

**DR. A.P.J. ABDUL KALAM TECHNICAL  
UNIVERSITY LUCKNOW**



**STUDY & EVALUATION SCHEME WITH  
SYLLABUS  
FOR  
B. TECH 4<sup>th</sup> YEAR  
MECHANICAL & INDUSTRIAL ENGINEERING  
ON  
CHOICE BASED CREDIT SYSTEM  
(EFFECTIVE FROM THE SESSION: 2019-20)**

SEVENTH SEMESTER									
Sl.No.	Subject Code	Subject Name	Department	L-T-P	Th/Lab Marks	Sessional		Total	Credit
					ESE	CT	TA		
1		OPEN ELECTIVE COURSE-1	Other Deptt.	3-0-0	70	20	10	100	3
2		DEPTT ELECTIVE COURSE-3	Core Deptt.	3-0-0	70	20	10	100	3
3		DEPTT ELECTIVE COURSE-4	Core Deptt.	3-1-0	70	20	10	100	4
4	RME701	CAD/CAM	Core Deptt.	3-1-0	70	20	10	100	4
5	RME702	Automobile Engineering	Core Deptt.	3-0-0	70	20	10	100	3
6	RME751	CAD/CAM Lab	Core Deptt.	0-0-2	50		50	100	1
7	RME752	IC Engine & Automobile Lab	Core Deptt.	0-0-2	50		50	100	1
8	RMI753	INDUSTRIAL TRAINING	Core Deptt.	0-0-3			100	100	2
9	RMI754	PROJECT-1	Core Deptt.	0-0-6			200	200	3
	<b>TOTAL</b>				<b>450</b>	<b>100</b>	<b>450</b>	<b>1000</b>	<b>24</b>

DEPARTMENTAL ELECTIVE-3	
Sub.Code	Subject Name
RME070	Composite Materials
RME071	Power Plant Engineering
RME072	Supply Chain Management
RME073	Additive Manufacturing

DEPARTMENTAL ELECTIVE-4	
Sub.Code	Subject Name
RME075	Operation Research
RME076	Modelling & Simulation
RME077	Computational Fluid Dynamics
RME078	Automation & Robotics

- Students who was not-place in any company, it is mandatory to select any one subject from DE-5 & 6.
- Students who was place in any company, it is mandatory to select MOOC subject in both DE-5 & 6.

EIGHT SEMESTER									
Sl.No.	Subject Code	Subject Name	Department	L-T-P	Th/Lab Marks	Sessional		Total	Credit
					ESE	CT	TA		
1		OPEN ELECTIVE COURSE-2	Other Deptt.	3-0-0	70	20	10	100	3
2		DEPTT ELECTIVE COURSE-5	Core Deptt.	3-1-0	70	20	10	100	4
3		DEPTT ELECTIVE COURSE-6	Core Deptt.	3-0-0	70	20	10	100	3
4	RMI851	SEMINAR	Core Deptt.	0-0-3			100	100	2
5	RMI852	PROJECT-2	Core Deptt.	0-0-12	350		250	600	12
	<b>TOTAL</b>				<b>560</b>	<b>60</b>	<b>380</b>	<b>1000</b>	<b>24</b>

- Students who was not-place in any company, it is mandatory to select any one subject from DE-5 & 6.
- Students who was place in any company, it is mandatory to select MOOC subject in both DE-5 & 6.

DEPARTMENTAL ELECTIVE-5	
Sub.Code	Subject Name
RME080	Non-Destructive Testing
RME081	Advance Welding
RME082	Thermal Turbo Machine
RME083	Energy Conservation & Management

DEPARTMENTAL ELECTIVE-6	
Sub.Code	Subject Name
RME085	Total Quality Management
RME086	Gas Dynamics & Jet Propulsion
RME087	Design & Transmission System
RME088	Theory of Elasticity

OR

Sub.Code	MOOC Subject Name
RME084	Industrial Safety Engineering.

OR

Sub.Code	MOOC Subject Name
RME089	Manufacturing of Composites.

# **SEMESTER-VII**

**UNIT-I:****Principles of Computer Graphics:**

Point plotting, drawing of lines, Bresenham's circle algorithm.

**Transformation in Graphics:**

Co-ordinate system used in Graphics and windowing, view port, views.

2D transformations – rotation, scaling, translation, mirror, reflection, shear - homogeneous transformations – concatenation.

