

JSS MAHAVIDYAPEETHA
JSS SCIENCE AND TECHNOLOGY UNIVERSITY

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING



- Constituent College of JSS Science and Technology University
- Approved by A.I.C.T.E
- Governed by the Grant-in-Aid Rules of Government of Karnataka
- Identified as lead institution for World Bank Assistance under TEQIP Scheme



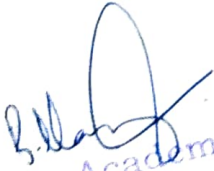
M.Tech Programme
in
NETWORKING AND INTERNET ENGINEERING

SCHEME I TO IV SEMESTER: 2021-2022
&
SYLLABUS I TO IV SEMESTER: 2021-2022


DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for M. Tech

(For the Academic year 2021-2022)


Dean Academics
JSS STU, Mysuru


Registrar
JSS Science & Technology University
JSS Technical Institutions' Campus
Mysuru 570 006, Karnataka


PRINCIPAL
Sri Jayachamarajendra College of Engineering
Constituent College of JSS Science and Technology University
MYSURU-570 006.

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Vision Statement of the JSS Science and Technology University

1. Advancing JSS S&T University as a leader in education, research and technology on the international arena.
2. To provide the students a universal platform to launch their careers, vesting the industry and research community with skilled and professional workforce.
3. Accomplishing JSS S&T University as an epicenter for innovation, center of excellence for research with state-of-the-art lab facilities.
4. Fostering an erudite, professional forum for researchers and industrialist to coexist and to work cohesively for the growth and development of science and technology for betterment of society.

Mission Statement of the JSS Science and Technology University

1. Education, research and social outreach are the core doctrines of JSS S&T University that are responsible for accomplishment of in-depth knowledge base, professional skill and innovative technologies required to improve the socio economic conditions of the country.
2. Our mission is to develop JSS S&T University as a global destination for cohesive learning of engineering, science and management which are strongly supported with interdisciplinary research and academia.
3. JSS S&T University is committed to provide world class amenities, infrastructural and technical support to the students, staff, researchers and industrial partners to promote and protect innovations and technologies through patents and to enrich entrepreneurial endeavors.
4. JSS S&T University core mission is to create knowledge led economy through appropriate technologies, and to resolve societal problems by educational empowerment and ethics for better living.





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Vision statement of the department of E&CE

Be a leader in providing globally acceptable education in electronics and communication engineering with emphasis on fundamentals-to-applications, creative thinking, research and career- building.

Mission statement of the department of E&CE

1. To provide best infrastructure and up-to-date curriculum with a conducive learning environment.
2. To enable students to keep pace with emerging trends in Electronics and Communication Engineering.
3. To establish strong industry participation and encourage student entrepreneurship.
4. To promote socially relevant eco-friendly technologies and inculcate inclusive innovation activities.



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Program Outcomes (POs)

1. **Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
4. **Conduct investigations of complex problems:** Using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6. **The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.



10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
11. **Lifelong Learning:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
12. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Program Specific Outcomes (PSOs)

1. Analyze, design and provide engineering solutions in the areas of electronic circuits and systems.
2. Demonstrate the mathematical modeling techniques, nurture analytical and computational skills to provide engineering solutions in the areas of electronics and communication.
3. Ability to address multidisciplinary research challenges and nurture entrepreneurship.

Program Educational Objectives (PEOs)

1. To enable the graduates to have strong Engineering fundamentals in Electronics & Communication, with adequate orientation to mathematics and basic sciences.
2. To empower graduates to formulate, analyze, design and provide innovative solutions in Electronics & Communication, for real life problems.
3. To ensure that graduates have adequate exposure to research and emerging technologies through industry interaction and to inculcate professional and ethical values.
4. To nurture required skill sets to enable graduates to pursue successful professional career in industry, higher education, competitive exams and entrepreneurship.





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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Semester wise Credit Distribution for M. Tech Program (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 + 1 week 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**

CONTINUOUS EVALUATION SCHEDULE FOR PROJECT WORK

Event	Credits	Marks	Schedule
III SEM			
Industrial Training	04	100	Within 8 th week
Synopsis Evaluation	05	50	Within 6 th week
Mid-term Evaluation 1 (Project work Phase I)	05	50	Within 18 th week
	Total	200	
IV SEM			
Mid-term Evaluation 2	18	200	Within 30 th Week
Final internal seminar and demonstration			Within 40 th Week
Report preparation			Within 44 th Week
Evaluation of Project work External evaluation and Viva voce exam		200	Within 52 nd Week
Declaration of results	Total	400	Within 54 th 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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M.Tech in Networking and Internet Engineering

SEMESTER 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	Professional Elective 1	4	1	0	5	6	50	50	100	3 hours
6	LNI 15X	Professional Elective 2	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 Lab -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 1 to 5 will be offered among 5 subjects)

SI No	Course 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

FIRST SEMESTER (Two electives to be chosen)

