REVISED LIST OF OPEN ELECTIVES

TO BE OFFERED IN THE EVEN SEMESTER (MIT CAMPUS)
R-2019

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
FACULTY OF MECHANICAL ENGINEERING								
DEPARTMENT OF PRODUCTION TECHNOLOGY								
B.E. Production Engineering								
1.	PR5691	Reliability Analysis and Maintainability	OE	3	3	0	0	3
2.	PR5692	Biomimetic Engineering	OE	3	3	0	0	3
3.	PR5693	Product Design and Development for Engineers	OE	3	3	0	0	3
B.E. Mechanical Engineering								
4.	ME5691	Basic Automobile Engineering	OE	3	3	0	0	3
5.	ME5692	Product Design and Process Development	OE	3	3	0	0	3
DEPARTMENT OF AUTOMOBILE ENGINEERING								
B.E. Automobile Engineering								
6.	AU5691	Automotive Power Train System	OE	3	3	0	0	3
7.	AU5692	Two–Wheeler Technology	OE	3	3	0	0	3
DEPARTMENT OF AEROSPACE ENGINEERING								
B.E. Aeronautical Engineering								
8.	AE5691	Control Engineering Principle	OE	3	3	0	0	3
9.	AE5692	Fundamentals of Aerodynamics	OE	3	3	0	0	3
10.	AE5693	Principles of Flight	OE	3	3	0	0	3
11.	AE5694	Fundamentals of Jet Propulsion	OE	3	3	0	0	3
12.	AE5695	Manned Space Mission	OE	3	3	0	0	3
13.	AE5696	Fundamentals of Satellite	OE	3	3	0	0	3
FACULTY OF ELECTRICAL ENGINEERING								
DEPARTMENT OF INSTRUMENTATION ENGINEERING								
B.E. Electronics and Instrumentation Engineering								
14.	EI5691	Introduction to Industrial Instrumentation and Control	OE	3	3	0	0	3
15.	EI5692	Introduction to Industrial Data Communication	OE	3	3	0	0	3
FACULTY OF INFORMATION AND COMMUNICATION ENGINEERING								
DEPARTMENT OF INFORMATION TECHNOLOGY								
B.Tech. Information Technology								
16.	IT5695	Basics of Programming and Data Structures	OE	3	3	0	0	3
17.	IT5696	Fundamentals of Information Security	OE	3	3	0	0	3
DEPARTMENT OF ELECTRONICS ENGINEERING								
B.E. Electronics and Communication Engineering								
18.	EC5695	Microcontroller Programming for Industrial Applications	OE	3	3	0	0	3
19.	EC5696	Introduction to Communication Systems	OE	3	3	0	0	3

DEPARTMENT OF COMPUTER TECHNOLOGY								
B.E. Computer Science and Engineering								
20.	CS5693	Data Structures and Applications	OE	3	3	0	0	3
21.	CS5694	Machine Learning using Python	OE	3	3	0	0	3
FACULTY OF TECHNOLOGY								
DEPARTMENT OF RUBBER AND PLASTICS TECHNOLOGY								
B.Tech. Rubber and Plastics Technology								
22.	RP5691	Polymer Properties	OE	3	3	0	0	3
23.	RP5692	Polymers in Electrical and Electronics Applications	OE	3	3	0	0	3

PR5691 RELIABILITY ANALYSIS AND MAINTAINABILITY

L	T	P	C
3	0	0	3

OBJECTIVES

- The ability to use statistical tools to characterize the reliability of an item.
- The working knowledge to determine the reliability of a system and suggest. approaches to enhancing system reliability.
- The ability to select appropriate reliability validation methods.
- To identify and correct the causes of failures.
- To improve effectiveness and efficiency of maintenance.

UNIT I RELIABILITY BASICS 9

Basics of Reliability - Definition – Quality and Reliability – Reliability functions – Hazard rate – Measures of Reliability – Design life – A priori and posteriori probabilities – Mortality of a component – Bath tub curve – Useful life.

UNIT II LIFE DATA ANALYSIS 9

Data collection – Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Normal, Exponential and Weibull – Design life – Hazard models – Hazard rate function.

UNIT III RELIABILITY EVALUATION 9

Reliability of simple systems - Different configurations – Redundancy – m/n system – Complex systems: RBD – Boolean truth table – Cut and tie sets – Fault Tree Analysis – Standby system.

UNIT IV RELIABILITY TRACKING 9

Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability.

UNIT V MAINTAINABILITY 9

Analysis of downtime – Repair time distribution – System MTTR – Maintainability – Factors affecting maintainability of systems – Design for maintainability – System Availability – Replacement theory.

TOTAL: 45 PERIODS

OUTCOMES:

- Analyse the interference between strength and stress, or life data for estimating reliability;
- Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects; specify life test plans for reliability validation

REFERENCES

1. Charles E. Ebeling, “An introduction to Reliability and Maintainability engineering”, TMH, 2000.
2. Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2007.

PR5692 BIOMIMETIC ENGINEERING L T P C
3 0 0 3

OBJECTIVES

- To appreciate and follow nature's design
- To understand living organism body interfaces with surrounding environment
- To learn sensing organs and path navigation in vertebrates
- To understand the working principles of mobility by various living organisms
- To introduce the ways of recreating biomimetic structures

UNIT I OVERVIEW OF BIOMIMETICS 9

Basic principles, building blocks, material property charts, nature's designs, examples of successful biomimetic designs.

Mechanical design – hierarchical construction, bio-composites, structure & properties of bamboo, silks, bones, teeth, shells, antlers and beaks, impact resistance, fracture mitigation, damping, self-healing.

UNIT II BIO INSPIRED SURFACES 9

Biological information, Dealing with friction, Muscles and artificial muscles, lotus effect, gecko adhesion,

Desert beetle, pitcher plants, bio-fouling, coating, Silver ant and heat dissipation,
insulation of fur and feathers, constructal theory.

UNIT III BIO INSPIRED SENSORS 9

Biological sensors, Bio-inspired sensors- structural colours, compound eyes, antireflection, stealth, imaging**.** Navigation – short & long range navigation techniques of bees, ants, turtles - migratory birds

UNIT IV BIO INSPIRED MOBILITY 9

Mechanical stiffness and motion, Neural control, Robot controllers, Running, Robustness, Crawling – Soft robotics, Gliding and Flapping flight, Hydrostatic stiffness and motion - Swimming-Macroscale walking, Macroscale flying.

UNIT V FABRICATION FOR MICRO/NANO STRUCTURES 9

Soft material – bottom up approach – Hard materials – top down approach – micro/nano structure in microelectromechanical (MEMS) – Macro components with micro/nano structures - Examples-Ethics.

OUTCOMES

- To describe the nature's design in damping, light weight high strength, self-healing etc.
- To elucidate living organism physical interactions with environment
- To relate the modern electronics to natural sensing organs and path navigation in vertebrates
- To explain the conceptual working principles of mobility by various living organisms
- To state the ways of manufacturing biomimetic nano/micro structures

TEXT BOOKS

1. Yoseph Bar-Cohen, Biomimetics: Nature-Based Innovation, CRC Press, 2016
2. Lakhtakia A, Martin-Palma RJ (eds); Engineered biomimicry; Elsevier, 2013

REFERENCES

1. Reich Y, A critical review of General Design Theory. Research in Engineering Design, 7 (1) 1-18 (1995).
2. Maria G. Trotta, Bio-inspired Design Methodology, International Journal of Information Science 1(1), pp 1-11 (2011).
3. Ashok K G, Daniel A McAdams, Robert B. Stone, Biologically inspired designs: computational methods and tools, Springer London, 2013.