3D Transformation – Perspective Projection – Technique (Description of techniques only).

**Geometric Modelling:**

Classification of Geometric Modelling – Wire frame, Surface and Solid Modelling, applications – representation of curves and surfaces – Parametric form.

Design of curved shapes- Cubic spline – Bezier curve – B-spline – Design of Surfaces - features of Surface Modelling Package – Solid Primitives, CSG.

B-rep and description of other modelling techniques like Pure primitive instancing, cell decomposition, spatial occupancy enumeration, Boolean Operations (join, cut, intersection), Creating 3D objects from 2D profiles (extrusion, revolving etc).

**UNIT-II:****Graphics standard & Data storage:**

Standards for computer graphics GKS, PHIGS. Data exchange standards – IGES, STEP - Manipulation of the model - Model storage.

**Finite Element Modelling:**

Introduction, Mesh Generation – mesh requirements.

Semi-Automatic Methods- Node-based approach, Region based approach, Solid-modelling-based methods.

Fully Automatic Methods- Element-based approach, Application, Mesh Refinements using Isoperimetric Finite Elements, Meshing in high gradient areas, Transition Regions. Sub modelling Concept.

An overview of modelling software's like PRO-E, CATIA, IDEAS, SOLID EDGE etc.

**UNIT-III:****CAM:**

Scope and applications – NC in CAM – Principal types of CNC machine tools and their construction features – tooling for CNC – ISO designation for tooling – CNC operating system – FANUC, SINUMERIK – LINUMERIK.

Programming for CNC machining – coordinate systems – manual part programming – computer assisted part programming – CNC part programming with CAD system.

**Material handling in CAM environment:**

Types – AGVS – AS/RS – Swarf handling and disposal of wastes – single and mixed mode assembly lines – quantitative analysis of assembly systems.

**UNIT-IV:****Robotics:**

Classification and specification – drive and controls – sensors - end effectors - grippers- tool handling and work handling – machine vision – robot programming concepts – case studies in assembly.

**Quality Function Deployment:**

Process Planning – CAPP – Variant and Generative systems- Concurrent Engineering and Design for Manufacturing.

Advanced manufacturing Planning Computer Aided Production Planning and Control – Aggregate production planning and master production schedule – MRP – MRP II – ERP - Capacity planning.

## **UNIT-V:**

### **Rapid prototyping:**

Need for rapid prototyping, Basic principles and advantages of RP, General features and classifications of different RP techniques with examples.

Introduction to three representative RP techniques: Fusion Deposition Modelling, Laminated Object Manufacturing and Stereo-lithography.

### **Flexible manufacturing cells:**

Systems – characteristics – economics and technological justification – planning, installation, operation and evaluation issues – role of group technology and JIT in FMS – typical case studies future prospects.

### **Books and References:**

1. Chris McMahon and - CAD/CAM – Principle Practice and Manufacturing Management, Jimmie Browne Addison Wesley England, Second Edition, 2000.
2. Dr. Sadhu Singh - Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.
3. P. Radhakrishnan, - CAD/CAM/CIM, New Age International (P) Ltd., New Delhi. S. Subramanian and V. Raju.
4. Groover M.P. and - CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall Zimmers EW. International, New Delhi, 1992.
5. Ibrahim Zeid - CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., Company Ltd., New Delhi, 1992.
6. Mikell P. Groover - Automation , Production Systems and Computer Integrated Manufacturing, Second edition, Prentice Hall of India, 2002.
7. S. Kant Vajpayee - Principles of Computer Integrated Manufacturing, Prentice Hall of India, 1999.
8. David Bed worth - Computer Integrated Design and Manufacturing, TMH, 1998.

# AUTOMOBILE ENGINEERING

L-T-P  
3-1-0

## UNIT-I:

### Introduction:

Basic concepts of Automobile Engineering and general configuration of an automobile, Power and Torque characteristics. Rolling, air and gradient resistance. Tractive effort. Gear Box. Gear ratio determination.

## UNIT-II:

### Transmission System:

Requirements. Clutches. Torque converters. Over Drive and free wheel, Universal joint. Differential Gear Mechanism of Rear Axle. Automatic transmission, Steering and Front Axle. Castor Angle, wheel camber & Toe-in, Toe-out etc... Steering geometry. Ackerman mechanism, Understeer and Oversteer. Hotchkiss drive and Torque tube drive.