Professional Elective 1			Professional Elective 2		
Course Code	Course Title	Credit Pattern	Course Code	Course Title	Credit Pattern
LNI141	Network programming	4:1:0	LNI151	Cyber forensics and information security	4:1:0
LNI142	Big data systems	4:1:0	LNI152	Cloud computing and virtualization	4:1:0
LNI143	Software defined Radio	4:1:0	LNI153	Underwater Communication	4:1:0
LNI144	Telecommunication Management and Regulation	4:1:0	LNI154	Optical and DWDM networks	4:1:0
			LNI155	Quantum Computing and Communication	4:1:0



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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	Professional Elective 3	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 26L	Networking Lab-2	0	0	1.5	1.5	3	50	-	50	-
7.	LNI 27L	Design and implementation Lab- 2	0	0	1.5	1.5	3	50	-	50	-
		TOTAL				28	36	350	250	600	



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

Code	Course Title	Credit Pattern
LNI210	Mobile computing	4:1:0
LNI220	Protocol engineering	4:1:0
LNI230	Web services	4:1:0
LNI240	Cognitive radio and Networks	4:1:0
LNI250	Ubiquitous Computing	4:1:0

Professional Elective 3: SECOND SEMESTER (one elective to be chosen)

Course Code	Course Title	Credit Pattern
LNI241	5G technologies	4:1:0
LNI242	Photonic systems and Technologies	4:1:0
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 – Internet of Things	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



Note:

Students from M. Tech (LNI & MAL) specialization can 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
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0

Students from M. Tech (LIE & MAL) specialization can 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
ECPGOL7	Deep learning	4:1:0
ECPGOL8	MEMS	4:1:0
ECPGOL9	Artificial Neural Networks	4:1:0

Students from M. Tech (LNI & LIE) specialization can 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 - Internet of Things	4:1:0
ECPGOL5	Heuristics for optimization	4:1:0
ECPGOL6	Organizational Behavior and Financial Management	4:1:0



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SEMESTER III

SI No	Subject Code	Course Title	No of Credits				Marks Allocated			Exam duration
			L	T	P	Total	CIE	SEE	Total	
1	LNI31T	Practical Training in Industrial Exploration Research	-	-	-	4	100	-	100	
2	LNI32P	Project work (Phase – I)	-	-	-	10	100	-	100	
		TOTAL	-	-	-	14	Total Marks		200	

SEMESTER IV

SI No	Subject Code	Course Title	No of Credits				Marks Allocated					Exam
			L	T	P	Total	CIE MIN	CIE MAX	SEE MIN	SEE MAX	Total	
1	LNI41P	Project Work (Phase – II)	-	-	-	18	50	100	150	300	400	
		TOTAL	-	-	-	18	Total Marks			400		



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: Diagonalization; 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. Comprehend the basic of Graph and trees and mathematical enumeration of trees using various formulations.
2. Describe the basics of Tree as data structure and types of trees,
3. Applications of bipartite graph, Euler's graph, Hamiltonian graphs.
4. Demonstrate the 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

Tress: 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 Coloring: 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*", Springer, 1st edition, 2008.
2. **J.A. Bondy and U.S.R. Murty,** "*Graph Theory with Applications*".
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

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

1. Understand the basic principles and classification techniques of data analysis Model.
2. Apply machine learning, statistics, visualization, algorithm, database technologies in data mining applications.
3. Develop a data mining application for data analysis using various tools.
4. Demonstrate the applications of neural networks.
5. Implementation of various map reduce techniques in Hadoop environment.

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.

08 Hours

Unit 2

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 3

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 4

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 5

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 analytics”**, John Wiley & Sons, 2012.
3. **Glenn J. Myatt**, “*Making Sense of Data*”, John Wiley & Sons, 2007.
4. **Pete Warden**, “*Big Data Glossary*”, O’Reilly, 2011.
5. **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

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

1. Identify system properties based on impulse response and Fourier analysis.
2. Apply transform techniques to analyze continuous-time and discrete-time.
3. Analyze the spectral characteristics of signals using Fourier analysis.
4. Demonstrate the applications of DFT & IDFT.
5. Implementation of convolution techniques in time domain and frequency domain.

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-plane 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. Schaffer**, “*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>



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. Construct Real Time Applications of Microcontrollers.
3. Demonstrate RTOS for Microcontrollers.
4. Translate Hardware applications using Microcontrollers.
5. Implement various hardware experiments using LCD, keyword, 7 segment display and verify the results.

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.

08 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.

08 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.

08 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, Analog input interfacing – Analog output interfacing – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments.

08 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.

08 Hours

References:

1. **Raj K a m a l**, “*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.



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

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

1. Formulate various mathematical models based on modeling tools and techniques.
2. Derive and use various simulation techniques.
3. Simulate examples based to realistic models using appropriate modeling tools.
4. Implement statistical simulation for various models and view the control simulations and their results.

Unit 1

Mathematical Modeling: Modeling and its principles, some methods of mathematical modeling: problem definition, dimensional homogeneity and consistency, abstraction and scaling, conservation and balance principles, system characterization, constructing linear models, discrete versus continuous modelling, deterministic versus stochastic.

