DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.Tech Program in

INDUSTRIAL ELECTRONICS

SCHEME I TO IV SEMESTER: 2021-2022

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SYLLABUS I TO IV SEMESTER: 2021-2022

Dean Academics
JSS STU, Mysuru

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

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

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.

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.

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.

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Teaching and Examination for M. Tech (Industrial Electronics)

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

SCHEME OF STUDY AND SYLLABUS FOR M. Tech in INDUSTRIAL ELECTRONICS 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	**14 credits**
Semester 4:		
	Project work and dissertation	**18 credits**
GRAND TOTAL		**88 credits**

<u>Academic schedule</u>:

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**

<u>CONTINOUS EVALUATION SCHEDULE FOR PROJECT WORK</u>

Event	**Credits**	**Marks**	**Schedule**
III Sem			
Industrial Training	04	100	Within 8th week
Synopsis Evaluation	10	50	Within 6th week
Mid-term Evaluation 1		50	Within 18th week
	Total	**200**	
IV Sem			
Mid-term Evaluation 2	18	200	Within 30th Week
Final internal seminar and demonstration			Within 40th Week
Report preparation			Within 44th Week
Evaluation of Project work External evaluation and Viva voce exam		200	Within 52nd Week
Declaration of results	**Total**	**400**	Within 54th Week

General guidelines:

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

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M. Tech in Industrial Electronics

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	LIE 130	Power Electronics	4	1	0	5	6	50	50	100	3 hours
4	LIE 140	Embedded Systems	4	1	0	5	6	50	50	100	3 hours
5	LIE 14X	Professional Elective 1	4	1	0	5	6	50	50	100	3 hours
6	LIE 15X	Professional Elective 2	4	1	0	5	6	50	50	100	3 hours
7	LIE 16L	Industrial Electronics Lab -1	0	0	1.5	1.5	3	50	-	50	-
8	LIE 17L	Design and implementation -1	0	0	1.5	1.5	3	50	-	50	-
		TOTAL				28	35	400	250	650	

Mandatory Courses-1

COURSE CODE	COURSE TITLE	CREDIT PATTERN
ECPGM11	Linear Algebra	3:0:0
ECPGM12	Graph Theory	3:0:0
ECPGM13	Data Analytics	3:0:0
ECPGM14	Transform Techniques	3:0:0
ECPGM15	Object Oriented Programming Using JAVA	3:0:0
ECPGM16	Advanced Microcontrollers and Applications	3:0:0
ECPGM17	Mathematical modeling and simulation	3:0:0

Mandatory Course - 2

COURSE CODE	COURSE TITLE	CREDIT PATTERN
ECPGM21	Technical report writing and documentation	2:0:0
ECPGM22	Research Methodology	2:0:0
ECPGM23	Sustainable technologies	2:0:0
ECPGM24	Social implications of technology	2:0:0
ECPGM25	Entrepreneurship and Project Management	2:0:0
ECPGM26	Electronic waste management	2:0:0
ECPGM27	Internet and Society	2:0:0

PROGRAM CORE COURSES: (Two courses from 1 to 5 will be offered among subjects, 6 and 7 are compulsory)

Sl. No	Code	Course Title	Credit Pattern
1.	LIE130	Power Electronics	4:1:0
2.	LIE140	Embedded systems	4:1:0
3.	LIE150	Smart materials	4:1:0
4.	LIE160	Electronic System Design and Manufacturing	4:1:0
5.	LIE170	Real Time Systems	4:1:0
6.	LIE16L	Industrial Electronics Lab -1	0:0:1.5
7.	LIE 17S	Design and implementation -1	0:0:1.5

PROGRAM ELECTIVES FOR INDUSTRIAL ELECTRONICS (LIE)

FIRST SEMESTER (Two electives to be chosen)

	Sl No	Code	Course Title	Credit Pattern
Professional Elective 1	**1**	LIE141	Advanced DSP	4:1:0
	2	LIE142	Mechatronics	4:1:0
	3	LIE143	Nano materials, Devices and Applications	4:1:0
Professional Elective 2	**1**	LIE151	Advances in VLSI	4:1:0
	2	LIE152	MEMS	4:1:0
	3	LIE153	Medical Electronics	4:1:0

M. Tech in Industrial Electronics

SI No	Code	Course Title	L	T	P	Total credits	Contact hours	CIE	SEE	Total Marks	Exam duration
1	LIE210	Digital control systems	4	1	0	5	6	50	50	100	3 hours
2	LIE220	Robotics and Industrial automation	4	1	0	5	6	50	50	100	3 hours
3	LIE 230	Automotive Electronics	4	1	0	5	6	50	50	100	3 hours
4	LIE 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	LIE 26L	Digital controls lab	0	0	1.5	1.5	3	50	-	50	-
7	LIE 27L	Design and implementation -2	0	0	1.5	1.5	3	50	-	50	-
		TOTAL				28	36	350	250	600	

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

Sl. No	Code	Course Title	Credit Pattern
1	LIE210	Digital control systems	4:1:0
2	LIE220	Robotics and Industrial automation	4:1:0
3	LIE230	Automotive Electronics	4:1:0
4	LIE240	Process Control Instrumentation	4:1:0
5	LIE250	Advanced Optical Systems	4:1:0
6	LIE 26L	Digital controls lab	0:0:1.5
7	LIE 27L	Design and implementation -2	0:0:1.5

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

Sl No	Code	Course Title	Credit Pattern
1	LIE241	Image processing using open CV	4:1:0
2	LIE242	Testing and Verification of VLSI circuits	4:1:0
3	LIE243	Operations Research and optimization	4:1:0
5	LIE244	Wearable Technologies	4:1:0
6	LIE245	Reconfigurable computing	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 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
ECPGOL4	Six Sigma and manufacturing	4:1:0
ECPGOL2	Solar Energy Systems	4:1:0
ECPGOL3	Machine learning	4:1:0

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

SEMESTER III

SI No	Subject Code	Course Title	No of Credits				Marks Allocated			Exam duration
			L	T	P	Total	CIE	SEE	Total	
1	LIE31T	Practical Training in Industrial / Exploration Research				4	100	-	100	
2	LIE32P	Project Phase - I				10	100	-	100	
		TOTAL				**14**	**Total Marks**		**200**	

SEMESTER IV

SI No	Subject Code	Course Title	No of Credits				Marks Allocated					Exam duration
			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**	

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

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

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

Unit 1

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

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

Unit 2

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

08 Hours

Unit 3

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

Unit 4

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

Unit 5

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

References:

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

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

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

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

Unit 1

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

Unit 2

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

Unit 3

Trees: Definitions and characterizations, Number of trees, Cayley's formula, Kircho-matrix-tree theorem, Minimum spanning trees, Kruskal's algorithm, Prim's algorithm, Special classes of graphs, Bipartite Graphs, Line Graphs, Chordal Graphs, Eulerian Graphs, Fleury's algorithm, Chinese Postman problem, Hamilton Graphs, Introduction, Necessary conditions and sufficient conditions. **08 Hours**

Unit 4

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

Unit 5

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

References:

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

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

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 – 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. **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 – Realtime Analytics Platform(RTAP) applications – case studies – real time sentiment analysis, stock market predictions. **10 Hours**

Unit 3

Frequent Item Sets and Clustering : Mining Frequent item sets – Market based model – A priori

Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent item sets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern based clustering methods – Clustering in non-Euclidean space – Clustering for streams and Parallelism. **10 Hours**

Unit 4

Frameworks and VisualizationMap Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – S3 – Hadoop Distributed file systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications. **10 Hour**

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 Pete Warden, Big Data Glossary, O'Reilly, 2011.
4. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.

