laplace Transform: The direct LT, Region of convergence, existence of LT, properties of LT. The inverse LT, Solution of differential equations, system transfer function. Linear Convolution: Graphical interpretation, properties of convolution, Correlation: Auto and Cross correlation, graphical interpretation, properties of correlation. **08 Hours**

Unit 2:

Discrete-time signals and systems: Sampling, classification of DT signals, Discrete-time energy and power signals, Linear Shift invariant systems, Stability and Causality, Linear constant coefficient systems, Frequency domain representation of discrete time systems and signals. **08 Hours**

Unit 3:

Linear Convolution: Graphical interpretation, properties of convolution. Correlation: Auto and Cross correlation, graphical interpretation, properties of correlation. **08 Hours**

Unit4:

Z-Transform: The direct ZT, Region of convergence, Z-plan e and S-plane correspondence. Inverse ZT, Properties of Z-transforms, Solution to linear difference equations, System transfer function. **08 Hours**

Unit 5:

Discrete Fourier series, Sampling the z-transform, Discrete Time Fourier Transform (DTFT), properties of DTFT, Discrete Fourier Transform(DFT), properties of DFT, Linear convolution using DFT. **08 Hours**

References:

1. **B.P. Lathi**, "*Signals, Systems and Communication"*, BS Publications, 2006.
2. **Luis F. Chaparro**, "*Signals and Systems using MATLAB"*, Academic press, 2011
3. **Alan V. Oppenheim and Ronald W. Schafer**, "*Digital Signal Processing"*, PHI, 2008.

Subject Name & Code	Object Oriented Programming Using JAVA ECPGM15
No. of Teaching Hours – 40	Credits : 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Explain the behavior of programs involving the fundamental concepts.
2. Analyze and develop programs on object oriented concepts.
3. Apply the knowledge of exceptions and collections in java programming
4. Design the Java applications using threads and networking.
5. Demonstrate the Java programming skills in the analysis and simulation using various IDE tools.

Unit 1:

Object Oriented Programming Concepts– Abstraction – objects and classes – Encapsulation-Inheritance – Polymorphism.

08 hours

Unit 2:

An Introduction to Java, The Java Programming Environment, Fundamental Programming Structures in Java-Overview of Java, Datatypes, operators, String handling, Wrapper classes, Control statements **08 hours**

Unit 3

Objects and Classes, Inheritance, Inner Classes, Packages and Interfaces, Streams. **08 hours**

Unit 4

Exception Handling -Exception-Handling Fundamentals, Exception Types, Using try and catch,

Java's Built-in Exceptions, User Defined exceptions.

Multithreading–Java Thread model, creating a Threads, Creating Multiple Threads, Thread Priorities, Thread Synchronization, Inter-thread Communication, Thread life cycle. **08 hours**

Unit 5

Collections- Collections Overview, The Collection Interfaces, The Collection Classes, Accessing a Collection via an Iterator,Sets, Lists, Maps,Vector Class

JDBC- JDBC Driver Types; JDBC Packages; Database Connection; Associating the JDBC/ODBC Bridge with the Database; Statement Objects; Result Sets **08 hours**

SLE Components: RMI: Remote Method Invocation concept; Server side, Client side, Servlets programming, Networking

References:

1. Cay S Horstmann, ***Core Java Volume I--Fundamentals ,9th Edition, Core Series***, November 2012
2. Cay S Horstmann, ***Core Java, Volume II--Advanced Features (9th Edition) (Core Series*)** by, Prentice Hall March, 2013.
3. Herbert Schildt ,***Java: The Complete Reference,*** Mcgraw-Hill Osborne Media, 10th edition, 2014

NPTEL Course:

1. http://nptel.ac.in/courses/106106147/3
2. https://onlinecourses.nptel.ac.in/noc19_cs07/preview
3. https://nptel.ac.in/courses/106105084/28
4. https://fr.coursera.org/lecture/distributed-programming-in-java/2-1-introduction-to-sockets-XiZXU

Subject Name & Code	Advanced Microcontrollers and applications ECPGM16
No. of Teaching Hours – 40	Credits : 3:0:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Distinguish Types of computers & microcontrollers,
2. Generalize 8-Bit, 16- Bit & 32 Bit advanced Microcontrollers.
3. Construct Real Time Applications of Microcontrollers.
4. Demonstrate RTOS for Microcontrollers.
5. Translate Hardware applications using Microcontrollers.

Unit 1:

Overview of Architecture & Microcontroller Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – 8051 Microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication – Interrupts. **04 Hours**

Unit 2:

8051- Microcontrollers Instruction Set: Basic assembly language programming – Data transfer instructions – Data and Bit-manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt control flow. **06 Hours**

Unit 3:

Real Time Control: Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051. Timers: Programmable Timers in

the MCU's – Free running counter and real time control – Interrupt interval and density constraints. **10 Hours**

Unit 4:

Systems Design: Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs – Keyboard-cum-Display controller (8279) – Alphanumeric Devices – Display Systems and its interfaces – Printer interfaces – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash Memory – Interfaces – Interfacing to High Power Devices – Analog input interfacing – Analog output interfacing – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments. **10 Hours**

Unit 5:

Real Time Operating System for Microcontrollers: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers. 16-Bit Microcontrollers: Hardware – Memory map in Intel 80196 family MCU system – IO ports – Programmable Timers and High-speed outputs and input captures – Interrupts – instructions. ARM 32 Bit MCUs: Introduction to 16/32 Bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

10 Hours

References:

1. **Raj Kamal**, "*Microcontrollers Architecture, Programming, Interfacing and System Design*"– Pearson Education, 2005.
2. **Mazidi and Mazidi**, "*The 8051 Microcontroller and Embedded Systems*" – PHI, 2000.
3. **A.V. Deshmuk**, "*Microcontrollers (Theory & Applications)*" – WTMH, 2005.
4. **John B. Peatman**, "*Design with PIC Microcontrollers*" – Pearson Education, 2005.
5. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
6. The 8051 Microcontroller, Ayala, Cengage Learning.

Subject Name & Code	**Mathematical Modeling and Simulation ECPGM17**
No. of Teaching Hours – 40	**Credits : 3:0:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

This course is designed as an introductory graduate-level course to the concepts and techniques used in building mathematical models of physical systems. These ideas will be introduced together with the numerical techniques required to carry out simulation and optimization calculations.

The focus will be on continuous-time, macroscopic system modeling, but the discussion will be generic and the concepts can be easily extended to different space and time scales.

Case studies and examples from Chemical, Biological, Mechanical and Electrical Engineering will be discussed. Upon completing this course, the students are expected to gain the following abilities and skills: Ability to identify the scope and structure of the mathematical model of a physical system. Ability to develop first-principles or empirical equations relating the model inputs, states and outputs. Ability to implement the model equations in an equation-oriented computer modeling and simulation language Ability to carry out numerical simulation and optimization calculations. Ability to estimate unknown model parameters from available experimental data.

Subject Name & Code	Technical report writing and documentation ECPGM21
No. of Teaching Hours – 30	Credits : 2:0:0 L-T-P
CIE Marks: 50	

Unit 1

Report formats and introduction to LaTeX: Introduction basic concepts of report format and standard practice of learning LaTeX . Related exercises **06 Hours**

Unit 2

IEEE guidelines: Preparation of technical/research papers according to the standard IEEE guidelines **05 Hours**

Unit 3: Report writing and presentations

Guidelines for project report writing, differences between technical presentations and seminars. **05 Hours**

Unit 4: Technical literature and report writing

Introduction to technical writing and technical literature survey **05 Hours**

Unit 5: Case studies and exercises

Case studies on report writing, presentations, seminars and related exercises **05 Hours**

References:

1. **C.R. Kothari and Gaurav Garg**, "Research Methodology Methods and Techniques" 4th Edition, New Age International (P) Ltd, Reprint 2019.
2. "A guide to technical report writing", the IET (Institution of Engineering and Technology). 2015.

E-Resources

1. **https://nptel.ac.in/content/storage2/courses/121106007/Week1/LiteratureSurveyWritingUp.pdf**

Subject Name & Code	Research Methodology ECPGM22
No. of Teaching Hours – 30	Credits : 2:0:0 L-T-P
CIE Marks: 50	

Unit 1:

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, inductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance. **08 Hours**

Unit 2:

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. **07 Hours**

Unit 3:

Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. **07 Hours**

Unit 4:

Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism. **08 Hours**

References:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition.
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari.
4. Select references from the Internet.

Subject Name & Code	**Sustainable Technologies ECPGM23**
No. of Teaching Hours– 30	**Credits : 2:0:0 L-T-P**
CIE Marks: 50	

Topics covered:

Technology, Sustainability & Development: Definitions, Dimensions, Interpretations, Concepts and Principles; Current Issues and debates (examples, case studies and mini-assignment/project); Science, Engineering and Technology – concepts and interrelationship. Science, Technology and Design - Socio-Environmental and Economic Implications. Integrated (systemic) Sustainability Assessment, Modeling and Forecasting; Integrated Life-Cycle Studies; Identification and Selection of Appropriate Design/Technologies (examples, case studies and mini-assignment/project).

References:

1. **Bell, Simon and Stephen Morse**,"*Sustainability Indicators: Measuring the immeasurable*" Earthscan, London, 1998.
2. Technology Management Newsletter www.techmotivator.iitm.ac.in
3. Mani, M., Ganesh, L.S., and Varghese, K (2005) Sustainability and Human Settlements: Fundamental Issues, Modeling and Simulations, Sage Pub., New Delhi.
4. Petroski, Henry (1994) The Evolution of Useful Things; Vintage Books, New York.
5. DeGregori, Thomas R. (1989) A Theory of Technology: Continuity and change in human development; Affiliated East-West, New Delhi.
6. Rhodes, Richard (Ed.) (1999) Visions of Technology; Simon and Schuster, New York.