08 Hours

Unit 2

Approximating and Validating Models: Review of Taylor's formula and various trigonometric expansions, validating the model, error analysis, fitting curves to the data.

08 Hours

Unit 3

Basic Simulation Approaches: Methods for simulation and data analysis using MATLAB, statistics for simulations and analysis, random variates generation, sensitivity analysis.

08 Hours

Unit 4

Model and its Different Types: Linear and nonlinear population models, traffic flow models, transport phenomena, diffusion and air pollution models, statistical models, Poisson process, stochastic models, computer data communications, stock market, option pricing, Black-Scholes model, modeling engineering systems.



08 Hours

Unit 5

Software Support: MATLAB, **Experiment:** Implementation of numerical techniques using MATLAB based on course contents. **Projects:** The projects will be assigned according the syllabus covered.

08 Hours

References:

1. **Clive L. Dym**, "*Principles of Mathematical Modelling*", Elsevier Press, Second Edition, 2004.
2. **Edward A. Bender**, *An Introduction to Mathematical Modeling*, **Dover, 2000.**
3. **D Kincaid and W. Cheney**, *Numerical Analysis: Mathematics of Scientific Computing*,
4. *American Mathematical Society*, Third Edition, 2009.



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

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

1. Describe technical report formats and standard practices using LaTeX software.
2. Prepare technical papers according to standard IEEE guidelines applying LaTeX commands.
3. Develop project report, technical presentations, seminars and analyze case studies.
4. Work in a group to prepare and present project report, publications using online software tools.

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.

06 Hours

Unit 3

Report writing and presentations: Guidelines for project report writing, differences between technical presentations and seminars.

06 Hours

Unit 4

Technical literature and report writing: Introduction to technical writing and technical literature survey.

06 Hours

Unit 5

Case studies and exercises: Case studies on report writing, presentations, seminars and related exercises



06 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	

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

1. Describe the carried out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
2. Explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
3. Apply the details of sampling designs, measurement and scaling techniques and also different methods of data collections.

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.

06 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.

06 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.

06 Hours

Unit 4

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

06 Hours

Unit 5

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.

06 Hours

References:

1. **Donald Cooper & Pamela Schindler**, “*Business Research Methods*“, TMGH, 9th edition.
2. **Alan Bryman & Emma Bell**, “*Business Research Methods*“, Oxford University Press.
3. **C.R.Kothari**, “ *Research Methodology: Methods and Techniques*“, New Age International Publisher, 2019.



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

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

1. Understanding of the whole issue of "Sustainability" and its critical relevance for future managers and professionals.
2. Demonstrate an integrated approach in evaluating performances of business, organizations and individuals by taking into account both the positive and negative impact on economic, social and environmental systems.
3. Analyze the methods of synthesize multi-dimensional, hierarchical and quasi-quantitative information.

Unit 1

Introduction to technology, sustainability and sustainable development - Technology; concepts and definitions; Concepts of sustainability and sustainable development; Components of sustainability (Social, Economic, Environmental)

06 Hours

Unit 2

Linkages between resource use, technology and sustainability - Interactions between energy and technology, and their implications for environment and sustainable development; Technology diffusion and commercialization; Business and sustainability.

06 Hours

Unit 3

Measuring and Benchmarking Sustainability - Sustainability proofing; Frameworks for measuring sustainability; Indicators of sustainability.

06 Hours



Unit 4

Sustainability transitions “Technologies and Economic sectors/systems; Sustainability transition.

06 Hours

Unit 5

“Case Studies; Sustainable innovations “Drivers and Barriers; Policy and institutional innovations for sustainability transition.

06 Hours

References:

1. **Dorf, Richard C.**, Technology, humans, and society: toward a sustainable world, Academic Press, 2001.
2. **Rogers, P.P., Jalal, K.F. and Boyd, J.A.**, An Introduction to Sustainable Development, Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.
3. **Weaver, P., Jansen, L., Grootveld, G.V., Spiegel, E.V. and Vergragt, P.**, Sustainable Technology Development, Greenleaf Publishing, Sheffield, 2000.
4. **Grubler, A.**, Technology and Global Change, Cambridge University Press, Cambridge, 2003.



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

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

1. Understand the effects of technology on society.
2. Develop strategies for using and managing of technologies in our daily life.
3. Apply the strategies to reduce the social implications on new technologies.

Unit1

The relationship between technology and society: The Social Construction of Facts and Artifacts, The Intersection of Culture, Gender, And Technology

06Hours

Unit 2

Technology and values: Amish Technology: Reinforcing Values and Building Community Manufacturing Gender in Commercial and Military Cockpit Design.

06Hours

Unit 3

The complex nature of sociotechnical systems: Sociotechnical Complexity: Redesigning A Shielding Wall Bodies, Machines, And Male Power.

06Hours

Unit 4

Visions of a technological future: Technology and Social Justice, Nanotechnology: Shaping the World Atom By Atom.