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

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-plan e and S-plane correspondence. Inverse ZT, Properties of Z-transforms, Solution to linear difference equations, System transfer function.

08 Hours

Unit 5

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

08 Hours

References:

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

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

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

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

Unit 1

Object Oriented Programming Concepts– Abstraction – objects and classes – Encapsulation-Inheritance – Polymorphism. **08Hours**

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 **08Hours**

Unit 3

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

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. **08Hours**

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 **08Hours**

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, 10^{th} edition, 2014

NPTEL Course:

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

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

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

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

Unit 1:

Overview of Architecture & Microcontroller Resources: Architecture of a microcontroller – Microcontroller resources – Resources in advanced and next generation microcontrollers – 8051 Microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication – Interrupts. **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 Memory – Interfaces – 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 Kamal**, "*Microcontrollers Architecture, Programming, Interfacing and System Design*"– Pearson Education, 2005.
2. **Mazidi and Mazidi**, "*The 8051 Microcontroller and Embedded Systems*" – PHI, 2000.
3. **A.V. Deshmuk**, "*Microcontrollers (Theory & Applications)*" – WTMH, 2005.
4. **John B. Peatman**, "*Design with PIC Microcontrollers*" – Pearson Education, 2005.
5. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
6. The 8051 Microcontroller, Ayala, Cengage Learning.

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

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. **08 Hours**

Unit 2:

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

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. **08 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, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

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

References:

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

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

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) **08 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. **08 Hours**

Unit 3

Measuring and Benchmarking Sustainability - Sustainability proofing; Frameworks for measuring sustainability; Indicators of sustainability. **08 Hours**

Unit 4

Sustainability transitions “Technologies and Economic sectors/systems; Sustainability transition “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 **06Hours**

The Social Construction Of Facts And Artifacts, The Intersection Of Culture, Gender, And Technology

Unit 2

Technology and values **06Hours**

Amish Technology: Reinforcing Values And Building Community, Manufacturing Gender In Commercial And Military Cockpit Design

Unit 3

The complex nature of sociotechnical systems **06Hours**

Sociotechnical Complexity: Redesigning A Shielding Wall, Bodies, Machines, And Male Power

Unit 4

Visions of a technological future **06Hours**

Technology And Social Justice, Nanotechnology: Shaping The World Atom By Atom

Unit 5

Twenty-first-century challenges **06Hours**

Energy, Society, And Environment: Technology For A Sustainable Future, People's Science In Action: The Politics Of Protest And Knowledge Brokering In India

Reference:

Deborah G. Johnson and Jameson M. Wetmore, Technology and society: building our sociotechnical future , 2009 Massachusetts Institute of Technology

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 to 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", Heinnemann, 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, 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.

08Hours

Unit 2

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.

07 Hours

Unit 3

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.

07 Hours

Unit 4

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; The Bamako Convention. The Rotterdam Convention. Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union, Restrictions of Hazardous Substances (RoHS) Directive.

08 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.

08 Hours

Unit 2

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

07 Hours

Unit 3

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

07Hours

Unit 4

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

08 Hours

References:

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

Subject Name & Code	**Power Electronics LIE130**
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 the operation of power semiconductor devices, power electronic circuits and explore their applications.
2. Analyze power electronic circuits, derive important relations and interpret the results
3. Solve power electronic circuits and compute important performance parameters
4. Design power electronic circuits for the given specifications
5. Carry out a group task making use of simulation and analytical tools, document and give an effective presentation.

Unit 1

Power Semiconductor Devices: Introduction to Power Electronics, Construction of power semiconductor devices. Operation, switching characteristics, specifications of Power Diodes, Power BJTs, Power MOSFETs and IGBTs. Firing, Protection and base drive Circuits. Design of snubbers

10 Hours

Unit 2

DC-DC Switched -Mode Converters: Basic switching Regulator, Switched mode power supplies, Continuous and discontinuous conduction modes of non-isolated Buck, Boost and Buck-Boost Converters. Effect of converter non-idealities, Switch utilization factor, Buck and Boost derived isolated converters – single ended forward converter, Half-bridge, Full Bridge and Push pull converters. Isolated Cuk converters, Multi output converters **12 Hours**

Unit 3

DC-AC Switched -Mode Converters: Voltage Source, Current Source and Current Regulated, Principle of operation of half, full bridge single phase and three phase inverters. Performance Parameters – Voltage Control of Single Phase and three phase Inverters using various PWM techniques, Harmonics reduction techniques. **10 Hours**

Unit 4

Multilevel Inverters: Introduction, types, diode clamped multi-level inverters, features & applications. **10 Hours**

Unit 5

Resonant Converters: ZCS Resonant Switch Converter, ZVS Resonant Switch Converter, Series resonant inverter, Series resonant DC-DC Converter, Parallel resonant DC-DC Converter, Resonant Converter Comparison, Resonant DC link converter **10 Hours**

References:

1. Ned Mohan, Tore M Undeland& William P Robbins: ***Power Electronics - Converters, Applications and Design*** 3rd Ed, John Wiley, 2014.
2. Joseph Vithayathil : ***Power Electronics, Principles and Applications,*** McGraw Hill, 2013.
3. V.R Moorthi: ***Power Electronic Devices, Circuits & Industrial Applications***, Oxford University Press.
4. Daniel W. Hart: ***Power Electronics***, TATA McGraw Hill,2012.

Subject Name & Code	Embedded Systems LIE140
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 the basics of Embedded systems.
2. Know about various Devices and communication Protocols.
3. Get familiarized with Device drivers and Interrupts.
4. Understand program modeling, hardware software co-design and embedded firmware development.
5. Learn the basic concepts of RTOS.

Unit 1:

Introduction to Embedded Systems: Embedded systems, Processor Embedded into a system, Embedded Hardware Units and Devices in a system, Embedded Software in a system, Examples of Embedded Systems, Embedded SOC and use of VLSI Circuit Design Technology, Complex system Design and processors, Design Process in Embedded system, Formalization of System Design, Design Process and Design Examples. **10Hours**

Unit 2:

Devices and Communication Buses for Device Network: I/O types and examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing features in Device Ports, Wireless Devices, Timers and counting Devices, Networked Embedded Systems, Serial Bus Communication Protocols, Parallel Bus Device Protocols, Network Protocols, Wireless and Mobile system protocols. **12Hours**

Unit 3:

Device Drivers and Interrupt Service Mechanism: Programmed I/O Busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing mechanism, multiple interrupts, DMA, Device Driver Programming, EDLC. **10 Hours**

Unit 4:

Hardware Software Co-Design, Program Modeling, Embedded Firmware Design and Development: Fundamental Issues in Hardware Software Co-Design, Computational models in Embedded Design, Hardware Software tradeoffs, Embedded Firmware Design approaches, Embedded Firmware Development languages, Programming in Embedded C.

10 Hours

Unit 5:

RTOS based Embedded System Design: OS basics, Types of Operating Systems, Tasks, process and Threads, Multiprocessing and Multi tasking, Task Scheduling, Threads, Processes and Scheduling, Task Communication, Task Synchronization , Device Drivers, How to chose an RTOS. **10 Hours**

References:

1. Raj Kamal, " ***Embedded Systems Architecture, Programming and Design***" , 2nd Edition, TMH, 2008.
2. Shibu K V, " ***Introduction to Embedded Systems***", TMH, 2009.
3. James K Peckol, " ***Embedded Systems- A Contemporary Tool***" John Wiley, 2008

Subject Name & Code	Smart Materials and Applications LIE150
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. Discuss the properties of smart materials
2. Smart materials structural analysis
3. Application of smart materials in design of sensors and actuators.
4. Applications of smart materials to disciplines beyond Electrical and Mechanical engineering.

