JSS Mahavidyapeetha
JSS Science And Technology University
(Established Under JSS Science and Technology University Act No. 43 of 2013)
(Formerly Known as SJCE)

M.TECH PROGRAMME IN

AUTOMOTIVE ELECTRONICS

SCHEME I TO IV SEMESTER: 2020-2021

&

SYLLABUS I TO IV SEMESTER: 2020-2021

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

Scheme of Teaching and Examination for M. Tech (MAL)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

Scheme of Teaching and Examination for M. Tech (MAL)

SEMESTER	CREDITS
I	28
II	28
III	04
IV	28
TOTAL	88

SCHEME OF STUDY AND SYLLABUS FOR M. Tech in AUTOMOTIVE 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	**04 credits**
Semester 4:		
	Project work and dissertation	**28 credits**
GRAND TOTAL		**88 credits**

JSS MAHAVIDYAPEETHA

JSS SCIENCE & TECHNOLOGY UNIVERSITY, MYSURU

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

Scheme of Teaching and Examination for M. Tech (MAL)

SEMESTER: I

SL 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	**MAL110**	Design of Automotive Dynamics Systems	4	1	0	5	6	50	50	100	3 hours
4	**MAL120**	Digital Control Systems	4	1	0	5	6	50	50	100	3 hours
5	**MAL14X**	Elective 1 Group A	4	1	0	5	6	50	50	100	3 hours
6	**MAL15X**	Elective 2 Group B	4	1	0	5	6	50	50	100	3 hours
7	**MAL 16L**	Digital Control Systems Lab	0	0	1.5	1.5	3	50		50	-
8	**MAL17L**	Design and implementation -1	0	0	1.5	1.5	3	50		50	-
		TOTAL				**28**	**35**	**350**	**250**	**650**	

Mandatory Courses-1

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

Mandatory Course-2

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

PROGRAM CORE COURSES: (Two courses from among 1 to 4 will be offered)

Sl No	Code	Course Title	Credit Pattern
1	**MAL110**	Design of Automotive Dynamics Systems	4:1:0
2	**MAL120**	Digital Control Systems	4:1:0
3	**MAL130**	Automotive Software Engineering	4:1:0
4	**MAL140**	Automotive Materials	4:1:0
5	**MAL16L**	Digital Control Systems lab	0:0:1.5
6	**MAL17L**	Design and Implementation lab	0:0:1.5

PROGRAM ELECTIVES (Two electives to be chosen)

	Sl No	Code	Course Title	Credit Pattern
Group1	**1**	**MAL141**	Robotics Automation	4:1:0
	2	**MAL142**	Automotive Transmission	4:1:0
	3	**MAL143**	Advanced Embedded Systems	4:1:0
Group 2	**1**	**MAL151**	Chassis and Body Electronics	4:1:0
	2	**MAL152**	Vehicle Body Engineering & Safety	4:1:0

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SEMESTER: II

SL No	Code	Course Title	L	T	P	Total credits	Contact hours	CIE	SEE	Total Marks	Exam duration
1	**MAL210**	Hybrid Electric Vehicles (HEV's)	4	1	0	5	6	50	50	100	3 hours
2	**MAL220**	Vehicle Engineering	4	1	0	5	6	50	50	100	3 hours
3	**MAL230**	Automotive Instrumentation	4	0	1	5	6	50	50	100	3 hours
4	**MAL24X**	Elective 1	4	1	0	5	6	50	50	100	3 hours
5	**ECPGOLX**	Open Elective	4	1	1	5	6	50	50	100	3 hours
6	**MAL26L**	Computer Aided Design Lab	0	0	1.5	1.5	3	50		50	
7	**MAL27L**	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	**MAL210**	Hybrid Electric Vehicles (HEV's)	4:1:0
2	**MAL220**	Vehicle Engineering	4:1:0
3	**MAL230**	Automotive Instrumentation	4:1:0
4	**MAL240**	PLCs and Industrial Automation	4:0:1
5	**MAL250**	Design of Mechanical Systems	4:1:0
6	**MAL16L**	Computer Aided Design Lab	0:0:1.5
7	**MAL17S**	Design and implementation -2	0:0:1.5

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

Sl No	Code	Course Title	Credit Pattern
1	**MAL241**	Automotive Networking	4:1:0
2	**MAL242**	Emission & Control	4:1:0
3	**MAL243**	Automotive Electrical & Electronic system	4:1:0

LIST OF OPEN ELECTIVE COURSES:

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

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

Department of Electronics and Communication Engineering, SJCE, Mysore

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

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

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

Unit 1

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

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

Unit 2

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

08 Hours

Unit 3

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

Unit 4

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

Unit 5

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

References:

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

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

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

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

Unit 1: Introduction

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

Unit 2: Connected graphs and shortest paths

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

Unit 3: Trees

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

Unit 4: Independent sets coverings and matchings

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

Unit 5: Vertex Colorings

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

08 Hours

References:

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

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

Unit 1: Data Analysis

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

Unit 2: Mining Data Streams

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

Unit 3: Frequent Item Sets and Clustering

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

Unit 4: Frameworks and Visualization

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

References:

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

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

Unit 1:

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

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

Unit 2:

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

08 Hours

Unit 3:

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

Unit4:

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

Unit 5:

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

References:

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

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

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

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

Unit 1:

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

08 hours

Unit 2:

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

Unit 3

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

Unit 4

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

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

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

Unit 5

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

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

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

References:

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

NPTEL Course:

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

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

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

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

Unit 1:

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

Unit 2:

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

Unit 3:

Real Time Control: Interrupts: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline – Multiple sources of the interrupts – Non-maskable interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051. Timers: Programmable Timers in the MCU's – Free running counter and real time control – Interrupt interval and density constraints. **10 Hours**

Unit 4:

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

Unit 5:

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

10 Hours

References:

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

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

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

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

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

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

Unit 1

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

Unit 2

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

Unit 3: Report writing and presentations

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

Unit 4: Technical literature and report writing

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

Unit 5: Case studies and exercises

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

References:

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

E-Resources

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

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

Unit 1:

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

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

Unit 2:

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

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

Unit 3:

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

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

Unit 4:

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

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

References:

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

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

Topics covered:

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

References:

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

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

This course is divided into three main sections:

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

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

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

Reference: IEEE transactions on SIT

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

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

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

References:

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

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

Objective:

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

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

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

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

AUTOMOTIVE DYNAMIC SYSTEMS

Subject Code	**17MAL110**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	52+26	**Exam Marks**	**100**

Unit 1

INTRODUCTION TO ALTERNATIVE VEHICLES

Electric Vehicle, Hybrid Electric Vehicle, Electric and Hybrid Vehicle, Vehicle components, Electric and Hybrid History, EV/CEV Comparison. **4 Hrs.**

Unit 2

VEHICLE MECHANICS

Roadway Fundamentals, Laws of Motion, Vehicle kinetics, Dynamics of Vehicle Motion, Propulsion power, Velocity & Acceleration, Tire-Road Force, and Mechanics.