Subject Name & Code	**Social Implications of Technology ECPGM24**
No. of Teaching Hours – 30	**Credits : 2:0:0 L-T-P**
CIE Marks: 50	

This course is divided into three main sections:

1) After a brief introduction to the bi-directional relationship between technology and society, we begin by looking at the policy implications of the collision between the proliferation of increasingly powerful technologies and the unavoidable vulnerability imposed by human error and malevolence (including terrorism). We will pay special attention to the case of "dangerous technologies", those capable of creating catastrophic destruction by design or by accident.

2) We then analyze the linkage between scientific/technological progress and economic factors. How does the nature and pace of technological advance affect industrial competitiveness and the ability of the economy to provide a growing standard of living? How are the market structure of and degree of competition in the private sector related to the character and rate of technological development? In what ways does public policy affect technological development? How does the nature of technological development affect the public policies we pursue? What are the appropriate roles of the public and private sectors?

3) Finally, we explore and critique the wider literature on the interaction of technology and society in the light of the analysis of sections one and two, through student presentations.

Reference: IEEE transactions on SIT

Subject Name & Code	Entrepreneurship and Management ECPGM25
No. of Teaching Hours – 30	Credits : 2:0:0 L-T-P
CIE Marks: 50	

Entrepreneurship: Entrepreneur characteristics – Classification of Entrepreneurships – Incorporation of Business – Forms of Business organizations –Role of Entrepreneurship in economic development –Start-ups.

Idea Generation and Opportunity Assessment: Ideas in Entrepreneurships – Sources of New Ideas – Techniques for generating ideas – Opportunity Recognition – Steps in tapping opportunities.: Project Formulation and Appraisal : Preparation of Project Report –Content; Guidelines for Report preparation – Project Appraisal techniques –economic – Steps Analysis; Financial Analysis; Market Analysis; Technical Feasibility. Institutions Supporting Small Business Enterprises: Central level Institutions: NABARD; SIDBI, NIC, KVIC; SIDIO; NSIC Ltd; etc. – state level Institutions –DICs- SFC- SSIDC- Other financial assistance. Government Policy and Taxation Benefits: Government Policy for SSIs- tax Incentives and Concessions – Non-tax Concessions –Rehabilitation and Investment Allowances.

References:

1. Arya Kumar, Entrepreneurship, Pearson, Delhi, 2012.
2. Poornima M.CH., Entrepreneurship Development –Small Business Enterprises, Pearson, Delhi,2009.
3. Michael H. Morris, ET. al., Entrepreneurship and Innovation, Cen gage Learning, New Delhi, 2011.

Subject Name & Code	**Electronic Waste management ECPGM26**
No. of Teaching Hours – 30	**Credits : 2:0:0 L-T-P**
CIE Marks: 50	

Objective:

In an approach to bridge the digital divide, it is necessary to get an affordable, equitable and quality access to ICT. It is estimated that two third of world's population is still offline so there is a need to provide affordable access to internet for all. For developing countries, it has become a priority area to alleviate poverty by promoting access to ICT. At the same time, tremendous growth in use of ICT devices and services, faster change of technology and frequent innovations in ICT sector, had left the world with a threat of deterioration in environmental conditions and human health as the-waste of electronic and electrical equipment, which contains hazardous components, is still handled in an environmentally unfriendly manner mainly in developing nations. It is huge challenge for the nations to handle e-waste in responsible manner and protect the environment.

E waste management rules and guidelines
Environmental impacts
Waste disposal and management
Case studies and field survey
National and global figures and statistics

Subject Name & Code	**Internet and Society ECPGM27**
No. of Teaching Hours – 30	**Credits : 2:0:0 L-T-P**
CIE Marks: 50	

1. Systematical and critical discussion, evaluation, and reflections on the key issues, debates, principles, concepts, and theories of Internet Research;
2. Employ and apply a wide range of concepts relating to Internet, social media and society;
3. Demonstration of an understanding and an ethical and critical appreciation of the importance ot the Internet and social media in contemporary society;
4. Usage of social media for disseminating journalistic information to the public and reflect on the journalistic use of social media;
5. Analysis and reflections on complex material in individual and group work;

Subject Name & Code	Advanced Communication Networks LNI130
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Demonstrate the importance and significance of Communication network concepts, models and techniques
2. Apply the concepts of switching, multiplexing, and routing issues
3. Analyze various Transmission protocols and addressing schemes.
4. Analyze various queuing techniques and disciplines
5. Demonstrate an awareness and familiarity about recent trends and techniques in Communication networks, systems, technologies and applications

Unit 1:

Review of fundamental concepts in networking and communication. Packet switching techniques and types, Foundations of networking protocols, Internet protocols and addressing **10 hours**

Unit 2:

Basics of wireless Networks and Mobile IP. Routers, Routing and internetworking, network layer routing, Least cost path algorithms, Non least cost algorithms, Intra domain routing protocols, inter domain routing protocols, Congestion control in network layer **10 hours**

Unit 3:

Transport and end to end protocols: Transport layer, TCP, UDP, Mobile transport protocols, TCP congestion control, Applications and network management **10 hours**

Unit 4:

Packet Queues and delay analysis, Queuing disciplines, Markovian systems, Non Markovian systems, Networks in Queues, Basics of QoS and resource allocation **10 hours**

Unit 5:

VPNs, Tunneling and Overlay networks, VPN, MPLS, P2P networks, Basics of VOIP, mobile ad hoc networks and wireless sensor networks. Recent trends in networking **10 hours**

References:

1. ***Nader Mir,*** "*Computer and Communication Networks*", Pearson Education 2007
2. ***Leon Garcia and Indra Widjaja: "****Communication Networks*", TMH Second Edition
3. ***Wayne Tomasi***: "*Introduction to Data Communications and Networking*", Pearson Education, 2007
4. ***Kurose and Ross***: "*Computer networking",* 3rd Edition, Pearson education, 2007

Subject Name & Code	**Cryptography and Network security LNI140**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Acquire and demonstrate the knowledge of Cryptographic and Network Security Architecture.
2. Analyze and implement Cryptographic Algorithms.
3. Write and test codes related to cryptographic tasks
4. Validate network security procedures using tools.
5. Demonstrate an ability to work individually or in a team to carry out assigned tasks, by effectively managing resources adhering to standard practices and ethics.

Unit 1:

Overview: Services, Mechanisms and attacks, OSI security architecture, Model for network security. Classsical Encryption Techniques: Symmetric cipher model, Substitution techniques, Transportation techniques, Rooter machine, Steganography, Problems. **10 Hours**

Unit 2:

Block Ciphers and DES (Data Encryption Standards): Simplified DES, Block cipher principles, DES, Strength of DES, Block cipher design principles, Block cipher modes operation, Problems. **10 Hours**

Unit:3

Public Key Cryptography and RSA: Principles of public key cryptosystems, RSA algorithm, Problems.

Other Public Key Crypto Systems and Key Management: Key management, Diffie-Hellman key exchange, Elliptic curve arithmetic, Elliptic curve cryptography, Problems. **10 Hours**

Unit 4:

Message Authentication and Hash Functions: Authentication requirements, Authentication functions, Message authentication codes, Hah Functions, Security od Hash functions and MAC's, Problems.

Digital Signature and Authentication Protocol: Digital signature, Authentication protocols, Digital signature standard.

Authentication Applications: Kerberos, X.509 authentication services, Authentication protocols, Digital Signature standard. **10 Hours**

Unit 5:

Electronic Mail Security: Pretty good privacy, S/MINE, Data compression using ZIP, Radix-64 conversion, PGP random number generator.

IP Security: Overview, IP security architecture, Authentication header, ESP (Encapsulating security pay load), Security associations, Key management, Problems.

Firewalls: Firewall design principles, trusted systems, System viruses

Problems and new research / advanced topics **10 Hours**

References:

1. **William Stallings**, "*Cryptography and network Security – principles and practice*",7th edition, Pearson India. Prentie Hall of India, 2019.

2. **Behrouz A Forouzan, Debdeep Mukhopadhyay**, "*Cryptography and Network Security*" 3rd Edition, McGraw-Hill, 2015.

3. **Atul Kahte,"** *Cryptography and Network security*", 3rd Ed, McGraw-Hill Education(India), 2013.

4. Recent technical Publications.

Subject Name & Code	Network Programming LNI141
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Explain basic networking concepts using Unix network models, processes and demonstrate the working of different communication modules.
2. Develop codes to demonstrate client-server model of interaction and networking applications.
3. Implement specific network programming constructs on UNIX platforms to create robust real-world sockets-based applications.
4. Analyze and Evaluate an understanding of the design considerations in building network applications considering multitasking and interoperability
5. Work individually or in a group to implement assigned tasks, manage resources efficiently, communicate effectively and document the work adhering to standard practices and ethics

Unit 1:

Introduction History, Layering, OSI Model, Processes, a Simplified Model, Client-Server Model.

The UNIX Model: Introduction, Basic Definitions, Input and Output, Signals, Process Control, Daemon Processes **10 Hours**

Unit 2:

Interprocess Communication

Introduction, File and Record Locking, A Simple Client-Server Example, Pipes, FIFOs, Streams and Messages, Name Spaces, System V IPC: Message Queues, Semaphores, Shared Memory, Sun RPC. **10 Hours**

Unit 3:

Introduction Transport Layer Sockets Introduction Elementary TCP Sockets TCP Client/Server Example Elementary SCTP Sockets SCTP Client/Server Example Name and Address Conversions. **10 Hours**

Unit 4:

IPv4 and IPv6 Interoperability, Daemon Processes and the inetd Super server, Advanced I/O Functions Unix Domain Protocols, Non blocking I/O, ioctl Operations. **10 Hours**

Unit 5:

Routing Sockets, Key Management Sockets, Broadcasting, Multicasting, Advanced UDP Sockets, Advanced SCTP Sockets, Out-at-Band Data, Signal-Driven I/O, Threads, IP Options, Raw Sockets, Data link Access, Client/Server Design Alternatives. **10 Hours**

References:

1. **Richard Stevens, "***UNIX Network Programming"*, 3rd edition, Prentice Hall, 2014.
2. **Richard Stevens**: "*UNIX Network Programming", Volume 2, Second Edition: Inter-process Communications*, Prentice Hall, 1999.
3. **Richard Stevens***: "UNIX Network Programming", Volume 1, Second Edition: Networking APIs: Sockets and XTI*, Prentice Hall, 1998.