Unit 1

Overview of Smart Materials, Structures and Products Technologies. Physical Properties of Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magneto electric Materials. Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials, Fiber-Optic Sensors. **10 Hours**

Unit 2

Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Impact Hammers; MEMS Sensors; Sensor Arrays. Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; Fluidic Pumps; Motors. Smart Transducers: Ultrasonic Transducers; Sonic Transducers; Air Transducers.

10 Hours

Unit 3

Measurement, Signal Processing, Drive and Control Techniques in Quasi-Static and Dynamic Measurement Methods; Signal-Conditioning Devices; Constant Voltage, Constant Current and Pulse Drive Methods; Calibration Methods; Structural Dynamics and Identification Techniques; Passive, Semi-Active and Active Control; Feedback and Feed forward Control Strategies.

12 Hours

Unit 4

Design, Analysis, Manufacturing: Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering applications. **10 Hours**

Unit 5

Applications of Engineering Smart Structures and Products. Emphasis on structures, automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications products, as well as medical and dental tools and equipment.

10 Hours

References:

1. M. V. Gandhi and B. So Thompson, Smart Materials and Structures, Chapman & Hall, London; New York, 1992 (ISBN: 0412370107).

2. B. Culshaw, Smart Structures and Materials, Artech House, Boston, 1996 (ISBN: 0890066817).

3. A. V. Srinivasan, Smart Structures: Analysis and Design, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).

4. A. J. Molson and J. M. Herbert, Electro ceramics: Materials, Properties, Applications, 2nd Edition, John Wiley & Sons, Chichester, West Sussex; New York, 2003 (ISBN: 0471497479).

5. G. Gautschi, Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).

6. K. Uchino, Piezoelectric Actuators and Wtrasonic Motors, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).

Subject Name & Code	Electronic System Design and Manufacturing LIE160
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 students shall be able to:

1. Design, analyse and optimize automated flow lines and assembly systems.
2. Develop material handling systems industry application.
3. Generate automated process plans for intended products.

Unit 1

Manufacturing Systems- Components & classifications, Automation in manufacturing systems, principles strategies, mathematical models, costs. Single-station manufacturing cells. Automated flow lines: Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration. **12Hours**

Unit 2

Analysis of Automated flow lines: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines. Assembly system and line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines. **12Hours**

Unit 3

Automated material handling: Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems. Automated storage systems, automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing. **10Hours**

Unit 4

Group Technology- Part classification & coding, Computer Aided Process Planning (CAPP) - Retrieval & Generative type process planning system. **10Hours**

Unit 5

Case study : Study of Guide lines to build manufacturing unit **08Hours**

References

1. Automation, Production Systems and Computer Integrated Manufacturing- M.P. Groover, PHI.
2. Computer Control of Manufacturing Systems- Y. Coren, McGraw Hill. 2. CAD/CAM/CIM- Radhakrishnan& Subramanian, Wiley Eastern.

Subject Name & Code	Real Time Systems LIE170
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 the basic of real time scheduling
2. Analyze the real time scheduling approaches
3. design and development of protocols related to real-time communication.

Unit-1

Introduction Definition, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency. **10 Hours**

Unit-2

Real Time Scheduling Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Optimality of Effective-Deadline-First (EDF) and Least-Slack-Time-First (LST) Algorithms, Offline Versus Online Scheduling, Scheduling Aperiodic and Sporadic jobs in Priority Driven and Clock Driven Systems. **10 Hours**

Unit-3

Resources Access Control**:** Effect of Resource Contention and Resource Access Control (RAC), Nonpreemptive Critical Sections, Basic Priority-Inheritance and Priority-Ceiling Protocols, Stack Based Priority-Ceiling Protocol, Use of Priority-Ceiling Protocol in Dynamic Priority Systems, Preemption Ceiling Protocol, Access Control in Multiple-Unit Resources, Controlling Concurrent Accesses to Data Objects. **12Hours**

Unit-4

Multiprocessor System Environment Multiprocessor and Distributed System Model, Multiprocessor Priority-Ceiling Protocol, Schedulability of Fixed-Priority End-to-End Periodic Tasks, Scheduling Algorithms for End-to-End Periodic Tasks, End-to-End Tasks in Heterogeneous Systems, Predictability and Validation of Dynamic Multiprocessor Systems, Scheduling of Tasks with Temporal Distance Constraints. **10 Hours**

Unit-5

Real Time Communication Model of Real Time Communication, Priority-Based Service and Weighted Round-Robin Service Disciplines for Switched Networks, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, Communication in Multicomputer System, An Overview of Real Time Operating Systems. **10 Hours**

References:

1. Real Time Systems by Jane W. S. Liu, Pearson Education Publication.

2. Real-Time Systems: Scheduling, Analysis, and Verification by Prof. Albert M. K. Cheng, John Wiley and Sons Publications.

Subject Name & Code	**IE laboratory – 1 LIE16L**
No. of Teaching Hours – 30	**Credits: 0:0:1.5 L-T-P**
CIE Marks: 50	

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

1. Read, interpret data sheets, select parameters and design as per the given specifications.
2. Prepare the observation format, and experimental setup to carry out a systematic conduction and document the results.
3. Relate the knowledge of theoretical concepts and practical skills through an effective communication.
4. Demonstrate the necessary skills to use simulation / analytical / Design tools related to the course.
5. Able to work effectively as a team member and demonstrate skills related to time and resource management with an ethical behavior.

List of Experiments:

1. Design and testing of firing circuits for choppers.
2. Design and testing of firing circuits for Inverters.
3. Performance analysis of Single-phase bridge inverter for RL Load and voltage control by single pulse width modulation.
4. Performance analysis of practical chopper fed DC Drive system.
5. Simulation and performance analysis of buck, boost, Buck-boost converters (Basic Topology) and with R and R-L Load for continuous and discontinuous current modes.
6. Simulation and performance analysis of Forward and fly back converters (Basic Topology) with R and R-L Load.
7. Simulation and performance analysis of sinusoidal PWM inverters with R-L Load.
8. Simulation and performance analysis of series resonant DC-DC converter with R load.
9. Generation of firing signals for converters / inverters using digital circuits / microprocessors.
10. Simulation and analysis of MOSFET and BJT drive circuits.

References:

1. Muhammad H. Rashid: ***SPICE for Power Electronics and Electric Power*** 3rd Ed, CRC Press.
2. L Umanand : ***Power Electronics, Essentials and applications*** 1st Ed, Wiley & Sons.

Subject Name & Code	Design and Implementation Lab-1 LIE17L
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 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)
8. Prepare technical report on the findings of the work carried out.

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.

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Subject Name & Code	**Advanced DSP LIE141**
No. of Teaching Hours – 52	**Credits : 4:0:1 L-T-P**
CIE Marks: 50	**SEE: 100**

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

1. Design basic IIR and FIR filters.
2. model random signals as output of digital filters.
3. Understand, analyze and implement adaptive filters and algorithms.
4. estimate power spectrum of a random signal from a realization.
5. explain and use concepts of multirate DSP systems.