Unit 3

Alternative Vehicle Architecture: Electric Vehicles, Hybrid Electric Vehicle, Plug-in Hybrid Electric Vehicle, Power Train Component Sizing, Mass Analysis & Packaging, Vehicle Simulation. **8 Hrs**

Unit 4

Battery Energy: Batteries in Electric & Hybrid Vehicles, Battery basis, Battery parameters, Electromechanical Cell Fundamentals, Battery Modeling, Traction Batteries, Battery Pack Management. **6 Hrs.**

Unit 5

Alternative Energy Strategies: Fuel Cells, Ultra Capacitors, Compressed Air Storage, Fly wheels. **2 Hrs.**

Unit 6

Power Electronics Converters: Power Electronics Converters, DC/DC Converters, Cell Balancing Converters. **6 Hrs.**

Unit 7

Electric Machine: Simple Electric Machine, DC Machine, Induction Machine, Permanent magnet Machine, stepper motors, Switched Reluctance Machine. Electric Drive Components, DC Drives, Operating Point, Analysis of SRM Drives. **4 Hrs.**

Unit 8

Vehicle controls – cruise control ,Vehicle controls – active suspensions active suspensions antilock braking– traction control vehicle stability & rollover four wheel steering ,active safety **6 Hrs.**

Reference Book:

1. Gillespie, T., 1992, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers,
2. Wong, J.Y., 1993, Theory of Ground Vehicles, 2nd edition, Wiley, New York.,
3. Kiencke, U. and L. Nielsen, 2000, Automotive Control Systems, Springer-Verlag, Berlin, 2000,
4. Rajamani, R., Vehicle Dynamics and Control, Springer, 2006.,
5. Bosch, 2000, Automotive Handbook, 5th Ed.

DIGITAL CONTROL SYSTEMS

Subject Code	**MAL120**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	52+26	**Exam Marks**	**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.

10 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.

Automotive Software Engineering

Subject Code	MAL130	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	04 + 02	Exam Hours	3
Total No. of Contact Hours	52+26	Exam Marks	100

UNIT I

Introduction and Overview

Professional software development, Software Engineering Ethics, Software process models, Process Activities, coping with change, The rational unified process, The Driver-Vehicle-Environment system,

Overview of Vehicle Electronic systems, Overview of Logical system, Processes in vehicle development,

Methods and Tools for the development of software for Electronic systems

UNIT II

Essential System Basics

Open-Loop and Closed-Loop Control systems, Discrete systems, Embedded systems, Real-Time systems,

Distributed and Networked systems, System Reliability, Safety, Monitoring, and Diagnostics

UNIT III

Support Processes for Electronic Systems and Software Engineering

Basic definitions of system theory, Process models and standards, Configuration management, Project management, Subcontractor management, Requirements management, Quality assurance

UNIT IV

Core Processes for Electronic Systems and Software Engineering

Requirements and Prerequisites, Basic definitions and Notations, Analysis of User requirements and Specification of logical system architecture, Analysis of logical system architecture and specification of Technical system architecture, Specification of Software components, Design and implementation of software components, Software component testing, Integration of software components, System integration test, Calibration, System and acceptance test.

UNIT V

Methods and Tools for Development

Off board Interface between Electronic control units and tools, Analysis of logical system architecture and specification of technical system architecture, Specification of software functions and validation of specification, Design and implementation of software functions, Integration and Testing of software functions, Calibration of software functions

Text Books

1. Jorg Schauffele and Thomas Zurawka, Automotive Software Engineering Principles, Processes Methods and Tools, SAE International Publishers

2. Ian Sommerville, Software Engineering, Pearson, 9th Edition, 2011

Robotics and Automation

Subject Code	**MAL131**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

AIM

To provide comprehensive knowledge of robotics in the design, analysis and control point of view.

OBJECTIVES

i. To study the various parts of robots and fields of robotics.

ii. To study the various kinematics and inverse kinematics of robots.

iii. To study the Euler, Lagrangian formulation of Robot dynamics.

iv. To study the trajectory planning for robot.

v. To study the control of robots for some specific applications.

UNIT I

BASIC CONCEPTS

Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov's laws of robotics – dynamic stabilization of robots.

UNIT II

POWER SOURCES AND SENSORS

Hydraulic, pneumatic and electric drives – determination of HP of motor and gearing ratio – variable speed arrangements – path determination – micro machines in robotics – machine vision – ranging – laser – acoustic – magnetic, fibre optic and tactile sensors.

UNIT III

MANIPULATORS, ACTUATORS AND GRIPPERS

Construction of manipulators – manipulator dynamics and force control – electronic and pneumatic manipulator control circuits – end effectors – U various types of grippers – design considerations.

UNIT IV

KINEMATICS AND PATH PLANNING

Solution of inverse kinematics problem – multiple solution jacobian work envelop – hill climbing techniques – robot programming languages

UNIT V

CASE STUDIES

Multiple robots – machine interface – robots in manufacturing and non- manufacturing applications – robot cell design – selection of robot.

TEXT BOOKS

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill Singapore, 1996.

2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.

REFERENCES

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 1992.

2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.

3. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi, 1994.

4. McKerrow P.J. Introduction to Robotics, Addison Wesley, USA, 1991.

5. Issac Asimov I Robot, Ballantine Books, New York, 1986.

Automotive Transmission

Subject Code	**MAL132**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

OBJECTIVES

To impart basic knowledge to students with respect to transmission system of automobiles and impart knowledge that will enable the student to understand the latest developments in the field.

UNIT – I

Gear Box: method of calculation of gear ratios for vehicles, performance characteristics in different speeds, different types of gear boxes, speed synchronizing devices, gear materials, lubrication.

Fluid coupling: advantages and limitations, construction details, torque capacity, slip in fluid coupling, performance characteristics. Means used to reduce drag torque in fluid coupling.