Subject Name & Code	Wireless Networks LNI160
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Outcomes: At the end of the course, the student should be able to

1. Understand fundamentals of wireless communications.
2. Analyze security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.
3. Apply knowledge of TCP/IP extensions for mobile and wireless networking.
4. Demonstrate basic skills for cellular networks design.

Unit 1: Wireless LAN

Introduction-WLAN technologies: Infrared, UHF narrowband, spread spectrum -IEEE802.11: System architecture, protocol architecture, physical layer, MAC layer, 802.11b, 802.11a – Hiper LAN: WATM, BRAN, HiperLAN2 – Bluetooth: Architecture, Radio Layer, Baseband layer, Link manager Protocol, security – IEEE802.16-WIMAX: Physical layer, MAC, Spectrum allocation for WIMAX. **10 Hours**

Unit 2: Mobile Network Layer

Introduction – Mobile IP: IP packet delivery, Agent discovery, tunneling and encapsulation, IPV6-Network layer in the internet- Mobile IP session initiation protocol – mobile ad-hoc network: Routing, Destination Sequence distance vector, Dynamic source routing. **10 Hours**

Unit 3: Mobile Transport Layer

TCP enhancements for wireless protocols – Traditional TCP: Congestion control, fast retransmit/fast recovery, Implications of mobility – Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Time out freezing, Selective retransmission, Transaction oriented TCP – TCP over 3G wireless networks**.** **10 Hours**

Unit 4: Wireless Wide Area Network

Overview of UTMS Terrestrial Radio access network-UMTS Core Network Architecture: 3G-MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IWMSC, Firewall, DNS/DHCP-High Speed Downlink packet access (HSDPA)- LTE network architecture and protocol. **10 Hours**

Unit 5: 4G/5G Networks

Introduction – 4G vision – 4G features and challenges – Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, OFDM-MIMO systems, Adaptive Modulation and coding with time slot scheduler, Cognitive Radio. **10 Hours**

References:

1. **Jochen Schiller**," Mobile *Communications*", Second Edition, Pearson Education 2012. (Unit I, II, III).
2. **Vijay Garg,** "*Wireless Communications and networking*", First Edition, Elsevier 2007. (Unit IV, V).

Subject Name & Code	Network planning, architecture and Design LNI170
No. of Teaching Hours – 52	Credits : 4:0:1 L-T-P
CIE Marks: 50	SEE Marks: 100

Course Objective: This course covers the principles of network analysis, architecture, and design. These principles help in identifying and applying the services and performance levels that a network must satisfy. Principles of network analysis include network service characteristics, performance characteristics, network requirements analysis, and network flow analysis. Principles of network architecture and design include addressing and routing, network management architecture, performance architecture and design, security and privacy architecture, and quality of service design.

Unit 1:

Introduction – Overview of Analysis, Architecture and Design Processes – A Systems Methodology – System Description – Service Description – Service Characteristics – Performance Characteristics – Network Supportability. Requirements Analysis: Concepts – User Requirements – Application Requirements – Device Requirements – Network Requirements – Other Requirements – The Requirements Specification and Map. **10 Hours**

Unit 2:

Requirements Analysis: Process – Gathering and Listing Requirements – Developing Service Metrics – Characterizing Behavior – Developing RMA Requirements – Developing Delay Requirements – Developing Capacity Requirements – Developing Supplemental Performance Requirements – Environment-Specific Thresholds and Limits – Requirements for Predictable and Guaranteed Performance – Requirements Mapping – Developing the Requirements Specification – Flow Analysis: Flows – Identifying and Developing Flows – Data Sources and Sinks – Flow Models – Flow Prioritization – Flow Specification – Example Application of Flow Analysis. **10 Hours**

Unit 3:

Network Architecture: Component Architectures – Reference Architecture – Architectural Models – Systems and Network Architectures – Addressing and Routing Architecture: Addressing Mechanisms – Routing Mechanisms – Addressing Strategies – Routing Strategies – Architectural Considerations. **10 Hours**

Unit 4:

Network Management Architecture: Defining Network Management – Network Management Mechanisms – Architectural Considerations – Performance Architecture: Developing Goals for Performance – Performance Mechanisms – Architectural Considerations – Security and Privacy Architecture: Developing a Security and Privacy Plan – Security and Privacy Administration – Security and Privacy Mechanisms – Architectural Considerations. **10 Hours**

Unit 5:

Network Design: Design Concepts – Design Process – Vendor, Equipment, and Service Provider Evaluations – Network Layout – Design Traceability – Design Metrics - Selecting Technologies for Network Design: Developing Goals for Network Design – Developing Criteria for Technology Evaluation – Guidelines and Constraints on technology Evaluations – Making Technology Choices for the Network Design – Interconnecting Technologies within the Network Design: Shared medium (No Interconnection) – Switching – Routing – Hybrid Mechanisms – Applying Interconnection Mechanisms to the Design. **10 Hours**

References:

1. **James D. McCabe**, "*Network Analysis, Architecture and Design*", 3rd Edition, Elsevier, 2007. ISBN: 978-0-12-370480-1.
2. **James D. McCabe**, "*Network Analysis, Architecture and Design*", 2nd Edition, Elsevier, 2003.
3. **Andrew S. Tanenbaum**, "*Computer Networks*", 5th Edition, Prentice Hall, Upper Saddle River, New Jersey, 2013.

Subject Name & Code	**Networking Laboratory– I LNI 16L**
No. of Teaching Hours – 40	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Verify practically the significance of Communication network principles, and techniques
2. Demonstrate various scenarios in switching, routing and troubleshooting using Simulators.
3. Analyze various Transmission protocols and addressing schemes by creating various network configurations
4. Work in a group to complete the task adhering to schedule and communicate effectively in written and oral formats.

Experiments and Exercises:

1. Network configurations, layered approach using CISCO packet tracer
2. Addressing schemes, VLANs, Switch configurations
3. Router configuration, routing protocols testing
4. Basic experiments with EXATA simulator, Network scenarios, testing and validation of results
5. Wireless LAN scenarios and protocols using EXATA and PT
6. Exercises related to IPv6
7. Exercises on Network Programming and Cryptography
8. Network Emulation exercises based on EXATA

Subject Name & Code	**Design and Implementation Lab-1 LNI17L**
No. of Teaching Hours – 40	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	

In this course students are advised to conduct an extensive literature survey, to select an idea or conceptualize a functional block, design and implement the same test /analyses the design for its functionality, and prepare a report as well as an article, and give a demonstration.

Course Objectives

1. To generate new innovative interdisciplinary ideas/concepts in groups
2. To generate a methodology to realize the ideas.
3. To create a mathematical design and implementation the same (prototype development)
4. To carry out tests and Analysis (functionality test, performance analysis)
5. To prepare a Technical Report and write an article on the work for publishing (Local news print / Magazines/conferences)

Course outcome: During the course period, the student must be able to

1. Conduct literature survey, listing out the objectives and synopsis preparation
2. Develop a Mathematical model and design the required circuit
3. Demonstrate various modern tools usage, to carry out the chosen work
4. Perform demo as per specifications, and meeting the objectives: Report writing (consolidated) & Article writing (keeping target audience in mind)
5. To demonstrate skills related to group activity adhering to standard ethics

General Guidelines for conducting Design and Implementation Lab:

1. Generate the Ideas according to market/societal needs, the idea to implementable within 4-months.
2. Refine the ideas suitably, create methodology, to materialize the ideas.

3. Design the complete circuit model
4. Develop functional blocks and to test them (functionality test)
5. Build prototype by integrating the sub blocks
6. Testing the functionality of the prototype(Testing)
7. Perform analysis of the circuit (Performance analysis)

NOTE

1. To promote group activity.
2. Group to accommodate minimum of 2 and maximum of 4 persons.
3. Group to generate project idea giving importance to its practicability.
4. Project can fall into any broad areas viz. Analog-Digital electronics/Digital signal processing/Microcontrollers and embedded systems/communication and networking etc. Sensors and controls etc.

Subject Name & Code	**Storage Area Networks LNI150**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: At the end of the course, the student should be able to

1: Demonstrate a knowledge of fundamentals of storage systems and network technologies.
2: Analyse the metrics used for designing storage area networks.
3: Demonstrate the knowledge of various concepts and techniques of storage virtualization
4: Identify and analyze reliability, security and management issues in storage infrastructure.
5: Work effectively in a group for collaborative learning and demonstrate efficient oral and writing communication skills

Unit 1: Storage Systems

Introduction to Information Storage and Management: Information Storage, Data Center Infrastructure, Information Lifecycle. Storage System Environment: Components of a Storage System, Disk Drive Architecture and Performance, Logical Components of the Host. Data Protection: Concept of RAID and different RAID levels **10 hours**

Unit 2: Storage Network Technologies

Direct Attached Storage and SCSI, Storage Area Networks: Fibre Channel. Network Attached Storage, IPSAN: iSCSI, FCIP. Network Attached Storage, Content Addressed Storage.

10 hours

Unit 3: Storage Virtualization

Forms of Virtualization, Storage Virtuaization Challenges, File and Block level Virtualization, Concepts in Practice. Cloud Computing: Cloud Services (SaaS, PaaS, and Iaas), Cloud concerns and implementations **10 hours**

Unit 4: Business Continuity

Business Continuity Life Cycle, Failure Analysis, Backup and Recovery: Architecture and different Backup/Recovery topologies, Local Replication technologies and their operation, Remote replication technologies and their operation. **10 hours**

Unit 5: Storage Security and Management

Storage Security framework, Storage Security domains, Security implementations in Storage Networking, Monitoring the Storage Infrastructure, Storage Management Activities, Storage Management Standards and Initiatives, Concepts in Practice. **10 hours**

References:

1. EMC Corporation, ***Information Storage and Management***, 1st edition, Wiley India.
2. Ulf Troppens, Rainer Erkens and Wolfgang Muller: ***Storage Networks Explained***, Wiley India, 2007.
3. Robert Spalding: "***Storage Networks The Complete Reference***", Tata McGraw-Hill, 2011.
4. Marc Farley: ***Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems***, Cisco Press, 2005.
5. Richard Barker and Paul Massiglia: "***Storage Area Network Essentials - A Complete Guide to understanding and Implementing SANs***", Wiley India, 2006.