ME5691 BASIC AUTOMOBILE ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Classifying the types of chassis and identify different class of automobiles
2. Outline the hybrid vehicle system architecture and their merits and demerits.
3. Illustrating the functions of various transmission systems.
4. Imparting the working of different braking and steering systems.
5. Understanding the working of electrical and electronic components

UNIT I INTRODUCTON 9

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Aerodynamic Drag, Specifications, Performance Parameters, Bharat New Vehicle Safety Assessment Program (BNVSAP) – Crash Test norms.

UNIT II HYBRID ELECTRIC VEHICLES 9

History and need for electric and hybrid vehicles, Concept of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles, comparison of diesel, petrol, electric and hybrid vehicles based on performance and emissions, limitations of electric vehicles and technical challenges

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes, manual and automatic, propeller shaft, slip joints, universal joints, Differential, and rear axle.

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Types of steering, Power Assisted Steering., Pneumatic and Hydraulic Braking Systems, Suspension Systems – Need & types.

UNIT V SAFETY AND COMFORT SYSTEMS 9

Passive Safety Systems – Airbags, Seatbelts, Crumple Zones, Active Safety Systems – Automatic Driver Assist Systems (ADAS), Antilock Braking System, Reverse parking system, Anti-collision system, Traction control system, Comfort Systems – Cruise control system, Heating, ventilation and Air-conditioning system (HVAC), Autonomous Driving Cars – Level of Driving Automation.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

1. Distinguish the different types of automobiles and chassis.
2. Interpret the various types of engines and their emission control.
3. Select the appropriate transmission systems.
4. Compare the braking and steering systems.
5. Infer the functions of different electrical and electronic components.

TEXT BOOKS:

1. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”,Tata McGraw Hill, 2004,10thEd
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011

REFERENCES:

1. Ganesan V, "Internal Combustion Engines", Tata McGraw Hill Book Co., 2003.
2. Ehsani, M, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2005
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Bosch “Automotive Handbook”, Robert Bosch GmbH, Germany, 2008, Eighthth Edition.

ME5692	PRODUCT DESIGN AND PROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and screening the concepts for new product design and development.
5. Testing and prototyping the concepts to design and develop new products.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT 9

Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development - Duration and Cost of Product Development - The Challenges of Product Development - The Product Development Process - Concept Development: The Front-End Process - Adapting the Generic Product Development Process - Product Development Process Flows - Product Development Organizations.

UNIT II OPPORTUNITY DENTIFICATION & PRODUCT PLANNING 9

Opportunity Identification: Definition - Types of Opportunities - Tournament Structure of Opportunity Identification - Effective Opportunity Tournaments – Opportunity dentification Process - Product Planning: Four Types of Product Development Projects - The Process of Product Planning

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS 9

Identifying Customer Needs: The Importance of Latent Needs - The Process of Identifying Customer Needs. Product Specifications: Definition - Time of Specifications Establishment - Establishing Target Specifications - Setting the Final Specifications

UNIT IV CONCEPT GENERATION & SELECTION 9

Concept Generation: Activity of Concept Generation - Structured Approach - Five step method of Concept Generation. Concept Selection: Methodology - Concept Screening and Concepts Scoring.

UNIT V CONCEPT TESTING & PROTOTYPING 9

Concept Testing: Seven Step activities of concept testing. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Apply the principles of generic development process; and understand the organization structure for new p1roduct design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and screen the concepts for new product design and development.
5. Test and prototype the concepts to design and develop new products.

TEXT BOOK:

1. Ulrich K.T., Eppinger S. D. and Anita Goyal, “Product Design and Development”McGraw-Hill Education; 7 edition,2020.

REFERENCES:

1. Belz A., 36-Hour Course: “Product Development” McGraw-Hill,2010.
2. Rosenthal S., “Effective Product Design and Development”, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Stuart Pugh., “Total Design –Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, 1991, ISBN 0-202-41639-5.
4. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.

AU5691 AUTOMOTIVE POWER TRAIN SYSTEM L T P C
3 0 0 3

OBJECTIVES:

- To introduce the various layout of vehicle chassis, engine types.
- To expose the need, constructional details and working principle of various clutches.
- To envisage the working of manual transmission systems.
- To explicate the operating principle of various automatic transmission systems.
- To relate the importance of driveline components, wheels and tyres.

UNIT I INTRODUCTION

Layout with reference to power plant. IC Engine operation - classifications and working principle. E – Vehicle layout, operation, advantages and limitations.

UNIT II CLUTCH

Requirements of Transmission system. Purpose and requirement of clutch. Principle of friction clutches. Principle and operation of single plate coil spring and multiplate clutches. Introduction to Electromagnetic clutch.

UNIT III GEAR BOX

Purpose and requirement of gear box. Construction and working principle of sliding mesh and constant mesh gear boxes. Construction and working principle of synchromesh gear box. Introduction to Automated Manual Transmission. Comparison between conventional and Automated Manual Transmission.

UNIT IV AUTOMATIC TRANSMISSION

Construction and working principle of Fluid Coupling, advantages and limitations. Construction and working principle of Torque Converter. Multistage and Polyphase Torque converter. Principle of CVT, advantages and limitations.

UNIT V FINAL DRIVE AND DIFFERENTIAL

Forces and Torque reaction on rear axle. Propeller shaft, Universal joints. Final Drive and its types. Construction and working principle of Differential. Introduction to Limited Slip Differential. Types of wheels and tyres.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course the students will,

- Visualize the power flow of various vehicle layouts.
- Understand the working principle the various positive engagement clutches.
- Appraise upon the constructional details and working principle of the manual transmission systems.
- Compare and contrast between various automatic transmission systems.
- Summarize the significant driveline components, wheels and tyres.

TEXT BOOKS

1. Rajput R.K., “A Textbook Of Automobile Engineering”, Laxmi Publications; Second edition, 2017.
2. K.Newton, W.Steeds and T.K. Garret, “The Motor Vehicle”, 13th Edison, Butterworth Heinemann, India 2004.
3. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, 10th Edison, McGraw-Hill Education, 2017.

REFERENCES:

1. David A Crolla, “Automotive Engineering: Powertrain, Chassis System and Vehicle Body”, Butterworth-Heinemann, 2009.
2. Ramalingam K.K, “Automobile Engineering”, Sci-Tec Book, 2005.
3. Heinz Heisler, “Advanced Vehicle Technology”, Butterworth-Heinemann, 2002.
4. “Bosch Automotive Handbook”, 10th Edition, Robert Bosch GmbH, 2018.

AU5692 **TWO-WHEELER TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES

- Identify various Engine layout for Two wheeler.
- Evaluate the necessity of Engine subsystems in Two Wheeler.
- Selection of Transmission system for Two wheeler
- Selection of Brakes, Wheels and Tyres for Two wheeler.
- Evaluate the current Two-wheeler technological advancements.

UNIT I POWER PLANT **9**

Two Stroke and Four Stroke SI and CI Engine Construction and Working, Limitations of CI engines in Two wheelers, Valve and Port Timing, Scavenging in Engines. Exhaust systems. Introduction to E-bike and its components.