UNIT 1

DSP overview: Discrete time signals and systems, structures of DT systems, convolution, deconvolution, correlation, Z transform, Fourier transforms, DFT, radix-2 FFT algorithms, FIR and IIR filters. **10 Hours**

UNIT 2

Parametric Signal modeling, Pade Approximation, Prony's method, Linear Prediction, Properties of LP filters, Lattice filters, Wiener filters, AR and ARMA models, Levinson-Durbin Alogorithm. **12 Hours**

UNIT 3

Introduction to Adaptive filters, applications of adaptive filters, Steepest descent algorithm, LMS, Normalized LMS and RLS algorithms, Convergence issues. **10 Hours**

UNIT 4

Introduction to Power Spectrum Estimation, Periodogram, Non- Parametric methods: Bartlett's method, Welch's method, Blackman-Tukey, Parametric Methods: AR, MA, ARMA spectrum estimation. **10 Hours**

UNIT 5

Introduction to Multirate DSP, Decimation, Interpolation, Sampling rate conversion, Applications of Multirate signal processing, Digital filter Banks, Introduction to STFT and Wavelet transforms, Applications. **10 Hours**

References:

1. John G Proakis and Dimitris G Manolakis, ***Digital Signal Processing***, Fourth Edition, Pearson Education, 2007.
2. Monson H. Hayes, ***Statistical Digital Signal Processing and Modelling***", John Wiley & Sons, 2008.
3. P. P.Vaidyanathan,***Multirate Systems and Filter Banks***, Pearson Education, 2006
4. Shalini Apte, ***Advanced Digital Signal Processing*** , Wiley India Ltd, 2013.

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Subject Name & Code	**Mechatronics LIE142**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. To understand the importance of systems and the scope for the automation of systems
2. To learn about the integration of various engineering disciplines for designing and developing mechatronics system.
3. To understand the types of sensors and transducers and signal conditioning techniques in applications
4. To evaluate for various needs for electrical actuation adaptable in automation process
5. To have complete knowledge of Microprocessors and Microcontrollers in the development of automotive mechatronics applications with a view on the development of smart and intelligent controls in automotive systems

UNIT 1

OVERVIEW OF MECHATRONICS: What is Mechatronics? Integrated Mechatronic Design Approach, System Interfacing, Embedded Systems, Instrumentation and Control Systems, Open and closed loop systems, importance of feedback systems, Transfer function, Microprocessor-Based Controllers and Microelectronics. An Introduction to Micro-technology and Nanotechnology, Mechatronics: Miniaturized, Examples and applications.

SYSTEM MODELING: Importance of Modeling in System Design, Modeling of systems – Physical and Virtual Modeling for Mechatronic System Designs, Modeling of Mechanical Systems for Mechatronics Applications, Analysis and Synthesis, Virtual Modeling Tools. Analogies of System Modeling. **10 Hours**

UNIT 2

SENSORS AND APPLICATION: Introduction to Sensors , Classification of sensors, Sensor – Static and Dynamic Characteristics, Sensors, Linear and Rotational Sensors, Acceleration Sensors, Force Measurement, Torque and Power Measurement, Flow Measurement, Temperature

Measurements, Distance Measuring and Proximity Sensors, Light Detection, Use of RF, Infra-Red sensors in automobiles, Image, and Vision Systems, Integrated, Micro-sensors, Selection Criteria. SIGNAL CONDITIONING: Introduction to Signal conditioning, importance of protection, isolation, filters – types of filters, amplification – types of amplifiers, Signal conversion- ADC and DAC, use of Multiplexers and Multiple signal measurements. **10 Hours**

UNIT 3

ACTUATORS: Introduction to Actuators – Mechanical, Electrical and combinational actuators, Electro-mechanical Actuators, Electrical Machines, Piezoelectric Actuators, Hydraulic and Pneumatic Actuation Systems, Applications of few types of actuators in automobiles, ELECTRICAL ACTUATION SYSTEMS: Importance of actuators, classification of Actuators, Mechanical Switches, Bouncing and De-bouncing in Mechanical Switches, Principles of Solenoids and relays, Classification of motors, Application of various motors - Block Diagram - Spindle motors – basic principles, DC motors with field applications, brushless permanent magnet DC motors, Stepper motors, Solid State Switches: transistors, Darling ton pair, Thyristors, Triacs

12 Hours

UNIT 4

COMPUTERS AND LOGIC SYSTEMS**:** Introduction to Computers and Logic Systems, Logic design concepts and Design, System Interfaces, Communication and Computer Networks, Fault diagnosis and Analysis in Mechatronic Systems, Logic System Design, Synchronous and Asynchronous Systems, Sequential Systems, Control System Architecture, Control with Embedded Computers and Programmable Logic Control, Digital Signal Processing for Mechatronic Applications, Adaptive and Nonlinear Control System Features, Neural Networks and Fuzzy Systems, Artificial Intelligence and Expert System Approach to control System design, Design Optimization of Mechatronic Systems. **10 Hours**

UNIT 5

DATA ACQUISITION AND SOFTWARE DEVELOPMENT: Introduction to Data Acquisition, Measurement, Techniques, Data Acquisition systems, Importance of data acquisition in automobiles. Computer-Based Instrumentation Systems, Software Design and Development, Data Recording and Data Logging, DAQ for automotive engine system and other Measurements, Electronic Control Unit (ECU), Features of design and system logic in multiple signal measurements. **10 Hours**

References:

1. ***Mechatronics*** – W.Bolton, Longman, 2Ed, Pearson Publications, 2007.
2. ***Microprocessor Architecture, Programming & Applications With 8085/8085A*** – R.S. Ganokar, Wiley Eastern, 2008
3. ***Mechatronics – Principles,Concepts and Applications*** – Nitiagour and Premchand Mohalik – Tata McGraw Hill – 2003.
4. ***Measurement, Instrumentation, and Sensors Handbook*** - John G. Webster. Editor-in-chief, CRC Press. 1999. 0-8493-2145-X. PDF files online available at www.engnetbase.com
5. ***Mechatronics Principles & Applications*** by Godfrey C. Onwubolu, Elsevier.
6. ***Introduction Mechatronics & Measurement Systems,*** David.G. Aliciatore

Subject Name & Code	**Nano materials, Devices and Applications LIE143**
No. of Teaching Hours – 52	**Credits : 4:0:1 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon the completion of this course student should be able to:

1. Understand the fundamental concept of nanostructures, effects of nanometer length scale, top down/bottom up fabrication processes.
2. Identify different spectroscopic techniques with property measurement.
3. Understand inorganic semiconductor nanostructures, quantum confinement, epitaxial growth of quantum wells, physical processes and characterization.
4. Identify the methods of measuring properties-structure, self assembling nano structured molecular materials, nano magnetic materials and devices.
5. Identify emerging trends of nanomaterials and devices in various applications.

Unit 1: Introduction

Overview of nano science and engineering. Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale. Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nano systems. **10 Hours**

Unit 2: Characterization

Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk, surface, spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties. **08 Hours**

Unit 3: Inorganic semiconductor nanostructures

Overview of semiconductor physics, Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super lattices, band offsets, electronic density of states. Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved edge overgrowth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nano crystals, colloidal quantum dots, self-assembly techniques. Physical processes: modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural. **12 Hours**

Unit 4: Methods of measuring properties-structure: atomic, crystallography, microscopy, spectroscopy. Properties of nanoparticles: metal nano clusters, semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis (RF, chemical, thermolysis, pulsed laser methods) Carbon nanostructures and its applications (field emission and shielding, computers, fuel cells, sensors, catalysis). Self assembling nano structured molecular materials and devices: building blocks, principles of self assembly, methods to prepare and pattern nanoparticles, templated nanostructures, liquid crystal mesophases. Nanomagentic materials and devices.

12 Hours

Unit 5: Applications

Nanocomposite materials toward electrical and electronics applications, specialty polymer materials, structured carbon nanomaterials, nano magentic materials, emerging trends of nano materials and nano devices with their related applications. **10 Hours**

References:

1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, ***"Nanoscale Science and Technology",*** John Wiley and Sons Pvt. Ltd., 2007.
2. Charles P Poole, Jr, Frank J Owens ***"Introduction to Nanotechnology",*** John Wiley and Sons Pvt. Ltd., Copyright 2006, Reprint 2011.