Subject Name & Code	Big Data and Analytics LNI142
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Acquire and demonstrate the knowledge of different techniques in big data analytics
2. Solve statistical and mathematical problems related to large data sets
3. Use HADOOP framework and Map Reduce technique for working with different datasets in big data analytics.
4. Apply tools to analyze and compare structured, semi-structured and unstructured data.
5. Explore advances in the domain by engaging in self-study / team work and give an effective presentation with proper documentation.

Unit 1: Introduction to Big Data

Introduction to Big Data Platform Challenges of Conventional Systems -Intelligent data analysis –Nature of Data -Analytic Processes and Tools -Analysis vs Reporting -Modern Data Analytic Tools -Statistical Concepts: Sampling Distributions -Re-Sampling -Statistical Inference-Prediction Error. **10 Hours**

Unit 2: Mining Data Streams

Introduction To Streams Concepts –Stream Data Model and Architecture -Stream Computing -Sampling Data in a Stream –Filtering Streams–Counting Distinct Elements in a Stream –Estimating Moments –Counting Oneness in a Window –Decaying Window -Real time Analytics Platform(RTAP)Applications -Case Studies -Real Time Sentiment Analysis, Stock Market Predictions. **10 Hours**

Unit 3: Hadoop

History of Hadoop-The Hadoop Distributed File System –Components of Hadoop-Analyzing the Data with Hadoop-Scaling Out-Hadoop Streaming-Design of HDFS-Java interfaces to HDFS Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map

Reduce Job run-Failures-Job Scheduling-Shuffle and Sort –Task execution -Map Reduce Types and Formats-Map Reduce Features. **10 Hours**

Unit 4: Hadoop Environment

Setting up a Hadoop Cluster -Cluster specification -Cluster Setup and Installation –Hadoop Configuration-Security in Hadoop -Administering Hadoop –HDFS -Monitoring-Maintenance-Hadoop Benchmarks-Hadoop in the cloud. **10 Hours**

Unit 5: Frameworks

Applications on Big Data Using Pig and Hive –Data processing operators in Pig –Hive services –HiveQL –Querying Data in Hive -fundamentals of HBase and ZooKeeper -IBM InfoSphere BigInsights and Streams. Visualizations -Visual data analysis techniques, interaction techniques; Systems and applications. **10 Hours**

References

1. **Michael Berthold, David J. Hand**, "*Intelligent Data Analysis*", Springer, 2007.

2. **Tom White,** " *Hadoop: The Definitive Guide*" Third Edition, O'reilly Media, 2012

3. **Chris Eaton, Dirk DeRoos**, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012

4.**Zikopoulos**, Paul, Chris Eaton, Understanding Big Data: Analytics for Enterprise Class Hadoop an d Streaming Data, Tata McGraw Hill Publications, 2011

Subject Name & Code	Software Defined Radio 17LNI143
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Demonstrate the knowledge related to SDR in advanced communication systems
2. Able to explain and analyses challenges and issues in SDR
3. To analyze spectrum efficiency and soft usage of spectrum considering cognitive features
4. Apply machine learning to CR
5. Illustrate and explain issues like sampling issues, Multi rate sampling, rate related issues.

Unit 1:

1. Application of SDR in advanced communication systems
2. Challenges and issues regarding the implementation of SDR
3. Adaptive wireless communication systems
4. Parameter estimation for adaptation of wireless communication systems (learning environment and other factors)

10 Hours

Unit 2:

1. SDR and cognitive radio architectures
2. Spectrum efficiency and soft spectrum usage
3. Multi-dimensional spectrum awareness
4. Applications of cognitive radio (specifically for public safety)

10 Hours

Unit 3:

1. Cognitive features in the upcoming wireless standards (LTE, WiMAX, etc)
2. Spectrum, network, context, environment, location awareness for cognitive radio
3. Blind receiver design
4. Femto-cells and relation to cognitive radio
5. Cognitive OFDM(A) **10 Hours**

Unit 4:

1. UWB and Cognitive radio (underlay and overlay)
2. Interference awareness
3. Signal analysis, signal awareness
4. Vertical hand-off and network interoperability - network awareness, multi-tier networks

10 Hours

Unit 5:

1. Sampling and ADC/DAC issues in CR and SDR
2. Multi-rate processing, sampling rate adjustments. Auto-rate detection and adjustments

10 Hours

References:

1. **Hüsyin Arslan**, *"Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems*," Ser. Signals and Communication Technology, xviii, 470 p., I. edition, ISBN: 978-1-4020-5541-6, Springer, August 2007
2. **Joseph Mitola**, "*Cognitive Radio Architecture: The Engineering Foundations of Radio XML*," John Wiley and Sons Ltd., February 2006.
3. **Jeffrey H. Reed**, "*Software Radio: A Modern Approach to Radio Engineering*," Prentice Hall PTR, 2002.
4. **Walter H.W. Tuttlebee**, "*Software Defined Radio: Enabling Technologies*," John Wiley and Sons Ltd., 2002.

Subject Name & Code	Telecommunication management and regulation LNI144
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Telecommunications System Management: Telecom Technology Systems Evolution: Telecommunication Management network (TMN), Teletraffic Theory and Network analysis, Network planning and design. Recent Developments in Telecom Industry, Regulation & Liberalization policy.

Technomanagerial aspects of telecommunication, role of the telecommunication managers in a dynamic environment. The business of telecommunication, telecommunication as a facilitating infrastructure for economic development of the country, technical survey of the ways and means that voice, data and video traffic are moved long distances, data network, the telephone system. Issues of the monopolization and deregulation of telecom, national telecom policy, various institutions/ organizations like telecom regulatory authority etc, conveyance. Telecom service costing, economic evaluation of telecom projects, telecom project financing.

International Scenario in Telecommunication: Historical development and evolution of telecom, Patterns of Transaction in international telecom management, managing the market growth. Structure of the Telecommunications sector of developed and developing in select countries, trends in privatization, liberalization and deregulation. Role of telecommunications in socioeconomic development, new technologies and services for international telecommunications, business application of global networks. Regional prospectus on development of Telecom. Current issues and implications for the industry, Indian markets, policy issues, skill formation for ITM, problems, challenges of growth.

Telecom Dispute and Settlement: Types of disputes, agency for settlement. Telecommunication regulatory authorities, Role of ITU

Subject Name & Code	Cyber forensics and information security LNI151
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Analyze and evaluate the cyber security needs of an organization.
2. Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
3. Measure the performance and troubleshoot cyber security systems.
4. Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.
5. Design operational and strategic cyber security strategies and policies.

Unit 1:

NETWORK LAYER SECURITY &TRANSPORT LAYER SECURITY - IPSec Protocol - IP Authentication Header - IP ESP - Key Management Protocol for IPSec. Transport layer Security: SSL protocol, Cryptographic Computations – TLS Protocol. **10 Hours**

Unit 2:

E-MAIL SECURITY & FIREWALLS - PGP - S/MIME - Internet Firewalls for Trusted System: Roles of Firewalls – Firewall related terminology- Types of Firewalls - Firewall designs - SET for E-Commerce Transactions. **10 Hours**

Unit 3:

INTRODUCTION TO COMPUTER FORENSICS - Introduction to Traditional Computer Crime, Traditional problems associated with Computer Crime. Introduction to Identity Theft & Identity Fraud. Types of CF techniques - Incident and incident response methodology - Forensic duplication and investigation. Preparation for IR: Creating response tool kit and IR team. - Forensics Technology and Systems - Understanding Computer Investigation – Data Acquisition.

10 Hours

Unit 4:

EVIDENCE COLLECTION AND FORENSICS TOOLS - Processing Crime and Incident Scenes – Working with Windows and DOS Systems. Current Computer Forensics Tools: Software/ Hardware Tools.

10 Hours

Unit 5:

ANALYSIS AND VALIDATION - Validating Forensics Data – Data Hiding Techniques – Performing Remote Acquisition – Network Forensics – Email Investigations – Cell Phone and Mobile Devices Forensics. **10 Hours**

References:

1. **Man Young Rhee**, "*Internet Security: Cryptographic Principles*", "Algorithms and Protocols", Wiley Publications, 2003.
2. **Nelson, Phillips, Enfinger, Steuart**, "*Computer Forensics and Investigations*", Cengage Learning, India Edition, 2008.
3. **John R.Vacca,** "*Computer Forensics*", Cengage Learning, 2005.
4. **Richard E.Smith**, "*Internet Cryptography*", 3 rd Edition Pearson Education, 2008.
5. **Marjie T.Britz**, "*Computer Forensics and Cyber Crime*": An Introduction", 3 rd Edition, Prentice Hall, 2013.

Subject Name & Code	Cloud Computing and virtualization LNI152
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Implement and demonstrate simple Cloud Applications
2. Apply resource allocation, scheduling algorithms.
3. Implement Map-Reduce concept.
4. Create virtual machines from available physical resources.
5. Setup a private cloud.

Unit 1:

Introduction, Cloud Infrastructure Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing.

10 Hours

Unit 2

Cloud Computing: Application Paradigms. Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study on different areas and applications.

10 Hours

Unit 3

Cloud Resource Virtualization. Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization.

10 Hours

Unit 4

Cloud Resource Management and Scheduling. Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling Map Reduce applications subject to deadlines, Resource management and dynamic scaling.

10 Hours

Unit 5

Cloud Security, Cloud Application Development. Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2.

10 Hours

References:

1**. Dan C Marinescu**: "*Cloud Computing Theory and Practice"*. Elsevier(MK) 2013.

1**. RajkumarBuyya , James Broberg, Andrzej Goscinski**: "*Cloud Computing Principles and Paradigms"*, Willey 2014.

2. **John W Rittinghouse, James F Ransome**: "*Cloud Computing Implementation, Management and Security"*, CRC Press 2013.