UNIT – II

All spur and internal gear type planetary gearboxes, Ford T-model, Cotal and Wilson Gear box, determination of gear ratios, automatic overdrives.

UNIT – III

Principal of torque conversion, single, multi stage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives (e.g.) Leyland, White Hydro torque drives.

UNIT – IV

Automatic transmission: relative merits and demerits when compared to conventional transmission, automatic control of gears, study of typical automatic transmissions, Ford and Chevrolet drive, automatic control of gear box.

UNIT – V

Hydrostatic drives: advantages and disadvantages, principles of hydrostatic drive systems, construction and working of typical hydrostatic drives, Janney Hydrostatic drive.

Electrical drives: advantages and limitations, principles of Ward Leonard system of control Modern electric drive for buses and performance characteristics.

TEXT BOOKS

1.Heldt P.M - Torque converters- Chilton Book Co.-1992

2. Newton and Steeds - Motor Vehicle- Illiffee Publisher- 2000

REFERENCE

1. Design Practices, passenger Car Automotive Transmissions- SAE Hand book- 1994.

Advanced Embedded Systems

Subject Code	MAL133	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	04 + 02	Exam Hours	3
Total No. of Contact Hours	52+26	Exam Marks	100

UNIT-I

Typical Embedded System: Core of the Embedded System, Memory, Sensors and Actuators, Communication Interface, Embedded Firmware, Other System Components.

UNIT-II

Characteristics and Quality Attributes of Embedded Systems: Hardware Software Co-Design and Program Modeling: Fundamental Issues in Hardware Software Co-Design, Computational Models in Embedded Design, Introduction to Unified Modeling Language, Hardware Software Trade-offs.

UNIT-III

Embedded Hardware Design and Development:EDA Tools, How to Use EDA Tool, Schematic Design – Place wire, Bus , port, junction, creating part numbers, Design Rules check, Bill of materials, Netlist creation , PCB Layout Design – Building blocks, Component placement, PCB track routing.

UNIT-IV

ARM -32 bit Microcontroller family and Embedded Firmware Design and Development: Architecture of ARM Cortex M3 –General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register,. Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3. Exceptions Programming. Advanced Programming Features. Memory Protection. Debug Architecture. Embedded Firmware Design Approaches, Embedded Firmware Development Languages

UNIT-V

Real-Time Operating System (RTOS) based Embedded System Design and Development Environment: Operating System Basics, Types of OS, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, Task Communication, Task Synchronization, Device Drivers, How to Choose an RTOS The Integrated Development Environment (IDE), Types of Files Generated on Cross compilation, Disassembler/ELDompiler, Simulators, Emulators and Debugging, Target Hardware Debugging, Boundary Scan.

Reference Books:

[1]. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2009

[2]. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, Newnes, (Elsevier), 2008.
[3]. James K Peckol, “Embedded Systems – A contemporary Design Tool”, John Weily, 2008.

AUTOMOTIVE MATERIALS

Subject Code	**MAL140**	**No. of Credits**	**4 - 1 - 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

OBJECTIVE

To Impart knowledge on the structure, properties, treatment, testing and applications of metals and on non-metallic materials so as to identity and select suitable materials for various engineering applications.

Unit 1

Review(Not for Exam): Crystal structure – BCC, FCC and HCP structure – unit cell – crystallographic planes and directions, miller indices – crystal imperfections, point, line, planar and volume defects–Grain size, ASTM grain size number.

2 Hrs

Unit2

CONSITITUION OF ALLOYS AND PHASE DIAGRAMS

Constitution of alloys – Solid solutions, substitutional and interstitial – phase diagrams, isomorphous, eutectic, peritectic, eutectoid and peritectroid reactions, Iron – Iron carbide equilibrium diagram. Classification of steel and cast Iron microstructure, properties and application. **10Hrs**

Unit 3

HEAT TREATMENT

Definition – Full annealing, stress relief, recrystallization and heroidizing normalizing, hardening and Tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram CCR - Hardenability, Jominy end quench test – Austempering, martempering – case hardening, carburising, nitriding, cyaniding, carbonitriding – Flame and Induction hardening. **10 Hrs**

Unit 4

FERROUS AND NON FERROUS METALS

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V Ti & W) - stainless and tool steels – HSLA - maraging steels – Gray, White malleable, spheroidal -Graphite - alloy castirons. Copper and Copper alloys – Brass, Bronze and Cupronickel– Aluminium and Al-Cu – precipitation strengthening treatment – Bearing alloys. **10 Hrs**

Unit 5

NON-METALLIC MATERIALS AND COMPOSITES

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE Polymers – Urea and Phenol formal deliydes – Engineering Ceramics – Properties and applications of Al2O3, SiC, SiC, Si3, N4, PSZ and Sialon – Fibre and particulate reinforced composites. **10 Hrs**

Unit 6

MECHANICAL PROPERTIES AND TESTING

Mechanism of plastic deformation, slip and twinning Types of fracture – Testing of materials under tension, compression and shear loads – Hardness tests(Brinell, Vickers and Rockwell) Impact test Izod and charpy, fatigue and creeptest. **8 Hrs**

TEXT BOOKS

1. Kenneth G.Budinski and Michael K.Budinski "Engineering Materials" Prentice-Hall of India Private Limited, 4th Indian Reprint 2002.

REFERENCES

1.William D Callsber "Material Science and Engineering", John Wiley and Sons 1997.
2. Raghavan.V.Materials Science and Engineering, Prentice Hall of India Pvt.Ltd., 1999.
3. Sydney H.Avner "Introduction to Physical Metallurgy" McGraw-Hill Book Company, 1994.

Chassis & Suspension

Subject Code	**MAL141**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

Unit-I

Introduction to Chassis System

Introduction: Requirements of an automobile with types of automobiles, layout of an automobile with reference to power plant, power required for propulsion, various resistances to motion of the automobile. Frames: Types of frames, materials, calculation of stresses on sections, constructional details, loading points, testing of frames. Wheels and tyres: Types of wheels, construction. Structure and function of tyres.

UNTI-II

Steering systems

Types of steering gears, front axle. Under steer and over steer, wheel alignment, power steering, steering geometry, wheel balancing, centre point steering, steerability.

Unit-III

Brakes

Necessity of brake, stopping distance and time. Brake efficiency, weight transfer, brake shoe theory, determination of braking torque, braking systems -mechanical, hydraulic, disc, parking and emergency brakes, servo and electrical brakes, details of hydraulic system, mechanical system and components. Types of master cylinders, factors influencing operation of brakes such as operating temperature, lining, brake clearance, pedal pressure, linkages etc.