UNIT II ENGINE SUB – SYSTEMS AND STARTING SYSTEM **9**

Fuel System – Carburetor System, Fuel Injection System. Ignition Systems- Magneto coil and Battery Coil Spark Ignition System, Electronic Ignition System. Cooling Systems. Lubrication System. Starting System - Manual Starting System, Self-Starter System. Fuel Injection Testing

UNIT III STRUCTURE AND SUB – SYSTEMS **9**

Types of Frame and its Layout, Clutches, Gear box -Types, CVT, Need for Freewheeling devices. Final Drives. Steering Geometry. Front and Rear Suspension Systems. Suspension Testing.

UNIT IV BRAKES AND WHEELS **9**

Need for Braking System, Types of Brakes -Construction and Working of Drum Brakes, Disc Brakes. Types of Wheels – Construction of Wheel. Types of Tyres – Tubeless Tyres and Tubed Tyres, Radial Tyres and Cross Ply Tyres, Speed and Load Rating. Two wheeler Testing

UNIT V ELECTRICAL SYSTEM AND RECENT TRENDS **9**

Instrumentation and Controls on Handle Bar. Types of Head Lamps – LED, HID. Head Lamp Adjustment. Lead Acid Battery. Supercharging of Race Sports Bikes. Brakes: Antilock Braking System. Catalytic Converters, Emission Norms, Case Study of Two Wheeler.

OUTCOMES

On successful completion of this course students will be able to:

- Understand the assembly and layout pattern of Two Wheelers Engine.
- Understand the Ignition system and Fuel system involved in two wheelers.
- Understand the different types of Suspension systems and Transmission systems.
- Understand the working of Brakes, Types of Wheels and Tyres in Two wheelers.
- Understand the basic Auto Electrical systems and recent trends in Two wheeler.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. John Harold Haynes, Motorcycle Basics Techbook 2nd Edition, 2015
2. Irving, P.E., Motor cycle Engineering, Temple Press Book, London, 1992.
3. Dhruv U.Panchal, Two and Three Wheeler Technology,2015
4. K. K. Ramalingam, Two Wheelers, Scitech publications, Chennai

REFERENCES:

1. Marshal Cavandedish, ‘Encyclopedia of Motor cycling’, New York, 1989
2. Srinivasan.S., ‘Motor cycle, Scooter, Mopeds’, New century book house, 1988.

AE5691 CONTROL ENGINEERING PRINCIPLES L T P C
3 0 0 3

OBJECTIVES:

- To introduce the mathematical modeling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
- To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
- To introduce sampled data control system.

UNIT I MATHEMATICAL MODELLING 9

Introduction – transfer function – simple electrical, mechanical, ,pneumatic , hydraulic and thermal systems – analogies

UNIT II FEEDBACKCONTROL SYSTEMS 9

Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios

UNIT III TIME DOMAIN ANALYSIS 9

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT IV STABILITY ANALYSIS 12

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT V STATE SPACE TECHNIQUE 6

State vectors – state space models -Digital Controllers – design aspects

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to apply mathematical knowledge to model the systems and analyse the frequency\ domain.
- Ability to check the stability of the both time and frequency domain

TEXT BOOKS:

1. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2. Azzo, J.J.D. and C.H. HoupisFeed back control system analysis and synthesis, McGraw-Hill international 3rs Edition, 1998.

REFERENCES:

1. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2. Houpis, C.H. and Lamont, G.B. Digital control Systems, McGraw Hill Book co., New York, U.S.A. 1995.
3. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi,1998.

EI5691 INTRODUCTION TO INDUSTRIAL INSTRUMENTATION AND CONTROL **L T P C 3 0 0 3**

OBJECTIVES:

- To give an adequate knowledge about various techniques used for various parameters of measurement in Industries.
- To provide exposure to four important process variables namely level, pressure, flow and temperature.
- To understand, analyze and design various measurement schemes that meet the desired specifications and requirements of real time processes
- To acquire knowledge about the principles of conventional continuous controllers namely ON/OFF and PID controller.
- To get an overview of advanced control schemes used for industrial applications.

UNIT I LEVEL AND PRESSURE MEASUREMENT 9

Level Measurements: Float gauge – Displacer – D/P method – Load cell – Capacitive sensor– Ultrasonic sensor. Pressure Measurements: Manometer – Bourdon tube – Capacitive type pressure gauge – Piezo resistive pressure sensor – McLeod gauge – Thermal conductivity gauge.

UNIT II TEMPERATURE MEASUREMENT 9

Thermometers – RTD characteristics and signal conditioning – Thermistors – Thermocouples: Laws – signal conditioning – cold junction compensation. Radiation and optical pyrometers.

UNIT III FLOW MEASUREMENT 9

Orifice plate – venturi tube – Turbine flow meter – Rotameter – Coriolis mass flow meter – Thermal mass flow meter - Electromagnetic flow meter – Ultrasonic flow meter – Introduction to Calibration methods.

UNIT IV PROCESS CONTROL 9

Need for process control – Continuous and Batch processes – servo and regulatory operations – Control valve - Examples: Level process – Flow process - Heat Exchanger.
Controller: ON/OFF – PID controller – Electronic PID controller – Introduction to controller tuning.

UNIT V ADVANCED CONTROL SCHEMES 9

Ratio Control – Feed forward control - Cascade control – Model predictive control – Examples from boiler systems and distillation column.

TOTAL : 45 PERIODS

OUTCOMES :

- Apply the knowledge about the instruments to use them more effectively
- Ability to select appropriate level and pressure measuring instruments according tothe application
- Ability to design signal conditioning circuits and compensation schemes
- Able to understand the different conventional control actions, their relative merits,demerits and their typical applications.
- Able to analyze the need for advanced control and methods of implementation of these control techniques.
- Ability to design & implement a suitable control scheme for a given process.

TEXT BOOKS:

1. Doebelin. E.O and Manik D.N.," Measurement Systems: Application and Design", SpecialEdition, Tata McGraw Hill Education Pvt. Ltd, 2007
2. Bequette. B. W.," Process Control Modeling, Design and Simulation", Prentice Hall of India,2004

REFERENCES:

1. Liptak B.G., "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis", Fifth Edition, CRC Press, 2016.
2. Patranabis. D., "Principles of Industrial Instrumentation", 3rd Edition, Tata McGraw Hill, NewDelhi, 2010.

3. Stephanopoulos, “Chemical Process Control — An Introduction to Theory and Practice”, Prentice Hall of India, 2005.

MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

PO,PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
COOE1.1				M								M	S		
COOE1.2	M			S								M	S		
COOE1.3												M	S	S	
COOE1.4												M	S	S	
COOE1.5	M										M	M	S	S	
COOE1.6	M	M		M						M	M	M	S	S	S

EI5692 INTRODUCTION TO INDUSTRIAL DATA COMMUNICATION L T P C
3 0 0 3

OBJECTIVES

- To impart the basic concepts of data networks
- To introduce the serial communication interface standards for industrial data networks.
- To familiarize the students with the principles of MODBUS and CANBUS protocols.
- To introduce Foundation Fieldbus and HART Protocols.
- To introduce the principles of Wireless Networks used in Industrial Data Communication

UNIT I DATA NETWORK BASICS 9

Introduction to Data network – OSI Network model – LAN topologies – Ethernet Protocol – Overview of protocols and standards used in Industrial Data Networks.

UNIT II SERIAL COMMUNICATION STANDARDS 9

Introduction to Serial Communication Standards: EIA232, EIA485, I^2C and USB – Features, Elements, Connections and Handshaking.

UNIT III FUNDAMENTALS OF MODBUS AND CANBUS 9

MODBUS:- Overview, Protocol structure, Communication, Request and Response messages and Applications. CANBUS:- Standard and Extended CAN, Message types, Architecture, Data Transmission and Applications.