06Hours

Unit 5

Twenty-first-century challenges: Energy, Society, And Environment: Technology for A Sustainable Future People’s Science in Action: The Politics of Protest And Knowledge Brokering In India.

06Hours



Reference:

1. **Deborah G. Johnson and Jameson M. Wetmore**, "*Technology and society: building our sociotechnical future*", Massachusetts Institute of Technology, 2009.
2. Study articles related to above topics (IEEE transactions).



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

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

1. Explain entrepreneurship, management and innovation with an emphasis on their evolution. Identify various institutional support for starting new business, assessment of demand and supply in potential areas of growth, opportunity identification and feasibility analysis.
2. Analyze the importance of technology management with respect to organizational finance, ethics, team work and project planning. Investigate techno-economic feasibility of a project.
3. Identify the outcomes of innovation with regard to IPR and patents in technology-oriented business.
4. Assess various successful entrepreneurial profiles, analyze the startup ecosystem and new venture creations, working in teams study case examples, develop a business plan, prepare a report, and critically evaluate.

Unit 1

Introduction to Innovation: Creativity, Invention and innovation, Types of Innovation, Relevance of Technology for Innovation, The Indian innovations and opportunities, Strategy for Commercializing Innovation: Innovation Process, Risks and barriers for introducing products and services, selecting a Strategy, setting up the Investment and establishing organization, Evaluating the Costs and impact of the Project.

06 Hours

Unit 2

Entrepreneurship: Concept, meaning, need and competencies/qualities/traits of an entrepreneur, Technopreneurship. **Innovation:** Introduction, motivating to innovate, introduce core ideas about how to think about innovation, including key theories about factors that affect innovation. An in-depth review of how companies' structure to encourage and develop innovation. Product development and design.



06 Hours

Unit 3

Role of financial institutions: Role of financial institutions in entrepreneurship development and support Institutes: District Industry Centers (DICs), State Financial Corporations, Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Small Industries Corporation (NSIC) and other relevant institutions.

06 Hours

Unit 4

Engineering Management: Introduction to Engineering Management: Engineering and Management, historical development of engineering management. Functions of management: planning and forecasting, decision making, organizing, motivating and leading technical people, controlling.

Technology management: Managing projects: Project planning and acquisition, organization and types, leadership and control. Case Studies.

06 Hours

Unit 5

Project Report Preparation: Preliminary report, Techno-economic feasibility report, Project viability. Market Survey and Opportunity Identification: start-up industry, procedures for registration of industry. assessment of demand and supply in potential areas of growth, understanding business opportunity, considerations in product selection and development, data collection for setting up new ventures. Case studies examples.

06 Hours

Reference:

1. **Peter Duckers**, “Innovation and Entrepreneurship Practice and Principles”, Heinemann, 1985.
2. **Morse and Babcock**, “Managing Engineering and Technology”, 4th edition, PHI Learning Private Limited, New Delhi, 2009.
3. **Rabindra N. Kanungo** “Entrepreneurship and innovation”, Sage Publications, New Delhi, 1998.
4. **Peter F. Drucker**, “Innovation and Entrepreneurship



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

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

1. Understand about the environmental impacts of e-waste.
2. Apply various concept learned under e-waste management hierarchy.
3. Distinguished the role of various national and internal act and laws applicable for e-waste management and handling.
4. Analyze the e – waste management measures proposed under national and global legislations.

Unit 1

Introduction to E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management.

06 Hours

Unit 2

Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India.

06 Hours

Unit 3

E-waste hazardous on Global trade: Essential factors in global waste trade economy, Waste trading as a quint essential part of electronic recycling, Free trade agreements as a means of waste trading. Import of hazardous e-waste in India; India’s stand on liberalizing import rules, E-waste economy in the organized and unorganized sector. Estimation and recycling of e-waste in metro cities of India.

06 Hours

Unit 4

E-waste control measures: Need for stringent health safeguards and environmental protection laws



in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.

06 Hours

Unit 5

E- waste legislation: E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs. The international legislation: The Basel Convention.

06 Hours

References:

1. **Hester R.E., and Harrison R.M.**, “*Electronic Waste Management. Science*”, 2009.
2. **Fowler B.** “*Electronic Waste (Toxicology and Public Health Issues)*”. 1st Edition, Elsevier, 2017.
3. **Johri R.**, “*E-waste: implications, regulations, and management in India and current global best practices*”, TERI Press, New Delhi.



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

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

1. Describe the relations between technology and social change, power disparities, democracy, surveillance, work and participation.
2. demonstrate a basic understanding of how the internet and social media have been analysed sociologically, and independently grasp theoretical debates in the field of digital sociology.
3. Apply the technique in research of digital sociology.

Unit 1

Digital society, social media, Cyber Debates, Interaction and Identity, Communication and Networks.

06 Hours

Unit 2

Digital visibility and visibility, Feeling Digital, Digital Citizenship and Digital power and Exploitation.