Subject Name & Code	Underwater Communication LNI153
No. of Teaching Hours –52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Unit 1:

Adaptive Signal Processing: Adaptive Systems, Open Loop and Closed loop Adaptations, Adaptive Linear Combiner, Theory of Adaptation with stationary Signals, Adaptive Algorithms and Structures, Applications.

10 Hours

Unit 2:

Applications of Digital Signal Processing to Sonar: Characteristics of Sonar Signal propagation, Digital signal Processing for active sonar system and digital signal processing for passive sonar systems, Signal Processing Hardware -TMS 320 Series Signal Processors, real-time implementation considerations.

10 Hours

Unit 3:

Orthogonal Frequency division multiplexing: Key features, characteristics and principle of operation of OFDM, Channel coding and interleaving System model, Enhancement of spectral efficiencies, Transmission/ Reception of OFTD - OFDM Simulations.

10 Hours

Unit 4:

Acoustic Modem: Underwater Wireless Modem- Sweep spread carrier signal transmission characteristics in shallow water channel-separation of time varying multipath arrivals-Typical acoustics modems-characteristics and specifications Applications, Acoustic Releases-Real time wireless current monitoring system.

10 Hours

Unit 5:

Underwater Sensor Network: Underwater Networking- Ocean Sampling Networks, Pollution Monitoring, Environmental Monitoring and Tactical surveillance systems, Major challenges in

design of Underwater Sensor Networks, Factors that affect the UWSN- Sensor Node Architecture- GIBS, VRAP, DABSRAPT. etc.

10 Hours

References:

1. Digital Spectral Analysis with applications- S. Lawrence Marple Jr. Prentice Hall. Signal Processing Series, 1987.
2. Richard A. Haddad and Thomas W Parsons, "Digital Signal Processing: Theory Applications and Hardware", Computer Science Press, 1991.
3. 'Real time Deepwater Current Profiling Systems', Michael Uogel, etal, Marine Technology Symposium.
4. 'Acoustic Modems' Hydro International, June 2007, www.ece.gatech.edu.
5. 'Underwater Acoustics Sensor Network: Research Challenges: Ian F Akyildizetal, Elsevier, 3 (2005), pp 257-279.
6. 'Data Collection, Storage and Retrieval with an Underwater Sensor Network, Vasilescu, etal, Sensys' 05, Nov. 2-4, 2005, San Diego, CA.

Subject Name & Code	Optical and DWDM networks LNI154
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Identify, formulate and solve optical communication networks related problems using efficient technical approaches.
2. Design and implement WDM networks.
3. Apply the knowledge to control and manage the functions of optical networks.
4. Recognize the network survivability by various protection schemes.

Unit 1: OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN

Optical System Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters; Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion; Wavelength stabilization; Overall design considerations.

10 Hours

Unit 2: OPTICAL NETWORK ARCHITECTURES

Introduction to Optical Networks; SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies, Media-Access Control Protocols and Testbeds; Wavelength Routing Architecture.

10 Hours

Unit 3: WAVELENGTH ROUTING NETWORKS WDM

Network Elements; WDM Network Design - Cost tradeoffs, Virtual Topology Design, Routing and wavelength assignment, Statistical Dimensioning Models.

10 Hours

Unit 4: PACKET SWITCHING AND ACCESS NETWORKS

Photonic Packet Switching – OTDM, Multiplexing and De-multiplexing, Synchronization, Header Processing, Buffering, Burst Switching, Testbeds; Access Networks.

10 Hours

Unit 5: NETWORK MANAGEMENT AND SURVIVABILITY

Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface; network Survivability- Protection in SONET / SDH and IP Networks, Optical layer Protection, Interworking between layers.

10 Hours

References:

1. **Rajiv Ramaswami and Kumar N. Sivarajan**, "*Optical Networks: A Practical. Perspective*", Elsivier Third Edition 2010.
2. **C. Siva Ram Moorthy and Mohan Gurusamy**, "WDM Optical Networks : Concept, Design and Algorithms", Prentice Hall of India, Ist Edition, 2002.
3. **P.E. Green, Jr**., "*Fiber Optic Networks*", Prentice Hall, NJ, 1993.
4. **Biswanath Mukherjee**, "*Optical WDM Networks*", Springer, 2006.

Subject Name & Code	Quantum Computing and Communication LNI155
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course outcome: At the end of the course, the student should be able to

1. Explain the concepts and challenges of quantum mechanics as applied to communications.
2. Apply the techniques which determine the performance of a quantum network.
3. Analyze how applications actually operate over quantum a communication channel.
4. Design and simulate the behaviour of quantum networks.

Unit 1:

Quantum theory of light: Quantization of the electromagnetic field, evolution of the field operators, quantum states of the electromagnetic field.

10 Hours

UNIT 2:

Quantum information processing: Quantum Optical Communication Quantum information processing: quantum information, quantum communication, quantum computation with qubits, quantum computation with continuous variables. Density operators and super operators, fidelity, entropy, information and entanglement measures, correlation functions and interference of light, photon correlation measurements.

10 Hours

Unit 3:

Photon sources and detectors: Photon sources and detectors: Mathematical model of photo detectors, physical implementations of photo detectors, single-photon sources, entangled photon sources, quantum non-demolition photon detectors.

10 Hours

Unit 4:

Quantum communication with single photons: Quantum communication with single photons: photons as information carriers, quantum teleportation and entanglement swapping, decoherence-free subspaces for communication, quantum cryptography. Quantum computation with single photons.

10 Hours

Unit 5:

Quantum communication with continuous variables: phase space in quantum optics, continuous-variable entanglement, teleportation and entanglement swapping, entanglement distillation, quantum cryptography. Quantum computation with continuous variables. An ensemble of identical two-level atoms, electromagnetically induced transparency, quantum memories and quantum repeaters, the atomic ensemble of a single qubit, photon-photon interactions via atomic ensembles,

1**0 Hours**

Self - Learning Components:

Solid-state quantum information carriers: Definition and optical manipulation of solid-state qubits, interactions in solid-state qubit systems, entangling two qubit operations, scalability of solid-state devices.

References

1. **Michael A. Nielsen & Isaac L. Chuang: "***Quantum Computation and Quantum Information",* 10th Edition Cambridge University Press, 2010.
2. **P. Kok and B. W. Lovett:** "*Introduction to Optical Quantum Information Processing",* 1st edition, Cambridge university press, 2010.
3. **D. Bouwmeester, A. K. Ekert, and A. Zeilinger(Eds):** "*The Physics of Quantum Information"*, Springer, 2013.
4. **L. Mandel, and E. Wolf:** "*Optical Coherence and Quantum Optics"*, 1st Edition, Cambridge University Press, 1995.

Subject Name & Code	Mobile Computing LNI210
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Understand the principles of mobile computing and different generations.
2. Explain the working different OS used in mobile systems
3. Distinguish different mobile devices and understand their working
4. Understand different protocols used in mobile computing
5. Understand different tools in mobile computing

Unit 1:

Introduction to mobile computing, Cellular systems, 1G, 2G, 3G, 4G & 5G, GSM, architecture, Hand off, network signaling, SS7 Signaling **10 Hours**

Unit 2:

Challenges in mobile computing, Operating systems for mobile applications, Android, iOS, WinCE, Symbian and Palm. **10 Hours**

Unit 3:

Mobile devices, PDA, CDPD, Smart phones, GPRS, VOIP, Mobile IP, Ipv6, WLL

1**0 Hours**

Unit 4:

WAP, Client software, hardware, Mobile Ad hoc Networks (MANETs): Overview, Properties of a MANET, spectrum of MANET applications, routing and various routing algorithms, security in MANETs. **10 Hours**

Unit 5:

Tools, WML, XML, Bluetooth (User scenarios, physical layer, MAC layer, networking, security, link management) and J2ME. **10 hours**

References:

1. **John Schiller**, "*Mobile Communications*", Addison-Wiley second edition, 2008.

2. **Yi-Bang Lin,** "*Wireless and Mobile Network Architectures*", Wiley India,2012

3. **Hansmann, Merk, Nicklous, Stober**, "*Principles of Mobile Computing*", Springer, second edition, 2010.

4**. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal**, "*Mobile Computing*", McGraw Hill, 2nd Edition,2010

5. **Raj Kamal, "***Mobile Computing*" Oxford University Press, 2nd edition,2012

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Subject Name & Code	Protocol Engineering LNI220
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Explain the fundamental concepts of communication protocol, its architecture, operations and design.
2. Verify protocol testing, error testing procedures using different techniques and tools
3. Design and simulate simple protocols using formal and informal approaches.
4. Demonstrate the knowledge of developing simple protocols, their testing and writing test cases keeping abreast of industry preferences.
5. Demonstrate an ability to work individually or in a team to carry out assigned tasks, by leveraging recent open source tools, adhering to standard practices and ethics; Communicate effectively in oral and verbal methods.

Unit 1:

Introduction to communication protocols, software, subsystems development methods, protocol engineering process, reference models, services and interfaces protocols at various layers

10 Hours

Unit :2

Protocol specifications: components of protocol, service specifications, entity specifications interface and interactions, examples(HDLC,ABP, RSVP etc)

10 Hours

Unit :3

SDL: Features, communication system using SDL, examples of SDL based protocol specifications, other specification languages(LOTUS, UML etc.) protocol verifiation, validation design errors, validation approaches, examples.

10 Hours

Unit :4

Conformance testing, framework, conformance test architectures, test sequence generation methods, TTCN framework, examples.

10 Hours

Unit :5

Protocol testing: Types, performance testing, Interoperability testing, scalability testing. Protocol synthesis, protocol implementation requirements and methods. Advanced topics and new research outcomes.

10 Hours

References:

1. **Palappa Venkataram and Sunilkumar S Manvi**; "*Communication protocol engineering*", PHI publishers

2. IEEE Journals/ papers

Subject Name & Code	WEB SERVICES LNI 230
No. of Teaching Hours – 52	Credits : 4:0:1 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Explain with clarity concepts of web based services, architectures, protocols, functionalities with full range of technologies that support service oriented approaches.
2. Design, develop and demonstrate various JAVA based web applications using different design tools.
3. Design and implement registration and recovery techniques for web services from a business perspective.
4. Evaluate recent techniques , tools and standards for web service architecture
5. Demonstrate an ability to implement a group task and document it for effective communication by following standard practices and methods adhering to ethics.