UNIT IV INTRODUCTION TO FIELDBUS AND HART 9

Fieldbus:- Introduction, Protocol stack, Packet format, types and Applications — HART:- Features, modes, instruction formats and Applications.

UNIT V WIRELESS NETWORKS FOR INDUSTRIAL DATA COMMUNICATION 9

Wired Vs Wireless Communication – Challenges in Wireless Communication - Wireless LAN Protocol fundamentals, Introduction to Wireless HART Protocol.

TOTAL : 45 PERIODS

OUTCOMES

- Acquire knowledge about basic concepts of data networks
- Gain familiarity with various serial interface standards used in industrial datanetworks.
- Gain knowledge on the principles of MODBUS and CANBUS protocols.
- Get familiarized with Foundation Fieldbus and HART Protocols.
- Gain familiarity with wireless networks for industrial data communication.
- Apply the knowledge of various communication standards for different application and use them more effectively.

TEXT BOOKS

1 Mackay.S, Wrijut.E, Reynders.D and Park.J. "Practical Industrial Data Networks Design, Installation and Troubleshooting", Newnes Publication, Elsevier, 1st Edition, 2004.
2 Berge.J., "Field Buses for Process Control: Engineering, Operation and Maintenance",ISA Press, 2004.
3 Berhouz.A. Forouzan, "Data Communications and Networking", 4th Edition, TataMcGraw Hill, 2007.

REFERENCES

1 Buchanan.W., "Computer Buses", CRC Press, 2000.
2 NPTEL Notes on "Fieldbus Networks" and "Computer Networks", IIT Kharagpur.

MAPPING COURSE OUTCOMES WITH PROGRAMME OUTCOMES

PO,PSO CO	PO 01	PO 02	PO 03	PO 04	PO 05	PO 06	PO 07	PO 08	PO 09	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
COOE2.1											S	S	S		
COOE2.2											S	S	S		
COOE2.3											S	S	S		
COOE2.4											S	S	S		
COOE2.5											S	S	S		
COOE2.6											S	S	S		

IT5695 BASICS OF PROGRAMMING AND DATA STRUCTURES L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basics of C programming language.
- To learn the concepts of structures and pointers.
- To learn the concepts of Abstract Data Types.
- To understand the concepts of linear data structure like list, stack and queue.
- To understand the concepts of non-linear data structures.

UNIT I C PROGRAMMING FUNDAMENTALS 9

Data Types – Variables – Operations – Expressions – Conditional Statements – Control statements - Functions – Recursive Functions – Arrays.

UNIT II C PROGRAMMING - ADVANCED FEATURES 9

Structures – Union – Enumerated Data Types – Pointers - Variation in pointer declarations - Pointers to Variables and Arrays – Dynamic memory allocation – Preprocessor Directives.

UNIT III LINEAR DATA STRUCTURES 9

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked list based implementation – Doubly-Linked Lists – Circular Linked lists.

UNIT IV STACKS AND QUEUES 9

Stack ADT – Implementation of Stack – Array and Linked list implementation – Applications - Balancing the parenthesis – Infix to Postfix expression - Evaluating arithmetic expressions – Queue ADT – Implementation of Queue.

UNIT V NON-LINEAR DATA STRUCTURES 9

Trees – Binary Trees - Types of Binary Trees – Binary Search Tree - Implementation – Tree Traversals – Expression tree – Solving expressions using expression tree – Priority Queue: Binary heap.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Develop C programs for any real world/technical application.
- Apply advanced features of C in solving problems.
- Write functions to implement linear and non–linear data structure operations.
- Suggest and use appropriate linear/non–linear data structure operations for solving a given problem.
- Appropriately use stack and queue data structure for a given application.

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 1997.
2. Reema Thareja, “Programming in C”, Second Edition, Oxford University Press, 2016.

REFERENCES:

1. Brian W. Kernighan, Rob Pike, “The Practice of Programming”, Pearson Education, 1999.
2. Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
4. Ellis Horowitz, Sartaj Sahni and Susan Anderson, “Fundamentals of Data Structures”, Galgotia, 2008.

IT5696 FUNDAMENTALS OF INFORMATION SECURITY L T P C

3 0 0 3

OBJECTIVES

- To introduce the need for security in various applications
- To learn the mathematical background of cryptography
- To introduce security services and mechanisms
- To understand secure design and application of security
- To understand and appreciate hardware security

UNIT I INTRODUCTION 9

Introduction to security: Need for security – Security Goals – Attacks - Security services and mechanisms – Perfect Security - Computational security – semantic security – pseudorandom generators –Mathematics of cryptography: Integer arithmetic-modular arithmetic -algebraic structures - GF (2^n) field)- Primes- Factorization-Chinese Reminder Theorem – Exponentiation and discrete Logarithm.

UNIT II SECURITY SERVICES AND MECHANISMS 9

Formal Definition of Encryption and Adversarial Models –Kerchoff’s Principle – Substitution and Transposition Ciphers- Stream and Block Ciphers – Modern Symmetric key ciphers : DES , AES - Asymmetric Key Ciphers : RSA Cryptosystem – ElGamal Cryptosystem-Cryptographic Hash functions – MAC , HMAC - Digital Signatures- X.509 Certificate–Identity management and Access Control : Password and two factor authentication-Authentication protocols. Single sign-on : SAML and OpenID.

UNIT III HARDWARE SECURITY 9

Hardware security: Side Channel Attacks – Fault Attacks – Countermeasures – Introduction to PUFs, Designs of FPGAs, Machine Learning of PUFs – Introduction to Micro-architectural vulnerabilities - Trusted Computing- Intel SGX.

UNIT IV CYBER SECURITY AND APPLICATIONS 9

Cybersecurity: NIST Cybersecurity framework – Types of Cyber security - Social Engineering – Security of Micro ATMs, e-wallet and POS -Online Banking, Credit card and UPI Security- Smartphone security – Guidelines for social media security -Guidelines for Secure Password and Wi-Fi security

UNIT V APPLICATIONS OF SECURITY 9

Risk analysis – Multilevel and multilateral security –Network Attack and defences - Email security- Web Security - Dark Web and Deep Web - Cloud security - AI security- IoT Security – Blockchain for security - Cyber Laws and IPR- Electronic and Information Wars.

OUTCOMES:

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

- Understand the goals, services and mechanisms of security
- Apply the security algorithms to real world applications.
- Design secure systems and applications.
- Identify various vulnerabilities in hardware.
- Knowledge on Cybersecurity and protecting critical infrastructure.

TEXT BOOKS:

1. Forouzan, Behrouz A., and Debdeep Mukhopadhyay. Cryptography and network security. Vol. 12. New York, NY, USA: Mc Graw Hill Education (India) Private Limited, 2015.
2. Menezes, Alfred J., Paul C. Van Oorschot, and Scott A. Vanstone. Handbook of applied cryptography. CRC press, 2018.
3. Anderson, Ross. Security engineering: a guide to building dependable distributed systems. John Wiley & Sons, 2020
4. Mukhopadhyay, Debdeep, and Rajat Subhra Chakraborty. Hardware security: design, threats, and safeguards. CRC Press, 2014.

EC5695 MICROCONTROLLER PROGRAMMING FOR INDUSTRIAL APPLICATIONS L T P C 3 0 0 3

OBJECTIVES

- To study different microcontroller architectures and interfaces.
- To program the microcontroller for real time applications.
- To architect a microcontroller system for different hardware and software.
- To familiarize the students in Microcontroller.
- To provide strong foundation for designing the real world applications.