Unit-IV

Suspension

Types of suspension, leaf springs, materials, independent suspension, torsion bar, air bellows or pneumatic, suspension, hydraulic suspension, constructional details of telescopic shock absorbers, types, vibrations and riding comfort, role axis of spring suspension.

UNIT-V

Front Wheel Mounting, Rear Wheel Mounting, engine mounting, various types of springs used in suspension system. Requirements and various types, Material. Testing: Testing procedures, types of tests and chassis components, equipment for lab and road tests, preparation of test reports.

UNIT-VI

Two and three wheelers

Classification of two and three wheelers, construction details, construction details of frames and forks, suspension systems and shock absorbers, different arrangement of cylinders. Carburetion system and operation.

TEXTBOOKS

Automotive chassis and body -P. L. Kohli, TMH

Automobile engineering – Sudhirkumar – university science press

REFERENCES

Introduction to automobile engineering -N.R. Khatawate.Khanna pub.

Automotive mechanics -Joseph I heintner. Affiliated East West Press

Problems in Automobile Engineering -N.K.Giri, Khanna Pub

Automotive Chassis -P.M. Heldt, Chilton & Co.

Vehicle Body Engineering and Safety

Subject Code	MAL142	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	04 + 02	Exam Hours	3
Total No. of Contact Hours	52+26	Exam Marks	100

OBJECTIVE

At the end of the course, the students will be able to have a sound knowledge for the design of the vehicles body to give maximum comfort for the passengers and exposed to the methods of stream lining the vehicles body to minimize drag.

UNIT- I CAR BODY DETAILS 8

Types: saloon, convertibles, limousine, estate car, racing and sports car. Visibility: regulations, driver's visibility, tests for visibility, methods of improving visibility and space incars. Safety: safety design, safety equipment's for cars. Car body construction; design criteria, prototype making, initial tests, crash tests on full scale model, Dummies and Instrumentation

UNIT-II VEHICLE AERODYNAMICS 10

Objectives. Vehicle drag and types; various types of forces and moments, effects of forces and moments, side wind effects on forces and moments, Various body optimization techniques for minimum drag, wind tunnel testing: flow visualization techniques, scale model testing, component balance to measure forces and moments.

UNIT- III BUS BODY DETAILS 8

Types: mini bus, single decker, double-decker, two level and articulated bus. Bus body layout; floor height, engine location, entrance and exit location, seating dimensions. Constructional details: frame construction, double skin construction, types of metal sections used, Regulations, Conventional and integral type construction.

UNIT-IV COMMERCIAL VEHICLE DETAILS 9

Types of body; flat platform, drop side, fixed side, tipper body, tanker body, Light commercial vehicle body types. Dimensions of driver's seat relation to controls. Drivers cab design.

UNIT –V BODY MATERIALS, TRIM AND MECHANISMS 10

Steel sheet, timber, plastic, GRP, properties of materials; Corrosion, anticorrosion methods. Selection of paint and painting process.Body trim items.Body mechanisms.

UNIT –VI: **SAFETY DESIGN AND CONCEPTS** **8**

Design of the body for safety, engine location, deceleration of vehicle inside passengercompartment, deceleration on impact with stationary and movable obstacle, concept of crumble zone, safety sandwich construction. Active safety: driving safety, conditional safety, perceptibility safety, operating safety- passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact.

TEXT BOOK

1.J.Powloski - “Vehicle Body Engineering” - Business Books Ltd, London -1989

REFERENCES

1. Giles.J.C. - “Body construction and design” - Liiffe Books Butterworth & Co. - 1971.
2. John Fenton - “Vehicle Body layout and analysis” - Mechanical Engg. Publication Ltd., London – 1982.
3. Braithwaite.J.B. - “Vehicle Body building and drawing” - Heinemann Educational Books Ltd., London – 1977.

AUTOMOTIVE CONTROL SYSTEM LAB

Subject Code	**MAL 16L**	**No. of Credits**	**0 - 0 – 1.5**
No. of Lecture Hours / Week	**03**	**Exam Hours**	**-**
Total No. of Contact Hours	**39**	**Exam Marks**	**-**

Course Outcomes: Using MATLAB/SIMULINK/dSpace tools, student will be to

1. Analyze first and second order digital control systems.
2. Model and analyze DC/AC motors commonly used in automotive systems.
3. Study and calibrate various sensors in automotive systems
4. Design and implement digital controller for simple motor models.

List of Experiments

1. Analysis of first and second order analog/digital systems using MATLAB/Simulink.
2. Determination of transfer function of DC/AC motor.
3. Design of controller using root-locus and bode plots for a DC/AC motor on MATLAB/Simulink.
4. Measurement of parameters such as proximity, pressure, temperature and caliberation of appropriate sensors used in Automotives.
5. Design of controller and observer using state-space technique for position and velocity of DC motor MATLAB/Simulink..
6. Design of controller using state-space technique for position and velocity of brushless DC motor MATLAB/Simulink.
7. Light illumination control using dSpace tools.
8. Regular DC/Brushless DC motor control using dSpace tools.

TEXTBOOKS:

1 .J. P. Holman, ***Experimental Methods for Engineers***, McGraw Hill Education, 2001.

2. M. Gopal, **Digital Control and State Variable Methods,** McGraw Hill Education, 2012.

3.A. GalipUlsoy, HueiPeng, MelihCakmakci, ***Automotive Control Systems***, Cambridge University Press, 2012.

Hybrid Electric Vehicles

Subject Code	**17MAL210**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

Pre-requisites:

1. Control Systems Engineering.
2. Electrical Machines.
3. Power Electronics.

Course Objectives: At the end of the course the students will be able to;

CO1: Explain the knowledge of fundamental concepts, principles, and history of Hybrid and Electric vehicles.

CO2: Analyse the architectures of Hybrid and Electric Vehicles.

CO3: Explain the electric propulsion systems and their operation and maintenance.

CO4: Understand the energy storage elements like rechargeable battery types, energy storage devices and battery parameters.

CO5: Explain the principle, working and applications of alternative energy sources.

Unit 1:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles: General Description of Vehicle Movement, Vehicle Resistance, Dynamic Equation, Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed Vehicle Power Plant and Transmission Characteristics and Vehicle Performance.