06 Hours

Unit 3

Digital activism, mobile culture, software, algorithms and Data, Digital Social research, the research process.

06 Hours

Unit 4

Tools: Digital Ethnography, Mapping and mining digital Society, A Theory of digital media and social changes.

06 Hours

References:

1. **Lindgren Simon**, “*Digital media and society: theories, topics and tools*”, SAGE Publications, 2017.



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.

12 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*”, Second Edition, TMH.
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. Classical 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, Hash Functions, Security of 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/MIME, Data compression using ZIP, Radix-64 conversion, PGP random number generator. IP Security: Overview, IP security architecture, Authentication header, ESP (Encapsulating security payload), Security associations, Key management, Problems. Firewalls: Firewall design principles, trusted systems, System viruses Problems and new research / advanced topics

12 Hours

References:

1. **William Stallings**, “*Cryptography and network Security – principles and practice*”, 7th edition, Pearson India. Prentice 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, 2013.



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 Virtualization 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 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.

12 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	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

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 UTMIS Terrestrial Radio access network-UMTS Core Network Architecture: 3G- MSC, 3G-SGSN, 3G-GGSN, SMS-GMSC/SMS-IW MSC, 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.

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

1. Understand the principles of network analysis, architecture, and design.
2. Identifying the various requirement analysis for analysis of network flow and design.
3. Apply the principles of network architecture and design include addressing and routing, network management for measuring the network performance.

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.

12 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– 1 LNI 16L
No. of Teaching Hours – 30	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.

CISCO Packet Tracers Software Experiments

1. Study of different types of Network cables and practically implement the cross-wired cable and straight through cable using clamping tool.
2. Using CISCO packet Tracer, perform the following experiments
 - a. Configure a basic Network topology.
 - b. Ping and Trace.
 - c. Investigate Unicast, Broadcast and Multicast Traffic.
3. Using CISCO Packet Tracer, Perform the following experiments
 - a. Skills Integration challenge-planning subnets and configuring IP addresses.
 - b. Observing the effects of collision in a shared media environment.
 - c. Static routing and default routing.
4. Configure a Network topology using Distance Vector Routing protocol.
5. Configure a Network topology using Link State Routing protocol
6. Using CISCO Packet Tracer, Perform the followings
 - a. Network Address Translation (NAT)
 - b. Access Control List (ACLs)
7. Using packet Tracer, perform the following experiments



- a. Basic switching configuration.
- b. Configure VLAN and Inter-VLAN routing for a Network.

EXATA Software:

1. Emulation Test-Bed for VoIP Call using Softphones in Exata.
2. Emulation Test-Bed for video streaming over IP Network using Exata.



Subject Name & Code	Design and Implementation Lab-1 LNI17L
No. of Teaching Hours – 30	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.



Professional Electives

(I & II)



Professional Elective - I

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.

12 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	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 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

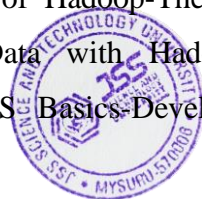
Unit 2

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 Info Sphere Big Insights and Streams. Visualizations -Visual data analysis techniques, interaction techniques; Systems and applications.

12 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 and Streaming Data*”, Tata McGraw Hill Publications, 2011.



Subject Name & Code	Software Defined Radio - LNI143
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

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

10 Hours

Unit 2

SDR and cognitive radio architectures, Spectrum efficiency and soft spectrum usage, multi-dimensional spectrum awareness, application of cognitive radio (specifically for public safety)

10 Hours

Unit 3

Cognitive features in the upcoming wireless standards (LTE, WiMAX, etc), Spectrum, network context, environment, location awareness for cognitive radio, Blind receiver design, Femto-cells and relation to cognitive radio, Cognitive OFDM(A)

10 Hours



Unit 4

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

12 Hours

Unit 5

Sampling and ADC/DAC issues in CR and SDR, 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

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

1. Understand the fundamental principles of telecom and telecom market dynamics.
2. Identify the opportunities and challenges that new information and communication technologies can bring.
3. Apply the dynamics structure of the industry and about the role of factors such as economies of scale, disruptive technologies, network externalities and regulation.

Unit 1

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

10 Hours

Unit 2

Techno managerial 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.

12 Hours

Unit 3

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.

10 Hours

Unit 4

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.

10 Hours

Unit 5

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

10 Hours

References:

1. **William Stallings and Thomas Case**, "*Business Data Communications*", 7th edition.
2. **Riaz Esmailzadeh** "*Broadband Telecommunications Technologies and Management*", 1st Edition.



Professional Elective - II

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.

12 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. Explore advances in the domain by engaging in self-study / team work and give an effective presentation with proper documentation.

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.

12 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.
2. **RajkumarBuyya , James Broberg, Andrzej Goscinski:** “*Cloud Computing Principles and Paradigms*”, Willey 2014.
3. **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

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

1. Understand the principle of acoustic signal and way the acoustic signal will propagation in water medium.
2. Apply the digital signal processing techniques to characterizing sonar signals.
3. Articulate the node architecture and various routing techniques used to communicate between two nodes in underwater environment.