Unit 1: Introduction

Web Services Overview: What Are Web Services? History Web Services Technology, Other Concerns, Java and Web Services, Application Scenarios, Implementation Scenarios, Benefits of Web Services, A Word about Standards, Service-Oriented Architecture, SOA Entities, SOA Characteristics, Component-Based Service Development, Development Lifecycle, Design, Verification and Validation, Maintenance.

10 Hours

Unit 2: Technologies

SOAP, The Case for SOAP, What Does SOAP Define? SOAP Message Structure, SOAP Message Elements, SOAP Processing Model, SOAP Encoding, WSDL, Describing a Web Service, Describing Functional Characteristics of Services of WSDL, 1.2 UDDI Discovering Web Services, Categorizing Services, Identifiers, Business Entity Relationships, UDDI's SOAP Interfaces, UDDI and SOAP/WSDL Relationships, Publishing WSDL Service Interfaces in UDDI, Internationalization and Multiple Languages, Extending a UDDI Registry, UDDI- Private UDDI Registries, ebXML, Architectural Overview of ebXML, Putting It All Together.

10 Hours

Unit 3: Java Web Services

Java Web Service Developer, Pack JAXP, JAXP Architecture, SAX, DOM, When to Use SAX, When to Use DOM, When Not to Use Either JAXP and XML Schemes, XSLT, XSLTc, JDOM, JAXP, RI JAX-RPC, JAX-RPC Service Model, Data Types and Serialization, JAX-RPC Development, Advanced JAX-RPC, JAX-RPC Interoperability, JAX-RPC and J2EE, JAXM Messaging and MOM Messaging and Web Services Messaging in Java, JAXM Architecture, Designing with JAXM, Developing with JAXM, JAXR Registries and Repositories, JAXR Architecture, The JAXR Information Model, The JAXR, API, JAXR to UDDI Mapping, JAXR and ebXML Registry, JAXB, The Need for Binding and JAXB, When to Use JAXB, JAXB Architecture, Developing with JAXB, XML-to-Java Mapping, The JAXBAPI Validation with]AXB Customizing JAXB, When to Use Custom Declarations

10 Hours

Unit 4: Advanced Topics

Transaction Management Concepts, A Transaction Model for Web Services, New Transaction Specifications, JSRs for Web Service Transaction Support Security, Security Considerations for Web Services, Web Services Security Initiatives, Canonical XML, XML Digital Signatures, Apache XML Security, XML Encryption Security Assertions, Markup Language Web Services Security Assertions, XML Access Control Markup Language, XML Key Management Specification, WS-I Specifications, Java Cryptography Extensions, Implementation Scenarios WEB 2.0.

10 Hours

References

1. **James McGovern, Sameer Tyagi, Michael E. Stevens, Sunil Mathew**: "*Java Web Services Architecture*", Morgan Kaufmann – 2003

2. **Richard Monsol-Haefel**, "*J2EE Web Services*", Pearson 2003

3. Steven Graham, Dong Davis,.., Building Web Services with Java, II Edition, Pearson-2005

Subject Name & Code	Cognitive Radio and Networks LNI240
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Unit 1:

Introduction to Software Radio Concepts, the need for software radios, what is a software radio, characteristics and benefits of a software radio, Design principles of a software radio

Radio Frequency Implementation Issues The purpose of the RF front-end, Dynamic range: The principal Challenge of receiver design, RF receiver front-end topologies, Enhanced flexibility of the RF chain with software radios, Importance of the components of overall performance, transmitter architectures and their issues, noise and distortion in the RF chain, ADC and DAC distortion.

10 Hours

Unit 2:

Digital Hardware Choices Introduction, Key Hardware Elements, DSP Processors, FPGA, Tradeoffs in using DSPs FPGAs and ASICs, Power Management Issues, Combinations of DSPs, FPGAs and ASICs.

10 Hours

Unit 3:

INTRODUCTION TO COGNITIVE RADIOS: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

10 Hours

Unit 4:

SIGNAL PROCESING - SPECTRUM: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time.

10 Hours

Unit 5:

DYNAMIC SPECTRUM ACCESS AND MANAGEMENT: Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

10 Hours

References:

1. **Jeffrey H. Reed**, "*Software Radio: A Modern Approach to Radio Engineering*", Pearson Education Low Price Edition.
2. **Ekram Hossain, Dusit Niyato, Zhu Han**, "*Dynamic Spectrum Access and Management in Cognitive Radio Networks*", Cambridge University Press.
3. **Kwang-Cheng Chen, Ramjee Prasad**, "*Cognitive radio networks*", John Wiley & Sons Ltd.
4. **Huseyin Arslan,** "*Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems* ", Springer.

Subject Name & Code	Ubiquitous Computing LNI250
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. To model Key Ubiquitous/Pervasive Computing Properties
2. Understand working of smart environment and smart devices.
3. Understand working of Human Computer Interaction in context of Pervasive Computing.
4. Understand management of smart devices in context of Pervasive Computing.

Unit 1:

Introduction to Pervasive Computing, Concept of Pervasive Computing, Modeling the Key Ubiquitous/Pervasive Computing Properties, Mobile Adaptive Computing, Mobility Management and Caching.

10 Hours

Unit 2:

Pervasive Computing Devices Smart Environment: CPI and CCI, Smart Devices: Application and Requirements, Ubiquitous Networks of Devices: CCI, Human to Human Interaction (HHI) Applications.

10 Hours

Unit 3:

Human Computer Interaction Explicit HCI, Implicit HCI, User Interface and Interaction for four hand-held widely used devices, Hidden UI via basic smart devices, Hidden UI via wearable and Implanted devices, Human centered design, user models.

10 Hours

Unit 4:

Management of Smart Devices Managing Smart Devices in Virtual Environments, Process and Application Management, Network Oriented Management, Monitoring and Accounting, Configuration Management, Fault Management, Performance Management, Service Oriented Computer Management, Managing Smart Devices in Physical Environments.

10 Hours

Unit 5:

Middleware for Pervasive Adaptive middleware, Context aware middleware, Mobile middleware, Service Discovery, Mobile Agents.

Challenges and Outlook Overview of challenges, smart devices, Smart Interaction, Smart physical environment device interaction, Smart human-device interaction, Human Intelligence versus machine intelligence, social issues.

10 Hours

References:

1. **Stefan Poslad**, "*Ubiquitous Computing, Smart devices, environment and interaction*", Wiley.

2. **Frank Adelstein, Sandeep Gupta, Golden Richard III, Loren Schwiebert**, "*Fundamentals of Mobile and Pervasive Computing*", Tata McGraw Hills

3. **Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtorff, Thomas Schaeck**, "*Pervasive Computing*", Pearson, Eighteenth Impression, 2014.

Subject Name & Code	**Networking Laboratory-II LNI26L**
No. of Teaching Hours – 52	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	

Course Outcomes: At the end of the course, the student should be able to

1. Verify practically the importance and significance of Protocols and protocol stack
2. Apply the concepts of Mobile computing and sensor networks in simulation exercises
3. Apply and analyze various scenarios in EXATA emulator related to cellular networks,
4. Apply and test several network configuration scenarios using NS3 simulators
5. Develop and demonstrate issues related to web services.

Experiments and Exercises:

6. Exercises on Protocol design and testing
7. Exercises on simulation using EXATA making use of cellular library
8. Exercises on simulation using EXATA making use of sensor network library
9. Introduction and familiarization to NS3 based simulations
10. Development and testing of scenarios for web services applications
11. Hands on working of mobile computing operating systems
12. Exercises related to Open-flow Switches.

Subject Name & Code	**5G Technologies LNI241**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

5G Technologies

Objectives: (Contents to be finalized)

Multi-User and Massive MIMO are cutting edge technologies for future 5G wireless networks. The large number of antennas in a Massive MIMO system significantly enhances the throughput of current wireless systems. Further, multi-user MIMO enables supporting a large number of users. Other features of Massive MIMO include simplified user scheduling due to channel hardening, leading to improved spectral efficiency and also resilience to intended/ unintended jamming, which enhances security of the link. However, the challenges in realizing this technology are immense. It requires the development of low cost RF chains for the large number of antennas, low complexity algorithms for optimal decoding of the received symbol vectors, and also efficient schemes for channel estimation, feedback and precoding for large scale MIMO systems. Further, the problem of pilot contamination arising from pilot reuse due to the extremely large number of users supported by Massive MIMO systems can also lead to a significant degradation of the quality of the channel estimate, which subsequently affects the decoding performance.

Theory behind Multi-User and Massive MIMO such as precoding, channel hardening, capacity, spatial modulation, low complexity decoding, pilot contamination etc..

MATLAB module to introduce the the practical implementation and simulation aspects of such systems, especially from the perspective of conducting research in Massive MIMO.

Subject Name & Code	**Photonic systems and technologies LNI242**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

1. **Photonic sources:** LEDs and laser diodes, Laser physics and operation. Characteristics of laser light, Laser technology. Spectral distribution. Coherence
2. **Modulation:** Optical signal generation, Electro-optic effect, phase and intensity modulation, modulation formats, bit stream generation.
3. **Signal propagation:** Propagation of a Gaussian pulse, impact of dispersion and management, impact of losses. Medium induced distortions
4. **Amplification:** Doped fiber optical amplifiers, fiber Raman amplifiers, semiconductor optical amplifiers. Gain and rate equations, noise.
5. **Signal recovery:** Photo detectors and photonic receivers, noise sources, sensitivity, bit error rate.
6. **Nonlinear effects:** Self-phase and cross phase modulation, solitons, four wave mixing, scattering processes.
7. **Multichannel systems:** WDM systems and components, OTDM.

References:

1. Nishihara: Integrated optics
2. Govind P Agarwal: Non linear fiber optics
3. BEA Saleh: Photonics

Subject Name & Code	Cyber Physical Systems LNI243
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Unit1:

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS,CPS HW platforms - Processors, Sensors, Actuators CPS Network - Wireless Hart, CAN, Automotive Ethernet CPS Sw stack - RTOS Scheduling Real Time control tasks).