Unit 2:

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Unit 3:

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit 4:

Energy Storage: Batteries in Electric and Hybrid Vehicles, Battery Basics and Parameters, Electrochemical Cell Fundamentals - electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Traction Batteries - lead acid batteries, nickel-based batteries, lithium-based batteries, Ultra-capacitors, Ultrahigh-Speed Flywheels and Hybridization of Energy Storages.

Unit 5:

Alternative and Novel Energy Sources and Stores: Solar Photovoltaic, Flywheels, and Fuel Cells - Hydrogen Fuel Cells, Fuel Cell Thermodynamics, Hydrogen storage system

Case Studies:

1. Power Electronics Converters: DC-DC Converters.
2. Rechargeable Battery Vehicles: Electric bicycles, Electric mobility aids, Low speed vehicles, Battery powered cars and vans.
3. Hybrid Vehicles: The Honda Insight, The Toyota Prius.

References:

1. **Iqbal Hussein,** Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. **Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi,** Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. **James Larminie, John Lowry,** Electric Vehicle Technology Explained, Wiley, 2003.

VEHICLE ENGINEERING

Subject Code	**MAL220**	**No. of Credits**	**4 -1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52 + 26**	**Exam Marks**	**100**

OBJECTIVE

To impact knowledge to students in various systems of Automobile Engineering and to have the practice for Assembling and Dismantling of Engine Parts.

Unit 1

VEHICLE STRUCTURE AND ENGINES

Types of Automobiles - Vehicle Construction – Chassis – Frame and Body –aerodynamics. Components of Engine – Their forms, Functions and Materials - Review of Cooling and lubrication systems in Engine – Turbo Chargers – Engine Emission Control by 3–Way Catalytic Controller – Electronic Engine Management System.

Unit 2

ENGINE AUXILIARY SYSTEMS

Carburetor–working principle- Electronic fuel injection system – Mono-point and Multi - Point Injection Systems – Construction, Operation and Maintenance of Lead Acid Battery - Electrical systems – Battery generator – Starting Motor and Drives – Lighting and Ignition (Battery, Magneto Coil and Electronic Type) -Regulators-cut outs.

Unit 3

TRANSMISSION SYSTEMS

Clutch – Types and Construction – Gear Boxes, Manual and Automatic – Simple Floor Mounted Shift Mechanism – Over Drives – Transfer Box Fluid flywheel-Torque convertors– Propeller shaft – Slip Joint – Universal Joints – Differential and Rear Axle – Hotchkiss Drive and Torque Tube Drive.

Unit 4

STEERING, BRAKES AND SUSPENSION

Wheels and Tyres – Wheel Alignment Parameters - Steering Geometry and Types of steering gear box Power Steering – Types of Front Axle – Suspension systems – Braking Systems – Types and Construction – Diagonal Braking System – Antilock Braking System.

Unit 5

ALTERNATIVE ENERGY SOURCES

Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles - Electric and Hybrid Vehicles, Fuel Cells.

Note: Practical training in dismantling and assembling of Engine parts Transmission System should be given to the students

TEXT BOOKS

1. Sethi H.M, “Automobile Technology”, Tata McGraw-Hill-2003

2. Kirpal Singh “Automobile Engineering Vol. 1& 2”, Standard Publishers, New Delhi.

REFERENCES

3.Crouse and Anglin “Automotive Mechanism”, 9th Edition. Tata McGraw-Hill, 2003.

4. Newton, Steeds and Garet, “Motor vehicles”, Butterworth Publishers, 1989.

5. Srinivasan.S , “ Automotive Mechanics” 2nd edition, 2003, Tata McGraw-Hill.

6. Joseph Heitner, “Automotive Mechanics”, 2nd edition, East-West Press, 1999.

AUTOMOTIVE INSTRUMENTATION

Subject Code	MAL230	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	04 + 02	Exam Hours	3
Total No. of Contact Hours	52+26	Exam Marks	100

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

1. To understand the philosophy of instrumentation concept applied to Automotive systems.
2. To understand the method of measurement of physical quantities, analyze the data & compute the uncertainty involved considering physical variables.
3. To develop Instrumentation systems involving parameters based on Force, Vibration, Temperature, Proximity, Displacement, Pressure.
4. To Understand & develop mathematical model of Instrumentation system based on concept of open & closed loop systems & to use the techniques, skills, and modern engineering tools necessary for engineering practice.
5. To develop Data acquisition system including communication protocols and to apply theory of metrology & understand mechanical measurement methods.

Unit 1

Basic concept of measurement, types of errors, standards, Device under calibration, calibration techniques, requirement of calibration laboratory, Analysis of measurement data, Uncertainty & Reporting the outcome of measurement process. **10 Hours**

Unit 2

Sensors, Actuators & systems. Static & Dynamic characteristics of sensors & systems including Frequency response, response time, damping, reliability. Generalized mathematical model of measurement system. Instrumentation system for measurement of Displacement, Strain, Vibration pressure, force & Torque Design of Instrumentation systems for a practical application using above sensors. Data acquisition systems using digital methods including PC based systems. **10 Hours**

Unit 3

Concept of open loop, closed loop control systems for a typical Instrumentation system. Mathematical analysis of first order & higher order systems for a typical practical Instrumentation system.Analysis of control system for a typical automobile. (Examples of Engine, Braking systems can be considered) **10 Hours**

Unit 4

Metrology: Standards, Slip gauges, Measurement of angles, tapers, threads. Mechanical inspection methods, Inspection of straightness, flatness, alignment & surface finish.