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 OFDM - OFDM Simulations.

12 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. **S. Lawrence Marple**, “*Digital Spectral Analysis with applications*”, 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. **Michael Uogel**, ‘*Real time Deepwater Current Profiling Systems*’, Marine Technology Symposium.
4. **Ian F Akyildizetal**, ‘*Underwater Acoustics Sensor Network: Research Challenges*’, Elsevier, 2005.
5. **Vasilescu**, “*Data Collection, Storage and Retrieval with an Underwater Sensor Network*”, San Diego, 2005



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

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

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.

12 Hours

References:

1. **Rajiv Ramaswami and Kumar N. Sivarajan**, “*Optical Networks: A Practical. Perspective*”, Elsevier 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,

12 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.



II Semester Syllabus



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

10 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.

12 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



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

Unit 2

10 Hours

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.

12 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. 2014.
2. **Miroslav Pipovic**, “*Communication Protocol Engineering*” CRC Press, 2018.



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.



10 Hours

Unit 3

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,

10 Hours

Unit 4

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 JAXB Customizing JAXB, When to Use Custom Declarations

10 Hours

Unit 5

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.

12 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*”, 2nd 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

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

1. Understand the fundamentals of cognitive radio and its architecture.
2. Identify each component in software radio and list its characteristics and benefits.
3. Analyze the spectrum for various cognitive radio applications.

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.

12 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. Describe the key Model for Ubiquitous/Pervasive Computing Properties
2. Articulate the working of smart environment and smart devices.
3. Apply the working of Human Computer Interaction in context of Pervasive Computing.
4. Analyze the 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.

12 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-2 LNI26L
No. of Teaching Hours-30	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

Experiments and Exercises:

NS2/NS3 Software Experiments:

For the experiments below modify the topology and parameters set for the experiment and take multiple rounds of reading and analyse the results available in log files. Plot necessary graphs and conclude using any suitable tool (NS2/NS3).

1. Implement three nodes point – to – point network with duplex links between them. Set the queue size, vary the bandwidth and find the number of packets dropped.
2. Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
3. Implement an Ethernet LAN using n nodes and set multiple traffic nodes and plot congestion window for different source / destination.
4. Implement simple ESS and with transmitting nodes in wire-less LAN by simulation and determine the performance with respect to transmission of packets.
5. Implement and study the performance of GSM on NS2/NS3 (Using MAC layer) or equivalent environment.
6. Implement and study the performance of CDMA on NS2/NS3 (Using stack called Call net) or equivalent environment.



7. Exercises on simulation using EXATA making use of cellular library.
8. Exercises on simulation using EXATA making use of sensor network library
9. Development and testing of scenarios for web services applications
10. Exercises related to Open-flow Switches.



Subject Name & Code	Design and Implementation Lab-2 LNI27L
No. of Teaching Hours – 30	Credits: 0:0:1.5 L-T-P
CIE Marks: 50	

Course Objectives:

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

Course Outcomes: At the end of the course, the student should 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	5G Technologies - LNI241
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 evolution of technology, compare various mobile standards, frequency allocation and players in 5G.
2. Understand various new technologies for 5G systems and study their applications.
3. Analyze the importance of various technology and new architectures to realize 5G services.
4. write codes to implement algorithms and investigate improvements & limitations.
5. Explore advanced topics analyze and prepare a PPT presentation to classwork as small teams adhering to standard ethics, promoting entrepreneurial spirit to innovatively implement ideas

Unit-01

Definition of 5G, 5G Spectrum and standard, 5G Technical Specification (IEEE Documents), 5G – Vision and Challenges (IEEE Documents). BOOK 1.

10 Hours

Unit -02

5G Radio Access Networks Technologies for 5G – C-RAN, 5G RAN, Architecture and Application, Channel modelling, large scale Antenna, MIMO, OFDM. Book-2 & 3

10 Hours

Unit -03

Physical layer Communication Technologies, Massive MIMO fundamentals and Application
Article 8.2 to 8.6 from Book 5

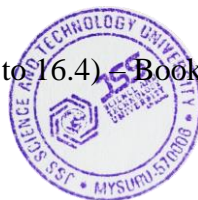
Full duplex protocol design for 5G Networks (Article 9.2 to 9.3, 9.4), Millimeter wave communication for 5G (Article 10.1, 10.2).

10 Hours

Unit-04

Network protocols & algorithms, Design of massive MIMO, Scheduling Protocols (Article 15.1, 15.2, 15.3)

Mobile data off-loading (Article 16.1 to 16.4) – Book 5



12 Hours

Unit-05

5G Access for IoT (article 17.1 to 17.8), M2M Communication (article 18.1 to 18.3),
SDN & NFV for 5G systems.

10 Hours

References:

1. 5G Spectrum and standards
2. **Wong Schober, NG and Wang**, "*Key Technologies for 5G wireless systems*".
3. Opportunities in 5G Networks: - CRC press
4. **Hrishikesh venkataraman and romona trestian**, "*5G Radio Access Networks*".
5. 5G Wireless Technologies or 5G outlook.