10 Hours

Unit 2:

Dynamical Systems and Stability Controller Design Techniques Stability Analysis: CLFs, MLFs, stability under slow switching Performance under Packet drop and Noise (2 hrs)

Tutorial: Mat lab toolboxes - Simulink, Stateflow)

10 Hours

Unit 3:

From features to software components, Mapping software components to ECUs

CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion Control, Bus and Network Scheduling using True time

10 Hours

Unit 4:

Advanced Automata based modeling and analysis: Basic introduction and examples

Timed and Hybrid Automata Definition of trajectories, zenoness Formal Analysis: Flow pipe construction, reachability analysis, analysis of CPS Software Weakest Pre-conditions, Bounded Model checking Hybrid Automata Modeling: Flow pipe construction using Flow star, SpaceX and Phaver tools CPS SW Verification: Frama-C, CBMC

10 Hours

Unit 5:

Attack models Secure Task mapping and Partitioning State estimation for attack detection Automotive Case study: Vehicle ABS hacking Power Distribution Case study: Attacks on Smart Grids Automotive and Avionics: SW controllers for ABS, ACC, Lane Departure Warning, Suspension Control etc., Flight (pitch, yaw, roll) Control Systems Healthcare: Artificial Pancreas/Infusion Pump/Pacemaker Green Buildings: automated lighting, AC control

10 Hours

References:

1. “Principles of Cyber-Physical Systems” - Rajeev Alur
2. "Introduction to Embedded Systems – A Cyber–Physical Systems Approach" - E. A. Lee, Sanjit Seshia
3. “Foundations of Cyber-Physical Systems” - Andre Platzer

LIST OF OPEN ELECTIVE COURSES

Students from any specialization have to register for ONE course in the even semester among these courses depending on which course is offered by the department

Course Code	Course Title	Credit pattern
ECPGOL1	IOT	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL5	Heuristics for optimization	4:1:0
ECPGOL6	Organizational Behavior and Financial Management	4:1:0
ECPGOL7	Deep learning	4:1:0
ECPGOL8	MEMS	4:1:0
ECPGOL9	Artificial Neural Networks	4:1:0

Subject Name & Code	Internet of Things ECPGOLI
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course Outcomes: At the end of the course, the student should be able to

1. Identify the basic concepts, enabling technologies, possibilities and applications of IOT from a present and a futuristic view point
2. Demonstrate the requirements and configurations for sensor technology and data acquisition in IOT
3. Explain and analyze the routing protocols suitable for IOT
4. Demonstrate working knowledge related to enabling technologies like WSN, Web service and cloud.
5. Demonstrate comprehensive understanding about applications, test bed scenarios related to IOT, based on group task, seminars etc.,

Unit 1:

Introduction: The definition of the Internet of Things, main assumptions and perspectives. Platform for IoT devices: Device architectures. - Conventional and renewable power sources for resource-constrained devices. - Operating systems for resource-constrained devices.

10 Hours

Unit 2:

The data link layer for IoT: -Wireless communication technologies. - Wire communication technologies. MANET Networks.

10 Hours

Unit 3:

The network layer for IoT- LowPAN adaptation layer for devices with limited resources. -

Dynamic routing protocols for wireless ad-hoc network.. Communication protocols for IoT

Service oriented protocols (COAP).-Communication protocols based on the exchange of messages (MQTT).• Service discovery protocols.

10 Hours

Unit 4:

The data processing for IoT - Organization of data processing for the Internet of things. - Cloud computing.-Fog computing.

10 Hours

Unit 5:

Applications - Smart Grid. Home Automation. Smart City. Case studies, test beds.

10 Hours

References:

1. John Holler et all: From M2M to IOT
2. Oliver : Hersent: IOT applications and protocols. Wiley student edition
3. Intel Galileo, http://www.intel-software-academic-program.com/pages/courses#diy
4. Modul Copernicus, http://galaxy.agh.edu.pl/~tszydlo/copernicus/
5. Jean-Philippe Vasseur and Adam Dunkels. Interconnecting Smart Objects with IP – The Next Internet, Morgan Kaufmann, 2010.
6. Zach Shelby, Carsten Bormann, 6LoWPAN: The Wireless Embedded Internet, Willey 2009.

Subject Name & Code	**Solar Energy Systems ECPGOL2**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Unit 1:

ENERGY RESOURCES AND SOLAR SPECTRUM World energy resources - Indian energy scenario - Environmental aspects of energy utilization. Renewable energy resources and their importance - Global solar resources. Solar spectrum – Electromagnetic spectrum, basic laws of radiation. Physics of the Sun - Energy balance of the Earth, energy flux, solar constant for Earth, greenhouse effect.

10 Hours

Unit 2:

SOLAR RADIATION AND MEASUREMENT Solar radiation on the earth surface - Extraterrestrial radiation characteristics, Terrestrial radiation, solar isolation, spectral energy distribution of solar radiation. Depletion of solar radiation - Absorption, scattering. Beam radiation, diffuse and Global radiation. Measurement of solar radiation – Pyranometer, pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).

10 Hours

Unit 3:

SOLAR RADIATION GEOMETRY AND CALCULATIONS (15 hours) Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability.

10 Hours

Unit 4:

SOLAR THERMAL ENERGY CONVERSION Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles - Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electricpower plant, central tower receiver power plant.

10 Hours

Unit 5:

SOLAR ELECTRICAL ENERGY CONVERSION Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.

10 Hours

References:

1. **Foster R., Ghassemi M., Cota A**., *"Solar Energy*", CRC Press, 2010.

2**. Duffie J.A., Beckman W.A**. "*Solar Engineering of Thermal Processes*", 3rd ed., Wiley, 2006.

3**. De Vos, A**., "*Thermodynamics of Solar Energy Conversion*", WileyVCH, 2008.

4. **Garg H.P., Prakash J**., "*Solar Energy Fundamentals and Applications*", Tata McGraw-Hill, 2005.

5**. Kalogirou S**., "*Solar Energy Engineering*", Processes and Systems, Elsevier, 2009.

6. **Petela, R**., "*Engineering Thermodynamics of Thermal Radiation for Solar Power*", McGraw-Hill Co., 2010

Subject Name & Code	**Machine learning ECPGOL3**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: At the end of the course, the student should be able to

1: Explain what is machine learning and its perspectives and issues.

2: Demonstrate Knowledge on various Decision tree methods.

3: Explain the role of artificial neural networks in the context of machine learning

4: Demonstrate Knowledge on probabilistic learning methods.

5: Explain theoretical characterization of the difficulty of machine learning problems and Capabilities of machine learning algorithms.

Unit 1:

Basic Principles: Introduction, The concept learning task. General-to-specific ordering of hypotheses. Version spaces. Inductive bias. Experimental Evaluation: Over-fitting, Cross-Validation.

10 hours

Unit 2:

Supervised Learning: Decision Tree Learning: Decision tree Representation, Appropriate problems for Decision Tree Learning, The Basic Decision Tree Learning Algorithm, Hypothesis Space Search in Decision Tree Learning, Inductive Bias indecision Tree Learning, Issues in decision Tree Learning.

10 hours

Unit 3:

Artificial Neural Networks: Neural Network Representation, Perceptrons, Multilayer networks and the back-propagation Algorithm. Remarks on the Back propagation Algorithm, An Illustrative Example: Face Recognition, Advanced Topics in Artificial Neural Networks.

10 hours

Unit 4:

Probabilistic Learning: Bayesian Learning: Bayes Theorem, Bayes Theorem and Concept Learning, Maximum Likelihood Hypothesis for predicting Probabilities, Gibbs Algorithm, Bayesian Belif Networks, The EM Algorithm.

10 hours

Unit 5:

Computational Learning Theory: probably learning an Approximately Correct Hypothesis, Sample Complexity for Finite Hypothesis Spaces, The Vapnik-Chervonenkis Dimension, Instance- Based Learning: K-Nearest Neighbour Learning.

10 hours

References:

1. Tom Mitchell. Machine Learning. McGraw Hill, 2nd Edition, 1997.
2. Christopher M. Bishop. Pattern Recognition and Machine Learning. 2nd Edition, Springer 2006.

Subject Name & Code	**Six Sigma Manufacturing ECPGOL4**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course Outcomes: At the end of the course, the student should be able to

1. Understand systematic method for achieving quality in product development and manufacturing with fundamentals of six sigma.
2. Design for six sigma towards product development.
3. Approach towards design for x by using algorithms.
4. Apply the tools and best practices for design development, optimization and verifying capability.
5. Revealing industry insider case studies.

Unit 1:

Quality concepts: What is quality? Quality assurance and product or service life cycle, development of quality methods. Six sigma fundamentals, what is six sigma? process, process mapping, process capability and six sigma, overview of six sigma process improvement and design for six sigma.

10 Hours

Unit 2:

Design for six sigma: What is six sigma theory? Why design for six sigma; phases of six sigma, difference between six sigma and design for six sigma (DFSS). Problems solved by DFSS, DFSS company and strategy. Design for six sigma project algorithm: Introduction, form of synergistic design team, determine customer expectations, understand functions required, evolution, generate concepts, select best concept, finalize the physical structure of selected concept, initiate design scoreboards and transfer function development, assess risk, transfer function optimization, design for x, prototyping design, validate design, launch mass production, project risk management. **10 Hours**

Unit 3:

Design for x: Introduction, design for manufacturing and assembly (DFMA), design for reliability (DFR), Design for manufacturability, design for serviceability, design for environmentality, design for life cycle cost (LCC).

08 Hours

Unit 4:

Failure mode-effect analysis: Introduction, FMEA fundamentals, development of FMEA, process FMEA, quality system and control plans. Reliability prediction, introduction to descriptive and inferential statistics, measurement systems analysis, multi-vari studies, regression, Taguchi method for robust design, response surface methods, optimization methods, analytical and empirical tolerance design, reliability evaluation, statistical process control, linking design to operations. **12 Hours**

Unit 5

Case studies on six sigma for technology and product development, Lean six sigma in services and manufacturing applications and case studies.