10 Hours

Unit 5

Specifying product features using mechanical, Pneumatic, Electronic & Optical methods. Use of Optical flats & Interferometer. **10 Hours**

TEXT BOOKS:

1. ***Experimental methods for engineers***: J. Holman 6th edition, McGrawhill
2. ***Instrumentation, Measurement & Analysis***: B.C.Nakra& K.K. Choudhary, TMH
3. ***Measurement systems, Application & Design***: E.O. Doeblin 4th edition, Mcgrahill
4. ***Mechanical measurement***: T.G.Beckwith, N.L.Buck& R.D. Martangoni, 3rd edition, Narosa Publishing House.
5. ***Metrology for Engineers***: J.W.F Gallies&C.R.Shotbolt
6. ***PC based Instrumentation- Concepts & practice***: N.Mathivanan PHI

PLCS AND INDUSTRIAL AUTOMATION

Subject Code	**MAL240**	**No. of Credits**	**4 - 0 - 1**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	52+26	**Exam Marks**	**100**

Unit 1

Introduction: What Is A PLC, Technical Definition Of PLC, What Are Its Advantages, Characteristic Functions Of A PLC, Chronological Evolution Of PLC, Types Of PLC, Unitary PLC Modular PLC, Small PLC, Medium PLC, Large PLC, Block Diagram Of PLC, Input / Output (I / O) Section, Processor Section, Power Supply, Memory, Central Processing Unit, Processor Software / Executive Software, Multitasking, Languages, Ladder Language., **6 Hrs**

Unit 2

BIT LOGIC INSTRUCTIONS : Introduction, Input And Output Contact Program , Symbols, Numbering System Of Inputs And Outputs, Program Format, Introduction To Logic, Equivalent Ladder Diagram Of AND Gate, Equivalent Ladder Diagram Of OR Gate, Equivalent Ladder Diagram Of NOT Gate, Equivalent Ladder Diagram Of XOR Gate, Equivalent Ladder Diagram Of NAND Gate, Equivalent Ladder Diagram Of NOR Gate, Equivalent Ladder Diagram to demonstrate De Morgan Theorem, Ladder Design.

8 Hrs

Unit 3

PLC TIMERS AND COUNTERS

Timer And Its Classification, Characteristics Of PLC Timer, Functions In Timer, Resetting – Retentive And Non-Retentive, Classification Of PLC Timer, On Delay, And Off Delay Timers, Timer-On Delay, Timer Off Delay, Retentive And Non-Retentive Timers, Format of a Timer Instruction. PLC Counter, Operation Of PLC Counter, Counter Parameters, Counter Instructions. Overview, Count Up (CTU),Count Down (CTD). **6 Hrs**

Unit4

ADVANCED INSTRUCTIONS

Introduction, Comparison Instructions, Discussions On Comparison Instructions, Addressing Data Files, Format Of Logical Address, Addressing Format For Micro logic System, Different Addressing Types. Data Movement Instructions, Logical Instructions. Mathematical Instructions. Main Features of Mathematical Instructions. Special Mathematical Instructions, Scale with Parameters or SCP Instruction. Data Handling Instructions Main Features Of Data

Handling Instructions. Program Flow Control Instructions. Proportional Integral Derivative (PID) Instruction. **8 Hrs**

Unit 5

PLC INPUT OUTPUT (I/O) MODULES AND POWER SUPPLY

Introduction, Classification Of I/O, I/O System Overview, Practical I/O System And Its Mapping, Addressing Local And Expansion I/O, Input-Output Systems, Direct I/O Parallel I/O Systems, Serial I/O Systems, Sinking And Sourcing, Sourcing and Sinking in PLC Interfacing, Discrete Input Module, Discrete DC Input Module, Discrete AC Input Module, Rectifier with Filter, Threshold Detection, Isolation, Logic Section, Specifications Of Discrete Input Module Discrete Output Modules, Advantages And Disadvantages Of Output Modules, Specifications Of Analog Input Module , Types Of Analog Input Module, Special Input Modules, Analog Output Module I/O Modules In Hazardous Locations, Power Supply Requirements Filters. 1**0 Hrs**

Unit 6

INDUSTRIAL COMMUNICATION AND NETWORKING

Introduction, Evolution Of Industrial Control Process, Types Of Communication Interface, Types Of Networking Channels, Parallel Communication Interface. Serial Communication Interface, Synchronous And Asynchronous Transmissions Compared, Standard Interface, Different Recommended Standards Compared, Software Protocol, Industrial Network. Network Topology, Media Access Methods, Open System Interconnection (OSI), Network Model, Network Components, Control Network Issues, Advantage Of Standardized Industrial Network, Intelligent Devices, Industrial Network Bus Network, Device Bus Network Vs. Process Bus Network, Controller Area Network (CAN), Device net, Control net, Ethernet Protocol , AS-I Interface, FOUNDATION FIELDBUS, Application Of Profibus For Real PLC Communication. **8 Hrs**

Unit 7

INDUSTRIAL AUTOMATION

Introduction, Utility of Automation, General Structure Of An Automated Process, Examples of Some Simple Automated Systems, Selection of PLC. **4 Hrs**

References:

1. **MadhuchhandaMitra and SamarjitSen Gupta, "***Programmable Logic Controllers (PLC)and Industrial Automation***", Penram International Publishing (India) Pvt. Ltd. 2007. ISBN: 81-87972-17-3.**

Design of Mechanical Systems

Subject Code	**MAL250**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

COURSE OUTCOMES: Upon completion of the course, students shall be able to,

1. Apply basic stress and strain analysis techniques to design machine elements.
2. To learn to use standard practices in selection of materials to design machine elements.
3. Utilize standard failure theories and fatigue analysis to develop safety factors for machine elements.
4. To learn to use standard practices in design of automobile machine elements and standard data.
5. Function effectively within engineering work teams.

Unit 1

Design cycle, stress analysis and types of loads, theories of failure . Design for variable loads: Endurance limit, Good's man and soderberg criteria, example problems.

Unit 2

Design of shafts: Causes of failure, materials, ASME code, design of shafts for fatigue loading considering the rigidity and stiffness. Design of clutches and brakes- calculation of heat generation and heat dissipation.

Unit 3

Gears: Gear tooth geometry, tooth systems, gear trains, design of spur gear, helical gear, bevel and worm gears from strength and wear considerations.

Unit 4

Introduction to Flywheel, Flywheel design: Bearings and lubrications, hydrodynamic theory, selection Procedure of antifriction bearings and journal bearings.

Unit 5

Hydrostatic bearings, design of Hydrostatic bearing, design factors, concept of concurrent and simultaneous engineering, example problems.

TEXT BOOKS/REFERENCE BOOKS

1. Mechanical engineering design by Joseph Edward shigly
2. Machine design by pc Sharma and D K Aggrawal, New edition.
3. Machine design by B V Bhandari.