3. Vinod Kumar Khanna, ***"Nanosensor: Physical, Chemical and Biological",*** CRC Press, Taylor Francis Group 2012.
4. Gregory L. Timp, ***"Nanotechnology",*** AIP Press, Springer 1999. Reprint 2005.
5. Jiri George Drobny, ***"Polymers for Electricity and Electronics",*** Wiley Interscience, 2012.
6. Rakesh K. Guptha, Elliot Kennel, Kwang- Jea Kim, ***"Polymer Nanocomposites Handbook",*** CRC Press, Taylor Francis Group 2010

Subject Name & Code	Advances in VLSI LIE151
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Understand the energy band diagram and small signal equivalent circuits of MESFET, MISFET and MOSFET
2. Analyze the SCE , processing challenges and understand the technology beyond CMOS
3. Construct and analyze different types of buffers, digital circuits
4. Design functional blocks using nMOS and CMOS
5. Understand the fundamental concepts of system design

Unit 1

MESFETS: MESFET and MODFET operations, quantitative description of MESFETS.

MIS structures and MOSFETS: MIS systems in equilibrium, under bias, small signal operation of MESFETS and MOSFETS. **10 Hours**

Unit 2: Short channel effects and challenges to CMOS: Short channel effects, scaling theory, processing challenges to further CMOS miniaturization

Beyond CMOS: Evolutionary advances beyond CMOS, carbon Nano tubes, conventional vs. tactile computing, computing, molecular and biological computing Mole electronics-molecular Diode **10 Hours**

Unit 3: Super buffers, Bi-CMOS and Steering Logic: Introduction, RC delay lines, super buffers- An NMOS super buffer, tri state super buffer and pad drivers, CMOS super buffers, Dynamic ratio less inverters, large capacitive loads, pass logic, designing of transistor logic, General functional blocks - NMOS and CMOS functional blocks. **10 Hours**

Unit 4: Special circuit layouts and technology mapping: Introduction, Talley circuits, NAND-NAND, NOR- NOR, and AOI Logic, NMOS, CMOS Multiplexers, Barrel shifter, Wire routing and module lay out. **12 Hours**

Unit 5: System design:CMOS design methods, structured design methods, Strategies encompassing hierarchy, regularity, modularity & locality, CMOS Chip design Options, programmable logic, Programmable inter connect, programmable structure, Gate arrays standard cell approach, Full custom Design. **10 Hours**

References:

1. Kevin F Brrnnan***: "Introduction to semi conductor device",*** Cambridge publications

2. Eugene D Fabricius: "***Introduction to VLSI design",*** McGraw-Hill International publications

3. D.A Pucknell: "***Basic VLSI design",***PHI Publication

Subject Name & Code	MEMS LIE152
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

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

1. Integrate the knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. Understand the rudiments of Microfabrication techniques.
3. Identify and understand the various sensors and actuators
4. Different materials used for MEMS
5. Applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

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 Flowsensors.

10 Hours

UNIT IV

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

12 Hours

UNIT V

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

10 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, editor, " 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	**Medical Electronics LIE153**
No. of Teaching Hours – 52	**Credits: 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Understand the origin of various bioelectric signals and issues related to its acquisition.
2. Acquire the knowledge on the acquisition of bioelectric signals and understand the applications of pacemakers and defibrillators.
3. Investigate the various lifesaving diagnosis and therapeutic instruments.
4. Describe the various patients monitoring system and understand the concept of telemedicine.
5. Acquire knowledge on the basic components and working principle behind different imaging modalities.

UNIT 1

Bioelectric Signals and Electrodes : Sources of biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems, Origin of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrodes – Electrode-tissue interface, Polarization, Skin contact impedance, Motion artifacts, Silver-Silver Chloride electrodes, Electrical conductivity of electrode jellies and creams. **10 Hours**

UNIT 2

Acquisition of Bioelectrical signals and Pacemakers: Electrodes for ECG, ECG leads, Effects of artifacts, Multi-channel ECG machine, Vector cardiograph, Phonocardiograph, Electrodes of EMG, Electrodes for EEG, 10-20 electrode systems, computerized analysis of EEG, Pacemakers & Defibrillator: Need for cardiac pacemaker, External pacemaker, Implantable pacemakers-types, Need for defibrillator, DC defibrillator, Automatic external defibrillator, Implantable defibrillators

10 Hours

UNIT 3

Diagnosis and Therapeutic Instruments: Spirometry: Basic spirometer, Ultrasonic spirometer, Ventilators, types, Modern ventilators, High frequency ventilators, Nebulizers, Artificial Kidney: Introduction, Dialyzers, Membranes for Hemodialysis, Hemodialysis machine, Oximetry, Blood flow measurement by Doppler imaging, Nuclear Magnetic Resonance& Laser Doppler flow meter.

12 hours

UNIT 4

Patient Monitoring Systems and Telemedicine: Cardiac monitor, Bedside patient monitoring system, measurement of heart rate-average and instantaneous heart rate meters, Measurement of pulse rate, Blood pressure measurement: Direct method, Indirect method-automatic pressure measurement using Korotkoff's method, Single channel telemetry systems, Multichannel wireless telemetry systems, Multi-patient telemetry, Telemedicine applications, Essential parameters for telemedicine, Telemedicine technology. **10 hours**

UNIT 5

Medical Imaging Systems: Basic components and working principle of X-rays, Ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI)& Radionuclide Imaging.

10 hours

References:

1. R.S.Khandpur,***Handbook of Biomedical Instrumentation***, 2nd Edition, Tata McGraw Hill, 2003
2. Kirk Shung, Michael Smith and Benjamin M.W Tsui, ***Principles of Medical Imaging***, Academic Press limited, 1992.
3. ***Biomedical Instrumentation and Measurement*** Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India.
4. Guyton & Hall,***Text Book Of Medical Physiology*,**11th edition, Saunders/Elsevier.
5. Joseph J. Carr and John M. Brown,***Introduction to Biomedical Equipment Technology*,** 4th Edition, Pearson Education, 2000.

6. Jerry L Prince and Jonathan M Links, **Medical Imaging Signals and Systems,**2nd Edition, Pearson/Prentice Hall of India, 2014.
7. ZhongHicho and Manbirsingh, **Fundamentals of medical imaging**, John Wiley.

Subject Name & Code	Digital Control Systems LIE210
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, student will be able to,

1. Analyze discrete time signals and systems using z-transforms
2. Analyze discrete time systems and evaluate their time response using transfer function and state-space model
3. Evaluate the stability of discrete time systems using algebraic methods, root locus technique and frequency domain plots
4. Design digital controllers using classical tools such as rootlocus, bode plots
5. Carry out a group task making use of simulation and analytical tools, document and give an effective presentation.

UNIT 1

Basic digital control systems, examples of digital control systems, revision of Laplace and Z-Transforms, solution of difference equations, solution of state equations; recursive and Z-Transform methods, similarity transformation, sampling, ideal sampler, evaluation of $E^*(S)$, properties of $E^*(S)$, zero order hold, first order hold and their frequency response.

10 Hours

UNIT 2

Open loop discrete time systems, relation between $E^*(S)$ and E (Z), pulse transfer function, modified Z-Transforms, systems with time delays, closed loop systems, transfer function using signal flow graph and block diagram reduction, system time response, system characteristic equation, mapping from S-Plane to Z-Plane, steady state error.

12 Hours

Unit 3

Stability, Lyapnov's method, Routh-Hurwitz and Jury's stability tests, stability analysis using root locus technique, effects of adding poles and zeros, stability analysis in frequency domain; Bode plot and Nyquist's plot. **10 Hours**

UNIT 4

Realization of digital systems, control and observer canonical forms, Jordan canonical form, tests for controllability and observability, Design of Digital controllers; Phase lag, phase lead, lag-lead and PID controllers.