10 Hours

References:

1. Kai Yang, Basem El-Haik, ***"Design for Six Sigma: A Road Map for Product Development",*** Tata McGraw Hill, 2003.
2. C.M. Creveloing, J.L. Slutsky, D. Antis, Jr., ***"Design for Six Sigma: In Technology and Product Development",*** Pearson Education 2003, Second impression 2008.
3. Peter S. Pande, Robert P. Neuman, Roland R. Cavanagh, ***"The Six Sigma Way: How GE, Motorala, and Other Companies are Honing their Performance",*** Tata McGraw Hill, 2000.
4. Sandra F. Furterer, ***"Lean Six Sigma in Services Applications and Case Studies",*** CRC Press, Taylor Francis Group 2009.
5. Peter S. Pande, Robert P. Neuman, Roland R. Cavanagh, K. ***"The Six sigma Way: Team Field Book",*** Tata McGraw Hill, 2003.
6. Joseph. A. De Fero, William Co Barnard, ***"Juran Institute's: Six Sigma Breakthrough and Beyond",*** Tata McGraw Hill, 2000

Subject Name & Code	Heuristics for Optimization ECPGOL5
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Introduction to evolutionary computation: Biological and artificial evolution, Evolutionary computation and AI, different historical branches of EC. Genetic Algorithms: Coding, Search operators, Selection schemes, Applications.

Simulated Annealing: Theoretical Approaches, Parallelization, Applications.

Tabu Search: Neighborhood, Candidate list, Short term and Long term memory, Applications

Ant Colony Algorithms: Overview, Basic algorithm, Variants, Formalization and properties of ant colony optimization, Applications.

Multi objective evolutionary optimization: Pareto optimality, Multiobjective evolutionary algorithms.

References:

1.Baeck T, Fogel D B & Michalewicz Z -Handbook on Evolutionary Computation- IOP Press

2.Michalewicz Z-Genetic Algorithms + Data Structures = Evolution Programms- Springer-Verlag,Berlin

3.Goldberg D E-Genetic Algorithms in Search, Optimization & Machine Learning- Addisson Wesley

4.Banzhaf W,Nordin P,Keller et al.-Genetic Programming :An Introduction- Morgan Kaufmann

5.Tabu Search-Fred Glover

Subject Name & Code	Organizational Behavior and Financial Management ECPGOL6
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Unit – 1

Introduction: Meaning-Definitions and scope of organizational behaviour-people- Organizational structure-technology and environment-OB as a Behavioral science- Foundations of Individual Behavior: Biological Characteristics-Age-Sex-Marital Status-Number of Dependents-Tenure-Ability-Intellectual Abilities- Physical Abilities-The Ability-Job fit personality-personality determinants-Personality Traits-Major Personality Attributes influencing OB-Matching personality and Jobs-learning –Theories of learning shaping-Values, attitudes, and Job satisfaction: Importance of Values-Sources of Value system-Sources and types of Attitudes.

10 Hours

Unit- 2

Motivation: The concept of Motivation-Early Theories of Motivation-Hierarchy of Needs theory-theory X and Theory Y-Hygiene theory-contemporary theories of motivation-ERG Theory-three needs theory-cognitive evaluation theory.

10 Hours

Unit-3

Foundation of group behavior: Defining and classifying groups-group process-group tasks-cohesive groups-group dynamics-leadership-nature and importance-functions-styles-communications-nature and types-effective communication-Roles of Formal and informal communication-Conflict management-The process of conflict-types of conflict-functional and dysfunctional conflict-resolution of conflict.

10 Hours

Unit-4

Financial management- Meaning, Scope, and functions – Financial Planning – Financial analysis- Financial Control - Objectives-Profit Maximization and Wealth Maximization, their social implications. Sources of capital, types of capital.

10 Hours

Unit-5

Working Capital Management & capital structure decision : Meaning – concept- determinants of working capital, Determination of optimal investment in working capital, Capital structure theories-NI, NOI, traditional and M-M theories; EBIT -EPS Analysis

10 Hours

Subject Name & Code	**Deep Learning ECPGOL7**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

Unit 1:

Deep Networks Regularization & optimization

Feed forward networks- Gradient based learning, hidden units, backpropagation. Regularization –parameter norm, Dataset augmentation, Noise robustness, semi-supervised learning, multitask learning, early stopping, sparse representation, bagging, ensemble, dropout, manifold learning. Optimization for training deep models- challenges in neural network optimization, adaptive learning rates, and optimization strategies. **10 Hours**

Unit 2:

Convolution networks

Convolution network, pooling, structured output, data types, efficient convolution algorithm, randomized and unsupervised features, Recurrent and recursive networks- unfold computation graphs, recurrent neural networks, encoder-decoder, deep recurrent network, recursive neural network, echo state network, optimization, and challenges. Practical methodology and its application- performance metrics, selecting hyper parameters. Some application of deep learning like computer vision, speech recognition. **10 Hours**

Unit 3:

Linear factor models

Probabilistic PCA and factor analysis, independent component analysis, slow feature analysis, sparse coding, and manifold interpretation of PCA. Auto encoders- auto encoders, regularized auto encoders, stochastic auto encoder- decoder, learning manifold with auto encoder, predictive sparse decomposition. **10 hours**

Unit 4:

Representation learning

Greedy unsupervised pre-training, transfer learning, distribution representation, exponential gain, providing clues for underlying causes. Structured probabilistic model for deep learning – challenges of unstructured modeling, using graph to describe unstructured model, sampling from graphical models, learning about dependencies, deep learning approach towards structured probabilistic model. Monte carlo methods- sampling monte- carlo methods, importance sampling, markov chain montecarlo methods, gibbs sampling. **10 Hours**

Unit 5:

Deep generative models

Boltzmann machine, restricted Boltzmann machine, deep belief networks, Boltzmann machine for real valued data, convolutional Boltzmann machine, other Boltzmann machine, back propogation through random operations, directed generative methods, generative stochastic methods, evaluating generative methods. **10 Hours**

References:

1. Deep learning - Ian Goodfellow and YoshuaBengio and Aaron Courville, MIT press, Cambridge, Massachusetts, London, ,2016.
2. Fundamentals of Deep Learning: Nikhil Buduma, Nicholas Locascio,O'Reilly media ,2017.
3. Deep Learning: Methods and Applications, Li Deng & Dong Yu, 2014.
4. Grokking Deep Learning– Andrew W trask, 2016

Subject Name & Code	**MEMS ECPGOL8**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE Marks: 100**

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

1: Explain fundamentals of sensors/actuators, polymers and device fabrication techniques.

2: Analyze the design considerations of sensors and actuators.

3: Apply MEMS to disciplines beyond electrical and mechanical engineering.

4: Engage in independent study as a member of a team and make an effective oral presentation on the usage of software tools/mini project.

UNIT I

INTRODUCTION: Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Microfabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis– Flexural beam bending- Torsional deflection. **10 hrs**

UNIT II

SENSORS AND ACTUATORS-I: Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators. **10 hrs**

UNIT III

SENSORS AND ACTUATORS-II: Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements. Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators –piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors. **10 hrs**

UNIT IV

MICROMACHINING: Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies Basic surface micromachining processes – Structural and Sacrificial Materials – Acceleration ofsacrificial Etch – Striction and Antistriction methods – Assembly of 3D MEMS – Foundry process.

12 hrs

UNIT V

POLYMER AND OPTICAL MEMS: Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene –Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS, Lenses and Mirrors – Actuators for Active Optical MEMS.

10 hrs

References:

1. **Chang Liu**, '*Foundations of MEMS'*, Pearson Education Inc., 2006.
2. **Nadim Maluf**, " *An introduction to Micro electro mechanical system design*", Artech House, 2000.
3. **Mohamed Gad-el-Hak**, " *The MEMS Handbook*", CRC press Baco Raton, 2000
4. **Tai Ran Hsu**, "*MEMS & Micro systems Design and Manufacture*" Tata McGraw Hill, New Delhi, 2002.
5. **Julian w. Gardner, Vijay k. varadan, Osama O.Awadelkarim**, "*Micro sensors mems and smart devices*", John Wiley & son LTD,2002
6. **James J.Allen**, "*Micro Electro Mechanical System Design*", CRC Press published in 2005

Subject Name & Code	Artificial Neural Networks ECPGOL9
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE Marks: 100

Unit 1:

Background to ANN: Introduction to artificial neural networks (ANN), intelligence, learning and knowledge. Historical development of Artificial Intelligence (AI) leading to ANN. PDP models -- Interactive and competetion (IAC) and Constraint Satifaction (CS) models.

10 Hours

Unit 2:

Basics of ANN: Basics of ANN, terminology, models of neurons, topology, basic learning laws, activation and synaptic dynamics models.

10 Hours

Unit 3:

Analysis of Feedforward Neural Networks (FFNN): Overview, linear associative networks, perceptron network, multilayer perceptron, gradient descent methods, backpropagation learning.

10 Hours

Unit 4:

Analysis of Feedback Neural Networks (FBNN): Overview, Hopfield model, capacity, energy analysis, state transition diagrams, stochastic networks, Boltzmann-Gibbs Law, simulated annealing, Boltzmann machine.

10 Hours

Unit 5:

Applications of ANN: Travelling salesman problem, image smoothing, speech recognition and texture classification.

10 Hours

References:

1.**B Yegnanarayana**, "*Artificial Neural Networks*", Prentice-Hall of India, New Delhi, 1999

2. **Simon Haykin**, "*Neural networks and learning machines*", Pearson Education, 2011

3. **Jacek M Zurada**, "*Introduction to artificial neural systems*", PWS publishing Company, 1992

4. David E Rumelhart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 1, Cambridge MA: MIT Press, 1986a

5. James McClelland, David E Rumelhart, and the PDP research group, Eds, Parallel and Distributed Processing: Explorations in Microstructure of Cognition, Vol 2, Cambridge MA: MIT Press, 1986b

6. David Rumel hart, James McClelland, and the PDP research group, Eds, Parallel and Distributed Processing: A handbook of models, Cambridge MA: MIT Press, 1989