Automotive Networking

Subject Code	MAL241	No. of Credits	4 - 1 – 0
No. of Lecture Hours / Week	04 + 02	Exam Hours	3
Total No. of Contact Hours	52+26	Exam Marks	100

Course outcomes: At the end of the course, the student have the ability to

1. Establish the need of Networking in an Automobile

2. Explain and analyze the principles and functionalities of various Automotive Communication Protocols (ACPs)

3. Design, simulate, emulate and analyze CAN and LIN based automotive embedded networks

4. Design ACP based In-Vehicle Networks (IVNs)

5. Proficiently use CANoe tool to develop IVN applications as well as to simulate, analyze and Troubleshoot ACP based IVNs

UNIT I: Basics of Data Communication Networks and Automotive Communication Protocols:

Need for networks, Types of networks, Need for standards, TCP/IP model, Topologies, Error detection and correction mechanisms, Encoding schemes, Serial/parallel transmission, Bits, Baud and bandwidth, Synchronous and asynchronous, Need and benefits of IVN, Classes of IVN protocols, Multiplexed electrical systems, Vehicle multiplexing, Bitwise contention, Network elasticity, Error processing and management and Case Study

10 Hours

UNIT II: Controller Area Network (CAN) Protocol:

History and foundation of CAN, CAN Applications, Main characteristics of CAN, CAN in OSI Reference Model, CAN Data Link Layer, Principles of data exchange in CAN, Arbitration, Data Frame, Remote Frame, Error detection and management in CAN, CAN physical Layer, Bit encoding, Bit timing and synchronization, Relationship between data rate and bus length, Single wire and twin wire media, CAN repeaters, Medium-to-medium gateway, Protocol handlers, Micro-controllers and line drivers, TimeTriggered CAN (TTCAN), Comparison with other IVN protocols, CANoe based applications development

10 Hours

UNIT III: CAN Higher Layer Protocols and LIN:

CAN Higher Layer Protocols: CAN in Automation (CiA), CANopen, CANopen device model, CANopen features, DeviceNet, DeviceNet Model, Device Object Model, DeviceNet Features, SAEJ1939, SAE J1939 Reference Model, CAN Kingdom and Case Study Local Interconnect Network (LIN) Protocol: Introduction to LIN, LIN consortium, LIN specification, LIN features, Technical overview, Work flow concept, LIN operation, LIN frame format, Scheduling table, Network management of LIN cluster, LIN Transport Layer, LIN node configuration and identification

10 Hours

UNIT IV: FlexRay and MOST Protocol:

FlexRay Protocol: Future on board systems, Need for FlexRay, Origin of FlexRay, FlexRay consortium, FlexRay Objectives, FlexRay Features, Application requirements, Working of FlexRay, Network topologies, ECU architecture, Segment Configuration, Communication Cycles, FlexRay frame format, Timing of configuration protocol, Error control, and FlexRay core mechanisms, Coding and Decoding, Medium Access Control, Frame and Symbol Processing, Clock Synchronization, FlexRay Components, Comparison with other IVN protocols and Case Study

Media Oriented System Transport (MOST) Protocol: Emerging in car systems, Introduction to MOST, MOST goals, Features, Cables and Connectors, Data Types, Topology, Frame Format, Application Areas, System Description, Specification, Device Model, Device Implementation, Diagnostics and Case Study **10 Hours**

UNIT V: In Vehicle Network Diagnostics:

Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study **10 Hours**

Reference Books:

1. Gilbert Held. Inter- and Intra-Vehicle Communications, CRC Press, (2007)

2. Behrouz Forouzan. Data Communications and Networking, McGraw-Hill. 2003

3. Ronald k. Jurgen. Automotive Electronics Handbook, McGraw-Hill. 1999

EMISSION & CONTROL

Subject Code	**MAL242**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

Unit-I

Engine Maintenance:

Engine troubles, effects & remedies, different major & minor services for engine, inspection and checking of components visually and dimensionally, reconditioning methods of engine components, engine tune-up, special tools & advanced equipment's.

Unit-II

Chassis Dive-line Maintenance:

Maintenance, repair and servicing of clutches, Fluid flywheel, gear boxes, Automatic transmission, CVT unit, propeller shaft, differential unit, front axle and rear axle, suspension systems, servicing of brake systems- hydraulic, air systems, brake bleeding and brakes adjustments, maintenance and servicing of steering system-Manual & Power Steering system, wheel balancing, wheel alignment, maintenance of tyres, tyre rotation, frame defects, chassis frame alignment.

Unit-III

Maintenance, servicing of auxiliaries:

Cooling system service, anti-corrosion additives, anti-freezing solutions, dry & wet liners, Petrol

Fuel and diesel fuel system maintenance, MPFI maintenance, lubrication system services, Chassis lubrication, lubrication chart, maintenance and care of storage batteries, battery testing methods, maintenance of ignition systems, tyre service & reconditioning.

Unit-IV

Air Pollution due to Automobile Exhaust:

Sources of Emission, Exhaust gas constituents & analysis, Ingredients responsible for air pollution, Smoke , odour, Smog formation, Sources of pollution, effects, Analysis of air pollutants, Air pollution control models and equipment's.

Unit-V

Exhaust Emission Control:

Basic method of emission control, catalytic converter, after burners, reactor manifold, air injection, crank case emission control, evaporative loss control, Exhaust gas recirculation,

Fuel additives. Pollution Norms : European pollution norms, Indian pollution norms as per Central Motor Vehicle Rules (C.M.V.R.).Characteristics of solid waste, Potential methods of solid waste disposal, Energy recovery from municipal and Industrial solid waste.

Reference Books:

1. Mechanics of Road Vehicles – W. Steed, Illefe Books Ltd. London
2. Automotive Chassis – P. M. Heldt, Chilton Co. NK
3. I. C. Engine – Litchy
4. I. C. Engine – Obert
5. Introduction to Internal Combustion Engines", Richard Stone, McMillan, London
6. Vehicle and Engine Technology – Hein Heister
7. Advance Vehicle Technology - Hein Heister
8. S. I. Engine – Fuel Injection Development - Charles A. Fisher, Chapman & Hall
9. Automotive Engines - Herbert E. Ellinger
10. Automobile Engg. Volume – I - American Technical Society, Chicago
11. Internal Combustion Engines Fundamentals – John B. Heyhood, McGraw Hill
12. Environmental Engineering, H.S.Peavy, D.R.Rowe, G.Tchobanoglous, McGrawHill Book Company, New York.
13. Introduction to Environmental Engineering and Science, G. Masters, PrenticeHall International Editions.
14. Environmental Considerations in Energy Development, Asian Development Bank (ADB) Manila.

Automotive Electrical & Electronic system

Subject Code	**MAL243**	**No. of Credits**	**4 - 1 – 0**
No. of Lecture Hours / Week	**04 + 02**	**Exam Hours**	**3**
Total No. of Contact Hours	**52+26**	**Exam Marks**	**100**

Course outcomes: At the end of the course, the student have the ability to

1: Understand and explain fundamentals of automotive electrical and electronics systems.