UNIT I INTRODUCTION TO 8051 MICRO CONTROLLER 9

Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, Interrupts, Timer/Counter and Serial Communication.

UNIT II PIC MICROCONTROLLER 9

PIC microcontroller Architecture - Memory - Parallel ports - Interrupts - Timers/Counters - UART- A/D converter - PWM.

UNIT III PROGRAMMING WITH C 9

Introduction to C - Microchip MPLAB IDE - CCS PCM C compiler - Proteus VSM - Microchip PICDEM Mechatronics board.

UNIT IV HUMAN AND PHYSICAL INTERFACES 9

Human interface from switches to keypads - LED displays - LCD - interfacing to the physical world-simple sensors: micro switch, Light-dependent resistors, Optical object sensing, opto-sensor applied as a shaft encoder, Ultrasonic object sensor - Actuators: DC and stepper motors - Interfacing to actuators.

UNIT V APPLICATIONS OF 8051 AND PIC MICROCONTROLLERS 9

LED Chasing circuit - Four digit LED Display interface, Interrupt driven event counter with 4-digit LED display - Simple Buzzer interface, Speaker interface - Electronic Siren - Interfacing Digital temperature sensor - Analog temperature sensor IC with A/D converter.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Use 8051 microcontroller suitable for industrial applications.
- Design hardware based on PIC microcontroller.
- Develop C Programs for Microcontroller.
- Provide Human & Physical interface for Microcontrollers.
- Apply Microcontrollers for Real Time Application.

TEXT BOOKS:

1. Muhammad Ali Mazidi and Janice GilliMazidi, The 8051 Micro Controller and Embedded Systems', Pearson Education, 5th Indian reprint, 2003.
2. Dogan Ibrahim, Microcontroller Projects in C for the 8051, Newnes, 2000.
3. Martin P.Bates, Programming 8-bit PIC Microcontrollers in C with interactive hardware simulation, Newnes Press, 2008.

REFERENCES:

1. Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers Principles and applications, Newnes, Elsevier, 2007.
2. Milan Verle, PIC Microcontrollers – Programming In C, MikroElektronika, 2009.

EC5696 INTRODUCTION TO COMMUNICATION SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

- To introduce the concept of basic Analog and Digital Communication Systems.
- To understand the various modulation techniques for Analog and digital communication Systems.
- To perform a block-diagram design of the transmitter and receiver for a basic Analog and Digital Communications System.
- To identify the performance, in terms of bit error rate, of a Digital Communication System.
- To study the wireless channel and Mobile Communication Systems.

UNIT I ANALOG COMMUNICATIONS 9

Basic concepts of Linear Modulation and Demodulation – Modulation Index -Power relation in AM wave- double and single sideband-Generation and Detection of Amplitude Modulation- Hilbert transform-analytic signal.

UNIT II ANGLE MODULATIONS 9

Frequency Modulation-comparison of frequency modulation and amplitude modulation-narrowband and wideband FM- Bessel functions-Carson's rule-bandwidth-Generation and Demodulation of frequency and phase modulation-Phase-locked loops.

UNIT III DIGITAL COMMUNICATIONS 9

Nyquist sampling theorem – Pulse amplitude modulation, Pulse code modulation – quantization noise, delta modulation, DPCM, ADPCM, Multiplexing and Multiple Access Techniques – FDM and FDMA, TDM and TDMA, CDMA.

UNIT IV DIGITAL MODULATION TECHNIQUES 9

Binary Phase Shift Keying - Binary Frequency Shift Keying - Pulse Amplitude Modulation (PAM), On - Off Keying OOK. Optimum receiver structures for digital communication - matched filtering, co-relation detection, probability of error.

UNIT V WIRELESS CHANNEL AND MOBILE COMMUNICATION 9

Overview of wireless systems-capacity of wireless channel- Examples of Wireless Communication Systems- Paging system, Cordless telephones systems, Cellular telephone Systems- Cellular concept- Large and small Scale Fading.

TOTAL: 45 PERIODS

OUTCOMES:

- Understand the basic concepts of Analog Communication Systems.
- Use of Angle Modulation techniques for Analog Communication.
- Identify and describe different techniques in modern Digital Communications.
- Explore various Digital Modulation Techniques.
- Analyse the performance of wireless channels for Mobile Communication.

TEXT BOOKS:

1. Thepdore. S.Rapport, "Wireless Communications: principles and practice" , 2nd eidtion, pearson education, india, 2009.
2. B.P.Lathi, "Modern Digital and Analog Communication systems", 4th Edition, Oxford university press, 2010.
3. S.Haykin , " Communication systems" 3/e John Wiley 2007.

REFERENCES:

1. David Tse and Pramod Viswanath, " Fundamentals of wireless communications" Wiley series in Telecommunications, cambridge university press, 2005.
2. J.G.Proakis, M.Salehi, " Fundamentals of Communication Systems" - Pearson education 2006.
3. H. P. Hsu, Schaum outline series - "Analog and Digital Communications" TMH 2006.
4. Andrea Goldsmith, " Wireless Communications", Cambridge University Press, 2005.

CS5693 DATA STRUCTURES AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES

- To understand arrays and applications such as vectors, matrices, polynomials
- To know about stacks, queues and their applications in handling expressions, strings, scheduling
- To understand dynamic creation of lists and knowing how to apply them for problem solving
- To understand the nonlinear data structure trees and data representation, processing using trees
- To understand sorting and searching of data values using different methodologies

UNIT I **9**

Arrays, Strings, Vectors, Matrix Representation using arrays, Multi-Dimensional Arrays, Sparse Arrays, Lists, Sets representation using Lists, Polynomials representation using Lists.

UNIT II **9**

Stacks, Queues, Maze Problem, Expressions Evaluation, String reversal, Circular Queue, Dequeue, Scheduling.

UNIT III **9**

Linked Lists, Doubly Linked List, Polynomial Addition and Multiplication, Linked Stacks and Queues, Nested Lists

UNIT IV **9**

Trees - Binary Trees - Traversals – Binary Search Trees - Operations – Decision Trees – Game Trees, Height Balanced Trees, Heaps, Priority Queues

UNIT V **9**

Insertion Sort, Shell Sort, Bucket Sort, Heap Sort, Merge Sort, Quick Sort, Linear search, Binary Search, m-way search, Fibonacci Search.

TOTAL: 45 PERIODS

REFERENCES

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, Galgotia, 1976.
2. Jean-Paul Tremblay and Paul G Sorenson, “An Introduction to Data Structures with Applications”, Second Edition, Tata McGraw Hill, 1991.
3. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 1996
4. Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , “ Data Structures and Program Design in C”, Second Edition, Pearson Education, 2007
5. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Second Edition, University Press, 2008

CS5694 MACHINE LEARNING USING PYTHON L T P C
3 0 0 3

COURSE OBJECTIVES:

- To know different types of machine learning algorithms like supervised, unsupervised and semi supervised
- To differentiate between regression and classification problems
- To study applications of classification and clustering algorithms
- To learn deep learning and its applications
- To implement machine learning algorithms using Python libraries

UNIT I INTRODUCTION TO MACHINE LEARNING AND PYTHON 9

Machine learning- Types of Machine Learning - Supervised Learning – Unsupervised Learning – Reinforcement Learning- Bias and Variance- Over fitting and Under fitting- Parametric vs. non-parametric Models- Understanding Python-Python Libraries.