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

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

1. Identify the different sources of performance degradation on an optical link.
2. Evaluate the limitations of an optical link based on fiber and light source parameters.
3. Evaluate the performance of optical data transmission based on bit error rates.
4. Compute power budgets, dispersion limits and rise time budget.

Unit 1

Photonic sources: LEDs and laser diodes, Laser physics and operation. Characteristics of laser light, Laser technology. Spectral distribution. Coherence.

10 Hours

Unit 2

Modulation: Optical signal generation, Electro-optic effect, phase and intensity modulation, modulation formats, bit stream generation.

10 Hours

Unit 3

Signal propagation: Propagation of a Gaussian pulse, impact of dispersion and management, impact of losses. Medium induced distortions. **Amplification:** Doped fiber optical amplifiers, fiber Raman amplifiers, semiconductor optical amplifiers. Gain and rate equations, noise.

12 Hours

Unit 4

Signal recovery: Photo detectors and photonic receivers, noise sources, sensitivity, bit error rate. **Nonlinear effects:** Self-phase and cross phase modulation, solitons, four wave mixing, scattering processes.

10 Hours



Unit 5

Multichannel systems: WDM systems and components, OTDM.

10 Hours

References:

1. **Nishihara:** Integrated optics
2. **Govind P Agarwal:** Nonlinear 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

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

1. Define embedded systems and cyber-physical systems (CPS) and give examples
2. Understand various modelling formalisms for CPS, such as hybrid automata, state-space methods, etc.
3. Articulate CPS security and safety aspects
4. Analyze the basics of CPS implementation

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, State flow)

10 Hours

Unit 3

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

12 Hours

References:

1. **Rajeev Alur**, "*Principles of Cyber-Physical Systems*" THE MIT Press, 2015.
2. **E. A. Lee, Sanjit Seshia**, "*Introduction to Embedded Systems – A Cyber-Physical Systems Approach*" 1st Edition, 2011
3. **Andre Platzer**, "*Logical Foundations of Cyber-Physical Systems*" Springer.



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 – Internet of Things	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	IoT - Internet of Things – ECPGOL1
No. of Teaching Hours – 52	Credits: 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

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

1. Summarize on the term 'internet of things' in different Contexts.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Raspberry Pi/Arduino
4. Apply data analytics and use cloud offerings related to IoT.
5. Analyze applications of IoT in real time scenario

Unit 1

FUNDAMENTALS OF IoT: Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

10 Hours

Unit 2

IoT PROTOCOLS: IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN, Zigbee, RFID and NFC. Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks (AODV & DSR), Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP, MQTT, AMQP and XMPP.

10 Hours

Unit 3

DESIGN AND DEVELOPMENT: Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino, Board details, IDE programming, Raspberry Pi, Interfaces and Raspberry Pi with Python Programming.



10 Hours

Unit 4

DATA ANALYTICS AND SUPPORTING SERVICES: Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning – No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG.

10 Hours

Unit 5

CASE STUDIES/INDUSTRIAL APPLICATIONS: Cisco IoT system, IBM Watson

IoT platform, Manufacturing, Converged Plant wide Ethernet Model (CPwE), Power Utility Industry, Grid Blocks Reference Model, Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

12 Hours

References:

1. **David Hanes** “*IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*”, Cisco Press, 2017.
2. **Arshdeep Bahga, Vijay Madisetti,**” *Internet of Things – A hands-on approach*”, Universities Press, 2015.
3. **David Boswarthick** “*The Internet of Things – Key applications and Protocols*”, Wiley, 2012 (for Unit 2).
4. **Catherine Mulligan** “*From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence*”, Elsevier, 2014.
5. **Dieter Uckelmann**, “*Architecting the Internet of Things*”, Springer, 2011.



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

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

1. Explain the technical and physical principles of solar cells and solar collectors,
2. Measure and evaluate different solar energy technologies through knowledge of the physical function of the devices,
3. Make critical comparisons of different solar energy systems,
4. Communicate technological, environmental and socio-economic issues around solar energy in a concise and an accessible way to a target group with basic technical skills.

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, pyrliometer, 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 electric power plant, central tower receiver power plant.

12 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 course, student will be able to

1. Analyze algorithms for linear regression
2. Analyze algorithms for classification
3. Analyze algorithms for unsupervised clustering algorithms
4. Evaluate various ANN, CNN and deep learning architectures
5. Apply regression and classification algorithms using modern computing tools.

Unit 1

Introduction to Machine Learning, Regression Problem and Classification Problem: Applications, Linear Regression: Single variable(feature), Linear Regression: Multivariable (multiple features) Normal Method, Gradient descent method, Bias Variance Trade off, Regularization (Ritz and Lasso)

10 Hours

Unit 2

Linear Classification: Issues, Evaluation Measures: Confusion Matrix, Accuracy, Precision, Recall Features, Feature vectors, Principal Component Analysis, Discrimination, Fisher Discriminant Analysis (Two class, Multiclass), Logistic Regression, Neural network: Introduction to Rosenbalt Perceptron, Boolean functions using NN, Multi Layer Perceptron, Back propagation algorithm, Gradient Descent, Stochastic Gradient Descent, Universal Approximation Theorem, NN model selection criteria.