## UNIT-III:

### Braking System:

General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes, Hydraulic brakes. Vacuum and air brakes. Thermal aspects. Antilock braking system (ABS), electronic brake force distribution (EBD) and traction control.

### Chassis and Suspension System:

Loads on the frame, Strength and stiffness, Independent front & rear suspension, Perpendicular arm type, Parallel arm type, Dead axle suspension system, Live axis suspension system, Air suspension & shock absorbers.

## UNIT-IV:

### Electrical System:

Types of starting motors, generator & regulators, lighting system, Ignition system, Horn, Battery etc.

### Fuel Supply System:

Diesel & Petrol vehicle system such as Fuel Injection Pump, Injector & Fuel Pump, Carburettor etc. MPFI.

## UNIT-V:

### Emission standards and pollution control:

Indian standards for automotive vehicles-Bharat I and II, Euro-I and Euro-II norms, fuel quality standards, environmental management systems for automotive vehicles, engine emission control by 3-way catalytic converter system, fuel additives and modern trends in automotive engine efficiency and emission control.

### Alternative Energy Sources:

Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, application of Fuel Cells. Prevention maintenance and overhauling.

### Books and References:

1. Automotive Engineering- Hietner.
2. Automobile Engineering - Narang.
3. Automobile Engineering –TTTI, Pearson India.
4. Automotive Mechanics- Crouse.
5. Automobile Engineering - Newton and Steeds.
6. Automobile Engineering –Ramakrishna, PHI, India.
7. Automobile Engineering - Kripal Singh.

## CAD/CAM LAB

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0-0-2

**List of Experiments:** (Total EIGHT Experiments are to be carried out. FOUR Experiments each from CAD and CAM.)

### A. CAD Experiments:

1. Line Drawing or Circle Drawing experiment: Writing and validation of computer program.
2. Geometric Transformation algorithm experiment for translation/rotation/scaling: Writing and validation of computer program.
3. Design of machine component or other system experiment: Writing and validation of computer program.
4. Understanding and use of any 3-D Modelling Software commands.
5. Pro/E/Idea etc. Experiment: Solid modelling of a machine component.
6. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package.
7. Root findings or curve fitting experiment: Writing and validation of computer program.
8. Numerical differentiation or numerical integration experiment: Writing and validation of computer program.

### B. CAM Experiments:

1. To study the characteristic features of CNC machine.
2. Part Programming (in word address format) experiment for turning operation (including operations such as grooving and threading) and running on CNC machine.
3. Part Programming (in word address format or ATP) experiment for drilling operation (point to point) and running on CNC machine.
4. Part Programming (in word address format or ATP) experiment for milling operation (contouring) and running on CNC machine.
5. Experiment on Robot and programs.
6. Experiment on Transfer line/Material handling.
7. Experiment on difference between ordinary and NC machine, study or retrofitting.
8. Experiment on study of system devices such as motors and feedback devices.
9. Experiment on Mechatronics and controls.

## I.C. ENGINES & AUTOMOBILE LAB

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**Experiments: Say at least 8 experiments out of following in depth and details.**

1. Performance Analysis of Four stroke S.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
2. Determination of Indicated H.P. of I.C. Engine by Morse Test.
3. Performance Analysis of Four stroke C.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
4. Study & experiment on Valve mechanism.
5. Study & experiment on Gear Box.
6. Study & experiment on Differential Gear Mechanism of Rear Axle.
7. Study & experiment on Steering Mechanism.
8. Study & experiment on Automobile Braking System.
9. Study & experiment on Chassis and Suspension System.
10. Study & experiment on Ignition system of I.C. Engine.
11. Study & experiment on Fuel Supply System of S.I. Engines- Carburettor, Fuel Injection Pump and MPFI.
12. Study & experiment on Fuel Supply System of C.I. Engines- Injector & Fuel Pump.
13. Study & experiment on Air Conditioning System of an Automobile.
14. Comparative study of technical specifications of common small cars (such as Maruti Swift, Hyundai i20, Chevrolet Aveo, Tata Indica, Ford Fusion etc.
15. Comparative study & technical features of common scooters & motorcycles available in India.
16. Visit of an Automobile factory.
17. Visit to a Modern Automobile Workshop.
18. Experiment on Engine Tuning.
19. Experiment on Exhaust Gas Analysis of an I.C. Engine.