UNIT II NEURAL NETWORKS 9

Neural Networks: Introduction, Perceptron- Multilayer Perceptron, Feed- forward Network, Types of Activation Function- Error Back Propagation.

UNIT III SUPERVISED LEARNING 9

Regression: Linear Regression, Multiple Linear Regression -Decision Trees-Random Forests-Naïve Bayes -K-Nearest Neighbors- Support vector machines.

UNIT IV UNSUPERVISED LEARNING 9

Clustering –Types: K-Means Clustering, Hierarchical Clustering, Density-Based Clustering- The Curse of dimensionality -Dimensionality Reduction: Principal Component Analysis

UNIT V ADVANCED LEARNING 9

Graphical Models: – Markov Model – Hidden Markov Model- Reinforcement Learning-Deep Learning- Implementation of machine and deep learning: object detection and recognition in images, Text Analysis, Speech Recognition.

TOTAL: 45 PERIODS

REFERENCES:

1. Stephen Marsland, “Machine Learning –An Algorithmic Perspective”, CRC Press, 2009.
2. Tom M Mitchell, “Machine Learning”, McGraw Hill Education, 2013..
3. Andreas C. Müller, Sarah Guido, ‘Introduction to Machine Learning with Python: A guide for Data Scientists’, O'Reilly Media, 2016.
4. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, Adaptive Computation and Machine Learning Series, MIT Press, 2014.
5. M.Kirk, “Thoughtful Machine Learning with Python”, O'Reilly, 2017

RP5691 POLYMER PROPERTIES L T P C

3 0 0 3

OBJECTIVES

To enable the students to

- Understand the fundamentals of polymers, structure and molecular weight
- Know about Tg and its importance
- Know about mechanical properties of polymers
- Understand the importance of electrical and optical properties of polymers

UNIT I INTRODUCTION 12

History of Macromolecules – Difference between simple organic molecules and macromolecules-Monomers – Functionality – Classifications of Polymers – Natural and synthetic polymers – Structure of natural rubber and proteins. Polymer Dissolution - Difference between simple solutions and polymer solutions – Molecular Weight - Average molecular weight – Degree of polymerization and molecular weight – Molecular weight distribution – Polymer fractionation-Polydispersity – Molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering – Basic Principles

UNIT II STATES OF AGGREGATION IN POLYMERS 10

Transitions and segmental mobility in polymers – Glass transition, Tg, and flexibility – Multiple transitions in polymers - Significance of transition temperatures – Semicrystalline polymers – Effect of crystallization on properties of polymers – Factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure- Melting of polymers – Rheology of Polymer melts.

UNIT III DEFORMATION & STRENGTH PROPERTIES OF POLYMERS 10

Polymer structure and Stress – Strain properties – Tensile properties – Flexural strength – Iimpact strength – Fatigue endurance – Hardness tests – Mechanical relaxations in polymers –Effect of temperature on mechanical behaviour of polymers – Visco-elastic properties– Damping characteristics – Crazing in glassy polymers – Role of crazing in fracture – Macroscopical fracture theory – Fracture and microstructure

UNIT IV ELECTRICAL PROPERTIES OF POLYMER 7

Structure-Property relationships – Polar and Nonpolar polymers - charge carriers – Electronic and Orientation Polarization-carrier mobility – Dielectric properties of polymers - Anti static and conductive of polymers –Volume resistivity measurements Molecular theories of dielectric relaxation in polymers – Dielectric breakdown.

UNIT V OPTICAL PROPERTIES OF POLYMERS 6

Introduction – Isotropic polymers – Anisotropic polymers – Dichroism – Optical applications of polymers – Transmission – Rheoptical properties and application-Birefringence-Photoelastic effects and Analysis in Polymers

TOTAL 45 PERIODS

COURSE OUTCOME

The students will be able to

- Understand the fundamentals of polymers and molecular weight
- Realize the importance of transitions in polymers
- Know about deformations in polymers
- Choose right type of polymers for electrical insulation purpose
- Know the importance of optical properties of polymer

TEXT BOOKS

1. Ulrich Eisele, Introduction to Polymer Physics Springer, 2011.
2. Bill Meyer.F.W. Text Book of Polymer Science, 3rd Edition, Wiley Interscience Publications, 2007
3. Seymour.R.B., and Carraher.C.E., Jr., Polymer Chemistry, 6th Edition, Marcel Dekker, 2003

REFERENCE

1. L.H.Sperling, Introduction to Physical Polymer Science, 4th Edition, Wiley Interscience, 2006

RP5692 POLYMERS IN ELECTRICAL AND ELECTRONICS APPLICATIONS L T P C

3 0 0 3

OBJECTIVES

To enable the students to

- Understand the fundamentals of polymers and their structure
- Design polymers for electrical applications
- Know about electrical properties of polymers
- Understand the importance of polymers in energy storage applications

UNIT I INTRODUCTION TO POLYMERS 9

Polymers - Difference between simple organic molecule and macromolecule - classification of polymers - Molecular weight - Polymerization Types and Techniques. Requirements for polymers as insulators, semiconductors and conductors. Design of conjugated polymers for organic electronics - chemical, electrochemical and enzymatic methods - doping - general considerations

UNIT II CONDUCTING/INSULATING POLYMERS AND PROPERTIES 9

Conducting Polymers- properties and applications of PANI, Polythiophene, polyacetylene and polypyrole. Photoconducting polymers and its applications. Insulating/Non conducting polymers used in electrical applications -PE, PVC, PF, Aminoplasts, epoxy and other flame retardant polymers. Properties - Electronic properties, electrochemical, electroluminescent properties, electrochromic and electromechanical properties

UNIT III ENERGY HARVESTING POLYMERS 9

Photovoltaic devices - working mechanism and light harvesting materials. Working mechanism and materials for thermoelectric generator, piezoelectric transducer and triboelectric generator- Dielectric Elastomer based Generating systems-energy harvesting using Magneto Rheological Elastomers and fluids

UNIT IV POLYMERIC ENERGY STORAGE DEVICES 9

Supercapacitors – Polymer based electrodes and electrolytes. Lithium ion batteries based on polymers – Polymer as active materials in electrode, polymer as separator and electrolyte.

UNIT V APPLICATIONS 9

Light emitting conjugated polymers - polymer light emitting diodes and electrochemical cells- electret -photoresist - positive and negative photoresist - wire and cable - encapsulation - polymers in optical data storage - optical fibers - corrosion and ESD protection, EMI shielding artificial muscles - electro chromic devices - electromechanical actuators - sensor devices- conductive composites, smart tyres- pressure monitoring systems-3D printing.

TOTAL 45 PERIODS

OUTCOMES

The students will be able to

- Relate the properties of polymers for electronics applications
- Select polymers for electrical applications
- Know about polymers used for harvesting solar energy
- Know about polymeric energy storage devices
- Understand various polymers for electrical applications

TEXT BOOKS

1. J.M. Margolis (Ed.), Conducting Polymers and Plastics, Springer, 2011.
2. R.W Dyson, “Specialty Polymers”, 2nd Edition, Springer, 1998
3. Soane.D.S. and Martynenko.Z., “Polymers in Microelectronics”, Elsevier, Amsterdam, 1989.

REFERENCES

1. Xin Fang, Wei Weng, Huisheng Peng, Xuemei Sun“Polymer Materials for Energy and Electronic Applications”, Elsevier, 2017
2. Hans Kuzmaly, Michael Mehring, Siegmar Roth, “Electronic Properties of Conjugated Polymers,” Springer, Berlin, 2012.