10 Hours

UNIT 5

Design of State Variable Feedback Controller and Observer for Discrete Time Systems.

Case studies: Servo motor system, environmental chamber control system, Air craft landing system, Neonatal fractional inspired oxygen, Latest works from **two** refereed journals of IEEE competence

10 Hours

References:

1. Charles L. Phillips, H. TroyNagle,AranyaChakraborthy,***Digital Control Systems, Analysis and Design***, 4th Edition, McGraw Hill, 2014.
2. M. Gopal, Digital Control and State Variable Methods, Mc Graw Hill India, 2012
3. Gene F. Franklin, J. David Powell and Michael Workman, ***Digital Control of Dynamic Systems***, 3rd Edition, Ellis-Kagle Press, 2006.
4. John Dorsey, ***Continuous and Discrete Control Systems, Modeling, Identification, Design and Implementation***, McGraw Hill, 2002.
5. **Landau**, IoanDoré, **Zito**, Gianluca, ***Digital Control Systems: Design, Identification and Implementation***, Springer, 2006.

Subject Name & Code	**Robotics and Industrial Automation LIE220**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Understand the Robot anatomy, required background material for Robotics and to describe mathematically the position and orientation in 3-space.
2. Understand the kinematics and inverse kinematics of robot arms and solve related problems.
3. Investigate the kinematics of velocities and static forces and model the dynamics of manipulators.
4. Describe the motions of manipulators in terms of trajectories through space and understand the methods of controlling a manipulator.
5. Aquire knowledge on the state of the art in external robot sensors and the role of robots in industrial automation.

UNIT 1

Introduction to Robotics: Definitions, Laws of Robotics, Robot anatomy, Design and control issues, Manipulation and Control, Sensors and Vision, Programming Robots.

Coordinate Frames, Mapping and Transforms: Mapping Frames, Description of objects in Space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation Matrices. **10 Hours**

UNIT 2

Modelling of Robots: Direct Kinematics, Mechanical Structures and Notations, Description of Links and Joints, Kinematic Modeling of Manipulator, Denavit-Hartenberg notation, Kinematic Relationship between Adjacent Links, Manipulator Transformation Matrix. Inverse Kinematics, Manipulator Workspace, Solvability of Inverse Kinematic Model, Solution Techniques and Closed form Solution. **10 Hours**

UNIT 3

Manipulator Differential Motion and Statics: Linear and Angular Velocity of a Rigid body, Relationship between Transformation Matrix and Angular Velocity, Mapping Velocity Vector, Velocity Propagation along Links, Manipulator Jacobian, Jacobian Inverse and Singularities, Static Analysis.

Dynamic Modelling: Lagrangian Mechanics, Two-degree of Freedom Manipulator, Lagrange-Euler Formulation and Newton-Euler Formulation and their Comparison, Inverse Dynamics

12 hours

UNIT 4

Trajectory Planning: Definitions and Planning Tasks, Joint Space Techniques and Cartesian Space Techniques and their Comparison.

Control of Manipulators: Open and Closed loop control, Manipulator Control problem, Linear Control Schemes, Linear Second Order SISO Model of a Manipulator Joint, Joint Actuators, Partitioned PD Control.

10 hours

UNIT 5

Robotic Sensors and Vision: Meaning of Sensors, Sensors in Robotics, Kinds of Robotic Sensors, Robotic Vision, Applications of Vision-Controlled Robotic Systems. Process of Imaging, Architecture of Robotic Vision Systems, Image Acquisition and Other Components of Vision System.

Industrial Applications of Robots: Material Handling, Processing Applications – Arc Welding, Assembly Applications, Inspection Applications, Robot Safety. **10 hours**

References:

1. R. K. Mittal and I. J. Nagarath: ***Robotics and Control,*** 6th Reprint, Tata Mcgraw-Hill Education, Delhi 2007.
2. K. S, Fu, R. C. Gonzalez, and C. S. G. Lee: ***Robotics: Control, Sensing, Vision, and Intelligence,*** 8th Ed, Pearson Education 2007.
3. **John J. Craig: "***Introduction to Robotics: Mechanics and Control***",** 3rd Ed, Pearson Education, New Delhi 2006.

Subject Name & Code	Automotive Electronics LIE230
No. of Teaching Hours – 52	**Credits: 4:0:1 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Get familiar with electrical and electronic system in the vehicle.
2. Know about various types of bus systems and control units used in vehicles.
3. Learn the basics of sensors and know about various physical effects of sensors.
4. Understand sensor measuring principles and various types of sensors used in vehicles.
5. Know about various types of actuators, Hybrid Drives and EMC.

UNIT 1

Electrical and electronic systems in the vehicle: Overview, Motronic-engine management system, Electronic diesel control, Lighting technology, Electronic stability program, Adaptive cruise control, Occupant-protection systems. **08 Hours**

UNIT 2

Networking and bus systems: Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Examples of networked vehicles.

Architecture of electronic systems & Control Units: Overview, Vehicle system architecture. Control units: Operating conditions, Design, Data processing, Digital modules in the control unit and control unit software. **10 Hours**

UNIT 3

Automotive sensors: Basics and overview, Automotive applications, Sensor market, Features of vehicle sensors, Sensor classification, Error types and tolerance requirements, Reliability, Main requirements & trends, Physical effects for sensors, Selection of sensor technologies.

10 Hours

UNIT 4

Sensor measuring principles: Sensors for the measurement ofposition, speed, rpm, acceleration, pressure, force, and torque, Flow meters, Gas sensors and concentration sensors, temperature sensors, Imaging sensors.

Sensor types: Engine speed sensors, Hall phase sensors, Sensors for transmission control & wheel speed, Yaw-rate sensors, Pressure sensors, Temperature sensors, Accelerator-pedal sensors, Steering angle sensors, Position sensors, Axle sensors, Piezoelectric knock sensors, Air mass sensors, Acceleration sensors, Force & torque sensors, Rain/light sensors, Oxygen sensors.

12 Hours

UNIT 5

Actuators: Electromechanical & fluid mechanical actuators, Electrical machines

Hybrid drives: Drive concepts, Operating strategies for electric hybrid vehicles, Recuperative brake system, Electrical energy accumulators.

EMC and Interference suppression: EMC ranges, EMC between different systems in the vehicle, EMC between the vehicle and its surrounding, Guarantee of immunity and interference suppression. **12 Hours**

References:

1. Robert Bosch GmbH "*Automotive Electrics and Automotive Electronics*", 5th Edition, John Wiley & Sons Ltd, 2007.
2. William B. Ribbens "*Understanding Automotive Electronics*", 6th Edition, Elsevier, 2003.
3. Tom Denton "*Automobile Electrical and Electronic Systems*" , 3rd Edition, Elsevier, 2004.

Subject Name & Code	Process Control Instrumentation LIE240
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, student will be able to,

1. Discuss the process control Principles.
2. Describe the various sensors and its Instrumentation systems.
3. Describe the principles of analog & digital signal conditioning.
4. Apply digital control implementation strategies for process control using PLC's.
5. Explain different types of controllers and their modes of operations.
6. Apply the digital control principles to distributed control applications.

UNIT 1

Introduction to Process Control: Control Objectives & Benefits, Multi variable control system & Applications of Control Theory. Mathematical modeling and representation using Differential Equations. Concept of Process Control, Analysis & Modeling of Process Control Systems.