2: Apply the various concepts of electrical and electronics to small vehicle system.

3: Analyze the design considerations of various engine control systems in automotive electrical and electronics.

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

Unit 1

Batteries: Principles and construction of lead-acid battery. Characteristics of battery, rating capacity and efficiency of batteries. Various tests on battery condition, charging methods. Constructional aspect of alkaline battery. **6 Hrs**

Unit 2

Starting System: Condition at starting. Behavior of starter during starting. Series motor and its characteristics. Principle & construction of starter motor. Working of different starter drive units, care and maintenance of starter motor. Starter Switches. **6 Hrs**

Unit 3

Charging System: Generation of direct current. Shunt generator characteristics. Armature reaction. Third brush regulation. Cut-out. Voltage and current regulators. Compensated voltage regulator alternators principle & constructional aspects and bridge benefits.

6 Hrs

Unit 4

Ignition, Lighting Systems and accessories : Types, Construction & working of battery coil and magneto ignition systems. Relative merits, Centrifugal and vacuum advance mechanisms, types and construction of spark plugs, electronic ignition systems. Lighting System & Accessories: Insulated & earth return systems. Positive & negative earth systems. Details of head light and side light. Headlight dazzling and preventive methods. Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper systems

8 Hrs

Unit 5

Automotive Electronics: Current trends in modern automobiles, Open and close loop Systems-Components for electronic engine management. Electronic management of chassis system. Vehicle motion control**.** **6 Hrs**

Unit 6

Sensors and Actuators: Basic sensor arrangement, Types of sensors such as-Oxygen sensors, Crank angle position sensors-Fuel metering/vehicle speed sensor and detonation sensor-Altitude sensor, flow sensor. Throttle position sensors. Solenoids, stepper motors, and relays.

6 Hrs

Unit 7

Electronic Fuel Injection and Ignition Systems: Introduction, feedback carburetor systems. Throttle body injection and multiport or point fuel injection, fuel injection systems, Injection system controls. Advantages of electronic ignition systems: Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control.

8 Hrs

Unit 8

Digital Engine Control System: Open loop and closed loop control systems-Engine cranking and warm up control-Acceleration enrichment-Deceleration leaning and idle speed control. Distributor less ignition-Integrated engine control systems, Exhaust mission control engineering. Electronic dashboard instruments-Onboard diagnosis system, security and warning system. **6 Hrs**

References

1. Judge. A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992.
2. Vinal. G.W. , Storage Batteries, John Wiley & Sons Inc., New York, 1985.
3. William B. Ribbens, Understanding Automotive Electronics, 5th Edition, Butterworth, Heinemann Woburn, 1998.
4. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997, Reprint 2012

Subject Name & Code	**Digital Control Systems Lab MAL26L**
No. of Teaching Hours – 40	**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**

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
17PGOL1	IOT	4:1:0
17PGOL2	Solar Energy Systems	4:1:0
17PGOL3	Machine learning	4:1:0
17PGOL4	Six Sigma and manufacturing	4:1:0
17PGOL5	Heuristics for optimization	4:1:0
17PGOL6	Organizational Behavior and Financial Management	4:1:0
17PGOL7	Deep learning	4:1:0
17PGOL8	MEMS	4:1:0
17PGOL9	Artificial Neural Networks	4:1:0

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

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

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

Unit 1:

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

10 Hours

Unit 2:

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

10 Hours

Unit 3:

The network layer for IoT- LowPAN adaptation layer for devices with limited resources. - Dynamic routing protocols for wireless ad-hoc network.. Communication protocols for IoT

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

10 Hours

Unit 4:

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

10 Hours

Unit 5:

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

10 Hours

References:

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

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

Unit 1:

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

10 Hours

Unit 2:

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

10 Hours

Unit 3:

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

10 Hours

Unit 4:

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

10 Hours

Unit 5:

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

10 Hours

References:

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

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

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

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

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

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

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

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

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

2: Demonstrate Knowledge on various Decision tree methods.

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

4: Demonstrate Knowledge on probabilistic learning methods.

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

Unit 1:

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

10 hours

Unit 2:

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

10 hours

Unit 3:

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

10 hours

Unit 4:

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

10 hours

Unit 5:

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

10 hours

References:

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

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

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

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

Unit 1:

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

10 Hours

Unit 2:

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

10 Hours

Unit 3:

Design for x: Introduction, design for manufacturing and assembly (DFMA), design for reliability (DFR), Design for manufacturability, design for serviceability, design for

environmentality, design for life cycle cost (LCC).

08 Hours

Unit 4:

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

12 Hours

Unit 5

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

10 Hours

References:

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

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

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

Simulated Annealing: Theoretical Approaches, Parallelization, Applications.

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

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

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

References:

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

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

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

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

5.Tabu Search-Fred Glover

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

Unit – 1

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

10 Hours

Unit- 2

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

10 Hours

Unit-3

Foundation of group behavior: Defining and classifying groups-group process-group tasks-cohesive groups-group dynamics-leadership-nature and importance-functions-styles-

communications-nature and types-effective communication-Roles of Formal and informal communication-Conflict management-The process of conflict-types of conflict-functional and dysfunctional conflict-resolution of conflict.

10 Hours

Unit-4

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

10 Hours

Unit-5

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

10 Hours

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

Unit 1:

Deep Networks Regularization & optimization

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

10 Hours

Unit 2: Convolution networks

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

application of deep learning like computer vision, speech recognition.

10 Hours

Unit 3: Linear factor models

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

10 hours

Unit 4: Representation learning

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

10 Hours

Unit 5: Deep generative models

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

10 Hours

References:

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

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

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

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

2: Analyze the design considerations of sensors and actuators.

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

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

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

MICROMACHINING: Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet

Etching – Gas Phase Etchants – Case studies Basic surface micromachining processes – Structural and Sacrificial Materials – Acceleration ofsacrificial Etch – Striction and Antistriction methods – Assembly of 3D MEMS – Foundry process.

12 hrs

UNIT V

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

10 hrs

References:

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

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

Unit 1:

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

10 Hours

Unit 2:

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

10 Hours

Unit 3:

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

10 Hours

Unit 4:

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

10 Hours

Unit 5:

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

10 Hours

References:

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

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

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

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

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

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