AE5692 FUNDAMENTALS OF AERODYNAMICS

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OBJECTIVES:

01 To introduce the basic concepts of mass, momentum and energy conservation relating to Aerodynamics.

02 To make the student understand the fundamentals of theory of airfoils and wing sections.

03 To introduce characteristics of Airfoils and the concept of Starting Vortex, theory of airfoils and it's applications.

04 To introduce concept of Vortex Filament, Horse Shoe Vortex , Lifting Line Theory and its limitations

05 To introduce the concepts of compressibility, to make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows.

UNIT I FUNDAMENTAL CONCEPTS 9

Introduction -Types of fluid flows – incompressible and compressible flows – low speed and high speed flows – rotational and irrotational flows - System and Control volume approach -Euler equation – incompressible and compressible forms of Bernoulli's Equation. Circulation and Vorticity - Streamline, Stream Function, Potential Function, Equi-potential Lines – Forces & Moment coefficients -Types of drag.

UNIT II POTENTIAL FLOWS 9

Elementary Flows and their combinations – uniform flow - Source Flow & sink flow – doublet flow – Rankine oval – vortex flow - Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, - Real flow over smooth and rough cylinder. Pressure distribution on an airfoil-Lift generation.

UNIT III INCOMPRESSIBLE FLOW OVER AIRFOILS 9

Airfoil Nomenclature-Aerofoil characteristics- -Starting Vortex, Kutta condition - Thin Airfoil applications.

UNIT IV SUBSONIC FLOW OVER FINITE WINGS 9

Downwash and Induced Drag- Vortex Filament -Helmholtz's theorems - Biot - Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory applications.

UNIT V PRELIMINARY ASPECTS OF COMPRESSIBLE FLOW 9

A brief of thermodynamics - Governing Equations for Inviscid, Compressible Flow-Compressibility - formation of shock waves and expansion waves – Speed of sound - Mach waves.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course students will be able

CO1: To familiarize themselves with the fundamental concepts of mass, momentum, energy conservation equations and their applications.
CO2: To acquire knowledge about ideal and real flow over the bluff and streamlined bodies.
CO3: Have the capability to estimate theoretically aerodynamic coefficients of airfoils.
CO4: Have the capability to estimate theoretically aerodynamic coefficients of finite wing.
CO5: To acquire knowledge on the effect of compressibility at high-speeds and effect of shocks and expansion waves.

TEXT BOOKS:

1 Anderson, J.D., Fundamentals of Aerodynamics, McGraw-Hill Education; 6th edition, 2017.

2 Rathakrishnan. E, Gas Dynamics, Prentice-Hall of India Pvt. Ltd, 6th edition 2017.

REFERENCES:

1 Clancy, L J., Aerodynamics, Shroff publishers 2006.
2 John J Bertin., Aerodynamics for Engineers, Prentice Hall publishers 6th edition, 2013.
3 Houghton E.L & Carruthers, N.B " Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
4 Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.

AE5693 PRINCIPLES OF FLIGHT L T P C
3 0 0 3

COURSE OBJECTIVES: of this course are

- To introduce the basic concepts of aeronautics.
- To impart knowledge about the different layers in International standard atmosphere.
- To provide basic knowledge on low speed aerodynamics.
- To describe about various systems and instruments used in airplanes.
- To provide basic knowledge on rocket motion.

UNIT I BASICS OF AERONAUTICS 9

Classification of flight vehicles-Components of an airplane and their functions- lift generation – airfoil nomenclature – Mach number- Speed regime- International Standard Atmosphere- Basic instruments for flying-Pitot static tube – I.A.S, E.A.S and T.A.S, Types of drag and Drag reduction in airplanes.

UNIT II AIRCRAFT STRUCTURES 9

Introduction to Aircraft structures -Types of construction of wing and fuselage- Different types of load carrying members on Wing and Fuselage. Materials used on modern airplane and their requirements.

UNIT III AIRCRAFT PROPULSION 9

Principles of piston and jet engines - Thrust equation- Construction and working of Turbo jet, Turbo prop, Turbo fan and Turbo shaft engines - Advantages and Disadvantages. Need for ramjet and scramjet engines.

UNIT IV AIRCRAFT SYSTEMS 9

Hydraulic systems –Pneumatic systems – Working principles –Braking system – Components, Starting systems - Landing Gear Systems – Engine control systems- Digital fly by wire system- Auto pilot system.

UNIT V FUNDAMENTALS OF SPACE FLIGHT 9

Principle of operation of rocket - types of rocket and their applications - Rocket parameters– two dimensional rocket motion - rocket trajectories – need for multi-staging –rocket performance.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1 Determine the properties of atmosphere at a given altitude in ISA.
CO2 Demonstrate different types of construction of aircraft structures.
CO3 Explain the operating principle of various systems used on airplane.
CO4 Explain the basics of flight mechanics of fixed wing airplane.
CO5 Demonstrate the equations pertaining to rocket motion.

TEXT BOOKS:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015.
2. Rathakrishnan, E., Introduction to Aerospace Engineering: Basic Principles of Flight, Wiley, 1st edition, 2021.

REFERENCES:

1. Kermode, A.C., Flight without Formulae, Pearson Education, 11th edition, 2011.
2. McKinley, J.L. and Bent R.D., Aircraft Maintenance & Repair, McGraw Hill, 6th edition, 1993.
3. Pilot's Handbook of Aeronautical Knowledge, FAA, 2012.

AE5694 FUNDAMENTALS OF JET PROPULSION L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

1. To make the students learn thermodynamics principle and general thrust equation.
2. To impart knowledge on piston and gas turbine engines of aircrafts.
3. To make the students familiarize with the ducted propulsive systems.
4. To give exposure on various types of rocket propulsion and propellant used in rocket engines.
5. To make the students learn the principle operation of space propulsion.

UNIT I BASIC LAWS AND THRUST EQUATION 9

Newton's law of motion, basics of thermodynamics, classification of jet propulsion, thrust equation, factors affecting thrust, methods of thrust augmentation, and performance parameters of aircraft engines.

UNIT II AIRCRAFT ENGINES 9

Operating principles of piston and gas turbine engines, gas turbine engine classification, basics of gas turbine engine components, operating characteristics of turboprop, turbofan and turbojet.

UNIT III DUCTED PROPULSION 9

History of ducted propulsion, ramjet engine, pulse jet, scramjet engine, combined cycle engine, Integral ramjet engines.

UNIT IV ROCKET PROPULSION 9

Classification of rocket propulsion, specific impulse, propellant classification, solid rocket motor, liquid rockets engine, monopropellant engines, bipropellant engines and hybrid rockets engine.

UNIT V SPACE PROPULSION 9

Basic of electrical propulsion, electrothermal thruster, electrostatic thruster, electromagnetic thruster, nuclear propulsion and solar sail.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of the course, Students will be able to

CO1: Apply different laws and basics of thermodynamic process to get thrust.
CO2: Acquire knowledge on the operation of piston and gas turbine engines and their operating characteristics.
CO3: Get exposure the knowledge on ducted propulsion system used in missile applications.
CO4: Acquire knowledge on the operation of rocket propulsion and various kinds of propellants.
CO5: Acquire knowledge on the working of space propulsion systems.

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Pearson education (2009).
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons; 8th Edition 2010.