10 Hours

UNIT 2

Sensors: Thermal Sensors, mechanical sensors, optical sensors, final control elements

08 Hours

UNIT 3

Analog and Digital Signal Conditioning: Principle of analog and digital signal conditioning, Op-amp circuit in Instrumentation, converters, data acquisition systems

08 Hours

UNIT 4: Discrete State Process Control: Definition, characteristic of the system, relay controllers and ladder diagrams and PLC's

10 Hours

UNIT 5

Controller Principles: Process Characteristics, control system parameters, controller modes, analog controllers **08 Hours**

UNIT 6

Digital Control: Computers in process control, process control networks, Characteristic of digital data, controller software.

08 Hours

References:

1. Thomas E Marlin: Designing Process & Control Systems for Dynamic Performance – Tata McGraw-Hill, Second Edition 2012
2. Process Control Instrumentation Technology, Curtis D. Johnson, PHI **,** Eighth Edition.
3. John P. Bentley, Principles of Measurement Systems, Third edition, Addison Wesley Longman Ltd., UK, 2000.

Subject Name & Code	Advanced Optical systems LIE250
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, student will be able to,

1. Describe the fiber optical properties
2. Apply optical links for communication system
3. Design the optical link with various parameters and components

Unit 1

Ray theory transmission in optical fiber, Electromagnetic mode theory for optical propagation, Modes in a planar guide, phase shift and Evanescent field, Goos-Haenchen Shift, Signal distortion and attenuation, Kerr nonlinearity, self phase and cross phase modulation, dispersion flattened and dispersion compensated fibers, profile dispersion, study of Polarization mode dispersion (PMD)

10Hours

Unit 2

LEDs, semiconductor lasers, construction and their characteristics, optical confinement and carrier confinement, transmitter design, Photo detectors and their characteristics, PIN and APD photo detectors, receivers structures, sensitivity, Noise analysis in photo detectors. **10Hours**

Unit 3

Introduction, performance characteristics, Semiconductor laser amplifiers, Raman and Brillouin fiber amplifier, EDFAs, optical couplers, Mach-Zehnder interferometer, optical add/drop multiplexers, isolators, circulators, optical filters, diffraction grating, switches. **12Hours**

Unit 4

Transmitter circuit, LED drive circuits, laser drive circuits, optical receiver circuit: pre-amplifier and AGC, Equalizations, Digital system design considerations: regenerative repeater, optical transmitter and optical receiver, temporal losses, Optical power budgeting, analog system planning, Pulse analog techniques. **10Hours**

Unit 5

Optical TDM, subscriber multiplexing (SCM), WDM Optical networking: data communication networks, network topologies, MAC protocols, Network Architecture- SONET/SDH, optical transport network, optical access network, optical premise network. **10Hours**

References:

1. Optical fiber Communications Principles and practice by John M.Senior, 3rd Edition, 2010,
2. Pearson education Optical Fiber Communication by Gerd Keiser, 5th Edition, 2013, Tata McGraw Hills
3. Fiber Optic Communications Technology by Djafar K Mynbaev & Lowell L Scheiner, 3rd Edition, 2008, Pearson Education.

Subject Name & Code	**Digital Control Systems Lab (IE lab-2) LIE26L**
No. of Teaching Hours – 30	**Credits : 0:0:1.5 L-T-P**
CIE Marks: 50	

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

1. Demonstrate second order system characteristics
2. Develop and Verify Statespace model
3. Design and verify by simulation digital controllers for transfer function and state-space models
4. Demonstrate controller performance using Hardware.

List of Experiments:

1. Demonstrate standard second order system characteristics
2. Demonstrate steadystate error for type-0,1,2 systems
3. Develop transfer function model of DC motor; Discretize the model with ZOH. Compare outputs of both continuous time and discrtete time model
4. Develop state-space models of DC motor; One for angular position as output and one for angular velocity as output. Discretize the model with ZOH. Compare outputs of both continuous time and discrtete time models
5. Design a PID controller for DC Motor.
6. Design Phase-lead controller for DC Motor
7. Design state-variable feedback controller with reference gain.
8. Design closed-loop observer and verify combined system.
9. Design digital controller for DC Motor by Ragazzinis method.
10. Demonstrate controller performance for Quanser inverted pendulum

References:

1. **John Dorsey**, "*Continuous and Discrete Control Systems, Modeling, Identification, Design and Implementation*", McGraw Hill, 2002.
2. Landau**, IoanDoré,** Zito**, Gianluca**, "*Digital Control Systems: Design, Identification and Implementation,*" Springer, 2006.
3. **Charles Philips, Troy Nagle, James Brickley, Aranya Chakraborty, "***Digital Control System Analysis & Design***", Pearson 2014**

Subject Name & Code	Design and Implementation Lab-2 LIE27L
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	Image Processing Using Open CV LIE241
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

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

1. Describe the image acquisition concepts using sensors and machines.
2. Apply the spatial domain operations to process images.
3. Analyze different frequency domain techniques.
4. design image processing algorithms using open CV library.

UNIT 1

Digital Image Fundamentals: Elements of visual perception, Light and electromagnetic spectrum, image sensing and acquisition, Image sampling and quantization, Basic relationships between pixels. Introduction to Open CV, Basics, installation, libraries

Image Enhancement in Spatial Domain: Basic gray level transformations, histogram processing, equalization, enhancement, image subtraction, averaging, smoothing and sharpening using spatial filters and their combination. Image read write, enhancement in spatial domain using Open CV

12 hours

UNIT 2

Image Enhancement in Frequency Domain: 2dimentional DFT, correspondence between filtering in spatial and frequency domain, smoothing and sharpening using Butterworth and Guassian Lowpass and highpass filters, Convolution, correlation, FFT and IFFT in 2d. Image enhancement in frequency domain using Open CV **10 hours**

UNIT 3

Color image processing: Color models RGB, CMY, HSI, Color transformations, Smoothing and sharpening, Segmentation in HSI and RGB color space

Basic Morphological Algorithms: Dilation and erosion, Opening and closing, boundary extraction, region filling, extraction of connected components, thinning, thickening and pruning. Color image segmentation and morphological operations using Open CV

12 hours

UNIT 4

Image segmentation: Point, line and edge detection (Robert, Canny and Prewitt techniques). Character segmentation, circular object detection using Hough's transform. Segmentation using Open CV functions.

10 hours

UNIT 5

Case studies: Character recognition, Braile recognition, Signature matching, face detection problems from recent journals

08 hours

References:

1. Rafael Gonzalez, Richard Woods, ***Digital Image Processing***, 3rd Edition, Pearson India, 2008.
2. Anil K. Jain, ***Fundamentals of Digital Image Processing***, Economic Edition,Prentice Hall of India, 2004.
3. Gloria Bueno Garcia, Oscar Deniz Suarez, ***Learning Image Processing with OpenCV***, *Packt Publishing Limited, 2015.*

Subject Name & Code	Testing and Verification of VLSI Circuits LIE242
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Understand the fundamentals of testing and verification of VLSI circuits
2. Analyze the fault models using different types of faults
3. Understand the concepts of testing of memory
4. Analyze the different test methodologies
5. Apply the concepts of testing to VLSI circuits using scan based, BIST and boundary scan methods

UNIT 1

Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs. Fundamentals of VLSI testing. **10 Hours**

UNIT 2

Fault models: Functional vs structural testing, levels of fault models, single stuck faults
Automatic test pattern generation for combinational and sequential circuits

12 Hours

UNIT 3

Memory test: Test levels, fault modeling, memory testing

Delay test: Path delay test, test methodologies

Iddq testing: methods, limitations **10 Hours**

UNIT 4

Digital DFT and scan design: Design rules, tests for scan circuits, partial scan design

BIST: Random logic BIST, Memory BIST **10 Hours**

UNIT 5

Boundary scan standard: System configuration BSDL

system test and core-based design: Functional test, diagnostic test, testable system design, core based design . **10 Hours**

References:

1. M. L. Bushnell and V.D. Agrawal: " *Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits*", Springer, 2005

2. M. Abramovici, M. Breuer, and A. Friedman: " *Digital System Testing and Testable Design"*, IEEE Press, 1994

Subject Name & Code	Operations Research and Optimization LIE243
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Understand the importance and significance of OR concepts and techniques
2. Understand and apply the concepts of Linear Programming and applications by way of case studies.
3. Understand, analyse and apply Methods used in transportation and assignment problems and apply them to practical cases.
4. Understand and solve network optimisation problems, integer programming and model problems related to game theory
5. Develop an awareness and familiarity about recent trends, software tools and techniques in OR and optimisation

UNIT 1

Introduction to OR, OVERVIEW OF or Modeling approaches, Introduction to Linear Programming assumptions, problem formulation **10 Hours**

UNIT 2

Solving LP Problems, Simples method Computer implementation Other algorithms for Linear programming Dual simples, parametric, Upper bound and interior point algorithms.