12 Hours

Unit 3

Bayesian Learning, Maximum Likelihood, Optimal classifier, Naïve Bayes Classifier, Hybrid Approach for Linearly non-separable data, Covers Theorem and related issues, Intro to Radial



Basis function networks, Clustering: Connectivity based, Centroid based, Distribution based, density based, graph based. RLS Algorithm.

10 Hours

Unit 4

Support vector Machine: Linearly separable pattern, Lagranges Optimization Technique (LOT), Applying LOT for SVM linearly separable case, Kernel functions, classifying linearly Not separable data using Kernel functions, Applying LOT for case of Linearly Not Separable data, Solving XOR problem using SVM kernel.

10 Hours

Unit 5

Introduction to Decision Tree Algorithm, Information Gain, Gini index, Ensemble Methods: Bagging, Boosting, Stacking, Random Forest Algorithm, Convolution Neural Network, Autoencoders, Deep Belief Networks (DBNs), Generative Adversarial Networks (GANs) Deep Learning Architectures LeNet 5, Alex Net, VGG 16, Inception, ResNet, ResNext, DenseNet

10 Hours

References:

1. **T. Hastie, R. Tibshirani, J. Friedman.** “*The Elements of Statistical Learning*”, 2e, 2009
2. **Christopher Bishop,** “*Pattern Recognition and Machine Learning*”. 2e., 2010
3. **Simon Haykin,** “*Neural Networks and Learning Machines*”, Pearson 3rd edition, 2008



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: need of 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 algorithms: 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).

10 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**, “*The Six Sigma Way: How GE, Motorola, 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

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

1. Understand diverse heuristic algorithms for solving hard optimization problems
2. Apply various optimization techniques in practice to solve problems
3. Evaluate the problems by adopting the heuristic algorithm

Unit 1

Introduction to evolutionary computation: Biological and artificial evolution, Evolutionary computation and AI, different historical branches of EC.

10 Hours

Unit 2

Genetic Algorithms: Coding, Search operators, Selection schemes, Applications.

10 Hours

Unit 3

Simulated Annealing: Theoretical Approaches, Parallelization, Applications. Tabu Search: Neighborhood, Candidate list, Short term and Long term memory, Applications.

12 Hours

Unit 4

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

10 Hours

Unit 5

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

10 Hours



References:

1. **Baeck T, Fogel D B & Michalewicz** “*Handbook on Evolutionary Computation*”, IOP Press
2. **Michalewicz** ,‘*Genetic Algorithms and Data Structures = Evolution Programs*’, Springer.
3. **Goldberg D E**,”*Genetic Algorithms in Search, Optimization & Machine Learning*”- Addison Wesley.
4. **Banzhaf W,Nordin P,Keller et al.**”*Genetic Programming :An Introduction*” Morgan Kaufmann .



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

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

1. Demonstrate the applicability of the concept of organizational behavior to understand the behavior of people in the organization.
2. Demonstrate the applicability of analyzing the complexities associated with management of individual behavior in the organization.
3. Analyze the complexities associated with management of the group behavior and financial in the organization

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.

12 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

References:

1. Robbins, S. P., & Judge, T. “*Organizational behavior*” 15th ed. Boston: Pearson, 2013.
2. Newstrom J. W., & Davis, K. “*Human behavior at work*”12th ed. Tata McGraw Hill, 2011.
3. Nelson, D , Quick, J.C., & Khandelwal, P., ORGB , Cengage Learning,2011.



Subject Name & Code	Deep Learning - ECPGOL7
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. Solve problems in linear algebra, probability, optimization, and machine learning.
2. Design convolution networks for handwriting and object classification from images or video.
3. Evaluate the performance of different deep learning models (e.g., with respect to the bias-variance trade-off, overfitting and underfitting, estimation of test error).

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 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 model: 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.

12 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 propagation through random operations, directed generative methods, generative stochastic methods, evaluating generative methods.

10 Hours

References:

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

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 Hours

Unit 2

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 Hours

Unit 3

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 Hours



Unit 4

MICROMACHINING: Silicon Anisotropic Etching – Anisotropic 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 of sacrificial Etch – Striction and Antistrication methods – Assembly of 3D MEMS – Foundry process.

12 Hours

Unit 5

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 Hours

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

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

1. Analyze ANN learning, Error correction learning, Memory-based learning, Hebbian learning, Competitive learning and Boltzmann learning.
2. Implement Simple perception, Perception learning algorithm, Modified Perception learning algorithm.
3. Analyze the limitation of Single layer Perceptron and Develop MLP with hidden layers

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 competition (IAC) and Constraint Satisfaction (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.

12 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.