REFERENCE BOOKS:

1. Ahmed F. El – Sayed, "Aircraft Propulsion and Gas turbine engines", CRC Press Taylor and Francis group, Second Edition 2017.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Pearson Education Canada; 6th edition , 2008.
3. David H. Heiser and David T. Pratt., "Hypersonic Air breathing Propulsion", AIAA Education Series, 1999.
4. Martin J. Chiaverini and Kenneth K. Kuo, "Fundamentals of Hybrid Rocket Combustion and Propulsion", Progress in Astronautics and Aeronautics, 2007.
5. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.

AE5695 MANNED SPACE MISSIONS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

The physics of space environment- A brief description on some space missions like space station, Moon mission and Mars missions - technological challenges involved in Manned vs. unmanned missions - benefits from space missions - Salient features of some international space missions with examples

UNIT II EARTH AND SPACE ENVIRONMENTS 9

Structure and Composition of Earth environment - Meteoroid, Orbital Debris & Radiation Protection - Safety of Crewed Spaceflight - Magnetosphere - Radiation Environment: Galactic Cosmic Radiation (GCR) , Solar Particle Events (SPE) - Radiation and the Human Body - Impact of microgravity and g forces on humans - space adaptation syndrome

UNIT III HUMAN LIFE SUPPORT SYSTEMS 9

Human Life Support Systems and Space Survival - Environment Controlled Life Support Systems (ECLSS) - Human I Machine Interaction - Human Factors in the Control Design of Life Support Systems - Design considerations for systems of Crew Accommodation

UNIT IV PLANNING OF MANNED SPACE MISSION 9

Ground Communication and Support - Space Resources and Mission Planning - Selection of Rockets and Launch Vehicles for the planned mission- Orbital Selection and Astrodynamics-Entry , Descent, Landing, and Ascent, Designing and Sizing Space elements - Designing, Sizing, and Integrating a Surface Base and Planetary Surface Vehicles

UNIT V OPERATIONAL ASPECTS IN MANNED SPACE MISSIONS 9

Space Operations - Basic aspects of Space Architecture , Attitude Determination and Control - Preliminary description of Power Systems design- Introduction to Extravehicular Activity (EVA) Systems and Space Robotics - Mission Operations for Crewed Spaceflight - Basics of Command, Control, and Communications Architecture

TOTAL = 45 PERIODS

TEXT BOOKS

1. Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGraw-Hill Higher Education , Washington , DC , 1999
2. McNamara, Bernard. 2000. Into the Final Frontier: The Human Exploration of Space.(Brooks Cole Publishing.)
3. Connors, M.M., Harrison, A.A , and Akins , F.R. 2005. Living Aloft: Human Requirements for Extended Spaceflight, University Press of the Pacific, Honolulu, Hawaii: ISBN: 1-4102-1983-6 Eckart, P. 1996. Spaceflight Life Support and Biospherics

AE5696 FUNDAMENTALS OF SATELLITE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To understand the concepts of orbital mechanics, satellite systems, configuration, functions, control and make the students eligible to enter into R&D organization.

UNIT I INTRODUCTION TO SATELLITE MISSION AND SYSTEMS 5

Mission Overview – Requirements for different missions- Common satellite applications – Space Environment, Spacecraft configuration - Satellite systems and their functions

UNIT II INTRODUCTION TO ORBITAL MECHANICS 9

Typical spacecraft orbits- Types -special orbits-Time and coordinate systems-Theory of elliptical orbits-Two body equation-kepler laws- First and second constant of motion-Orbital elements-Disturbances

UNIT III POWER SYSTEM AND BUS ELECTRONICS 9

Power sources – Energy storage – Solar panels-Types and power generation capacity-Bus electronics- Base Band Telemetry system – Modulation – TT & C – Telecommand system – Ground Control Systems

UNIT IV ATTITUDE AND ORBIT CONTROL SYSTEM 10

AOCS requirements – Environment effects – Attitude stabilization – Attitude sensors – Actuators – Station keeping types- orbit maintenance and control – introduction to control algorithms .

UNIT V PROPULSION, STRUCTURE AND THERMAL CONTROL SYSTEMS 12

Propulsion systems-importance-Types-Theory of operation- Need for satellite structure-requirements-guiding factors-Various loads-Importance of thermal control-Heat transfer-Types-Thermal control systems: active and passive methods.

TOTAL: 45 PERIODS

OUTCOMES:

1. Aware of the Satellite Mission, Configuration, Applications and Systems
2. Understand the concepts of Orbital theory
3. Understand the theory of satellite power and TTC subsystems
4. Understand the theory and design procedure of satellite AOC systems
5. Understand the theory and concepts of satellite propulsion, structure and TCS
6. Graduate will acquire knowledge about satellite systems up on completion of this course.

REFERENCES:

1. Space Mission Analysis and Design (Third Edition) by James R.Wertz and Wiley J.Larson – 1999.
2. James R.Wertz “Spacecraft Attitude Determination and Control”, Kluwer Academic Publisher, 1988.
3. Marcel J.Sidi “Spacecraft Dynamics and Control”, Cambridge University press, 1997.
4. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
5. Space Communications Systems, Richard.F, Filipowsky Eugen I Muehllorf, Prentice Hall, 1995.

PR5693 PRODUCT DESIGN AND DEVELOPMENT FOR ENGINEERS L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the global trends and development methodologies of various types of products and services
2. To conceptualize, prototype and develop product management plan for a new products
3. To understand requirement engineering and know how to arrive the requirements for new product development
4. To implement the modeling for system, sub-system and their interfaces
5. To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision – Social Trends – Technical Trends- Economical Trends – Environmental Trends – Political/Policy Trends – Introduction to Product Development Methodologies and Management – Overview of Products and Services – Types of Product

Development – Overview of Product Development methodologies – Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering – Types of Requirements – Requirement Engineering – traceability Matrix and Analysis – Requirement Management – System Design & Modeling – Introduction to System Modeling – System Optimization – System Specification – Sub-System Design – Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization – Industrial Design and User Interface Design – Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines – Concept Screening & Evaluation – Detailed Design – Component Design and Verification – Mechanical, Electronics and Software Subsystems – High Level Design/Low Level Design of S/W Program – Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping – Introduction to Rapid Prototyping and Rapid Manufacturing.

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification and validation processes and stages – Product Testing Standards and Certification – Product Documentation – Sustenance -Maintenance and Repair – enhancements – Product EoL – Obsolescence Management – Configuration Management – EoL Disposal.

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry – Engineering Services Industry – Product Development in Industry versus Academia – The IPD Essentials – Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems – Product Development Trade-offs – Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Define, formulate and analyze a problem
CO2: Solve specific problems independently or as part of a team
CO3: Gain knowledge of the Innovation and Product Development process in the Business Context
CO4: Work independently as well as in teams
CO5: Manage a project from start to finish

TEXT BOOKS:

1. Ali Jamnia "Introduction to Product Design and Development for Engineers"1st editon 2018
2. Ulrich, Karl T., Eppinger, Steve D., and Yang, Maria C., Product Design and Development. 7th ed., McGraw-Hill Education, 2020.
3. Kenneth B. Kahn, Mayoor Mohan "Innovation and New Product Planning" 2020
4. Anil Mital , Anoop Desai, Anand Subramanian, Aashi Mital "Product Development "Elsevier; 2nd edition 2014

REFERENCES:

1. Hiriyappa B, Corporate Strategy – Managing the Business, Author House, 2013.
2. Anoop Desai, Anil Mital "Sustainable Product Design and Development" 2020
3. Ronak Gandhi " Product design and value engineering " Kindle Edition 2020