12 hours

UNIT 3

Transportation and assignment problems. Network optimization methods examples, case studies. **10 Hours**

UNIT 4

BIP, Integer Programming branch and bound, constraint programming capacity assignments

10 Hours

UNIT 5

Game theory, solving simple games, Introduction to Queuing theory, distributions, applications

10 Hours

References:

1. Hiller and Lieberman: Introduction to Operations research eight edition TMH 2007
2. Hamdy Taha: Operations Research TMH 8th Edition
3. R. Pannerselvam: Operations Research TMH
4. Bronson and Naadimuthu : Operations Research - Schaum's Series , Tata McGraw Hill, 2nd Edition
5. Wayne Winston: Operations Research - Applications and Algorithms Cengage, 4th Edition

Subject Name & Code	**Wearable technologies LIE244**
No. of Teaching Hours – 52	**Credits : 4:1:0 L-T-P**
CIE Marks: 50	**SEE: 100**

Course outcomes: Upon completion of this course, student should be able to:

1. Study the present day wearable technologies
2. Design criteria for wearable technologies
3. Application of wearable technologies.

Unit 1

Issues on wearable technologies **10 Hour**

Unit 2

Wearable technology in health care **10 Hour**

Unit 3

Challenge in wearable technology **10 Hour**

Unit 4

Design criteria in wearable technology **12 Hour**

Unit 5

Applications of wearable technology in today's life **10 Hour**

References:

1. Nicola Carbonaro and Alessandro Tognetti **Wearable technologies, MDPI , 2018.**
2. **Refer journals related to topics**

Subject Name & Code	Reconfigurable Computing LIE245
No. of Teaching Hours – 52	Credits : 4:1:0 L-T-P
CIE Marks: 50	SEE: 100

Course outcomes: Upon completion of this course, student should be able to:

1. Describe the reconfigurable computation.
2. Analyze the coarse grained and fine grain configurability for performance enhancement.
3. Design and apply reconfigurable computing in various applications for optimization

Unit 1

Mapping algorithms into Architectures: Data path synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards. **10Hours**

Unit 2

Combinational network delay. Power and energy optimization in combinational logic circuit. Sequential machine design styles. Rules for clocking. Performance analysis. **10Hours**

Unit 3

Sequencing static circuits. Circuit design of latches and flip-flops. Static sequencing element methodology. Sequencing dynamic circuits. Synchronizers. **10Hours**

Unit 4

Data path and array subsystems: Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory. **12Hours**

Unit 5

Reconfigurable Computing- Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, Partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing. **10Hours**

References:

1. N.H.E.Weste, D. Harris, "CMOS VLSI Design (3/e)", Pearson, 2005.
2. W.Wolf, "FPGA- based System Design", Pearson, 2004.
3. S.Hauck, A.DeHon, "Reconfigurable computing: the theory and practice of FPGA-based computation", Elsevier,2008.

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

CO1: Summarize on the term 'internet of things' in different contexts.

CO2: Analyse various protocols for IoT.

CO3: Design a PoC of an IoT system using Raspberry Pi/Arduino

CO4: Apply data analytics and use cloud offerings related to IoT.

CO5: Analyze applications of IoT in real time scenario

UNIT I: 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.

08 Hours

UNIT II: 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.

12 Hours

UNIT III: **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 IV: 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.

12 Hours

UNIT V: 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.

10 Hours

References:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.
2. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
3. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).
4. "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Jan Ho¨ ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
5. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), 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, pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E).

10 Hours

Unit 3:

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

10 Hours

Unit 4:

SOLAR THERMAL ENERGY CONVERSION Thermodynamic cycles – Carnot – Organic, reheat, regeneration and supercritical Rankine cycles - Brayton cycle – Stirling cycle – Binary cycles – Combined cycles. Solar thermal power plants - Parabolic trough system, distributed collector, hybrid solar-gas power plants, solar pond based electricpower plant, central tower receiver power plant. **10 Hours**

Unit 5:

SOLAR ELECTRICAL ENERGY CONVERSION Solar photovoltaic energy conversion - Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants. **12 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*", Wiley VCH, 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

CO1: Analyze algorithms for linear regression

CO2: Analyze algorithms for classification

CO3: Analyze algorithms for unsupervised clustering algorithms

CO4 Evaluate various ANN, CNN and deep learning architectures

CO5 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)

08 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.

12 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

Text Books:

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

12 Hours

Unit 3:

Design for x: Introduction, design for manufacturing and assembly (DFMA), design for reliability (DFR), Design for manufacturability, design for serviceability, design for environmentality, design for life cycle cost (LCC). **08 Hours**

Unit 4:

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

Unit 5

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

10 Hours

References:

1. Kai Yang, Basem El-Haik, ***"Design for Six Sigma: A Road Map for Product Development",*** Tata McGraw Hill, 2003.

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

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

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 Programms*”, Springer.
3. **Goldberg D E**,”Genetic Algorithms in Search, Optimization & Machine Learning”- Addisson Wesley.
4. **Banzhaf W,Nordin P,Keller et al**.”*Genetic Programming :An Introduction*” Morgan Kaufmann
5. Tabu Search-Fred Glover

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

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.

10 Hours

Unit- 2

Motivation: The concept of Motivation-Early Theories of Motivation-Hierarchy of Needs theory-theory X and Theory Y-Hygiene theory-contemporary theories of motivation-ERG Theory-three needs theory-cognitive evaluation theory. **10 Hours**

Unit-3

Foundation of group behavior: Defining and classifying groups-group process-group tasks-cohesive groups-group dynamics-leadership-nature and importance-functions-styles-communications-nature and types-effective Communication-Roles of Formal and informal Communication-Conflict management-The process of conflict-types of conflict-functional and dysfunctional conflict-resolution of conflict. **12 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 networks

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

Unit 3:

Linear factor models

Probabilistic PCA and factor analysis, independent component analysis, slow feature analysis, sparse coding, and manifold interpretation of PCA. Auto encoders- auto encoders, regularized auto encoders, stochastic auto encoder- decoder, learning manifold with auto encoder, predictive sparse decomposition. **12 Hours**

Unit 4:

Representation learning

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

Unit 5:

Deep generative models

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

References:

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

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

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

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

2: Analyze the design considerations of sensors and actuators.

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

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

UNIT I

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

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

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

UNIT IV

MICROMACHINING: Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies Basic surface micromachining processes – Structural and Sacrificial Materials – Acceleration ofsacrificial Etch – Striction and Antistriction methods – Assembly of 3D MEMS – Foundry process. **12 hours**

UNIT V

POLYMER AND OPTICAL MEMS: Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene –Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS, Lenses and Mirrors – Actuators for Active Optical MEMS. **10 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.