## **DEPARTMENTAL ELECTIVE-3**

### **COMPOSITE MATERIALS**

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3-0-0**

#### **UNIT-I:**

##### **Introduction:**

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.

#### **UNIT-II:**

##### **Types of Reinforcements/Fibers:**

Role and Selection of reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential.

#### **UNIT-III:**

##### **Various types of composites:**

Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites.

#### **UNIT-IV:**

##### **Fabrication methods:**

Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament winding, compression moulding, resin transfer method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films, maximum stress and strain criteria, Von Mises Yield criterion for isotropic materials.

#### **UNIT-V:**

##### **Testing of Composites and Analysis:**

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc. Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.

##### **Books and References:**

1. Materials characterization, Vol. 10, ASM hand book.
2. Mechanical Metallurgy, by G. Dieter, McGraw Hill.
3. Analysis and Performance of Fiber Composites, by Agarwal, McGraw Hill.
4. Thermal Analysis of Materials, by R.F. Speyer, Marcel Decker.
5. Engineering Mechanics and Composite Materials, by Daniels, Oxford University Press.
6. Material Science and Engineering (SIE) with CD, by Smith, McGraw Hill.
7. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
8. Engineering Materials: Polymers, Ceramics and Composites, by A.K Bhargava Prentice Hall India.

# POWER PLANT ENGINEERING

L-T-P  
3-0-0

## UNIT-I:

### **Introduction:**

Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. Load estimation, load curves, various terms and factors involved in power plant calculations.

Effect of variable load on power plant operation, Selection of power plant units. Power plant economics and selection. Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.

## UNIT-II:

### **Steam power plant:**

General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverisers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.

## UNIT-III:

### **Diesel power plant:**

General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.

### **Gas turbine power plant:**

Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant, Integrated Gasifier based Combined Cycle (IGCC) systems.

## UNIT-IV:

### **Nuclear power plant:**

Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

### **Hydroelectric and Non-Conventional Power Plant:**

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

## UNIT-V:

### **Electrical system:**

Generators and generator cooling, transformers and their cooling, bus bar, etc.

### **Energy Saving and Control:**

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

**Books and References:**

1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt. Ltd.
2. Power Plant Engineering by Hedge, Pearson India.
3. Power Plant Technology, by Wakil, McGraw Hill.
4. Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
5. Steam & Gas Turbines & Power Plant Engineering by R. Yadav, Central Pub.House.
6. Power Plant Engineering by Gupta, PHI India.
7. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
8. Power Plant Engineering. Mahesh Verma, Metropolitan Book Company Pvt. Ltd.

## SUPPLY CHAIN MANAGEMENT

L-T-P

3-0-0

### UNIT-I:

Introduction to Supply Chain Management, Understanding the Supply Chain.

Supply Chain Performance: Competitive and Supply Chain Strategies, achieving Strategic Fit and Scope of Strategic Fit.

### UNIT-II:

Supply Chain Drivers and Metrics: Drivers of Supply Chain Performance, Framework for structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing and Pricing, Case Study: Seven-Eleven Japan Company.

### UNIT-III:

Planning Demand and Supply in a Supply Chain: Demand Forecasting in a Supply Chain, Aggregate Planning in a Supply Chain.

Designing Distribution Networks and Application to E-Business- Role of distribution, factors influencing distribution network design, design options for a distribution network, E-Business and the distribution network.

### UNIT-IV:

Network Design in the Supply Chain- Role of network design in the supply chain, factors influencing network design decisions, framework for network design decisions.

Role of Information Technology in supply chain, coordination in a supply chain, Bullwhip Effect, Effect on performance due to lack of coordination, obstacles to coordination in a supply chain.

### UNIT-V:

Factors influencing logistics and decisions.

Benchmarking and performance measurement.

### Books and References:

1. Supply Chain Management: Strategy, Planning & Operation- Sunil Chopra & Peter Meindle- Pearson Prentice Hall Publication.
2. Logistical Management: The integrated Supply Chain Process- Donald J. Bowersox & David J. Closs- TMH Publication.
3. Supply Chain Management – Martin Christopher.
4. World Class Supply Management: The key to Supply Chain Management- Burt, Dobler and Straling – TMH Publication.
5. Logistics and Supply Management – D K Agarwal – MacMillan Publication
6. Supply Chain Management in the 21<sup>st</sup> Century- B. S. Sahay- MacMillan Publication.
7. Supply Chain Management: Theories & Practices – R P Mohanty and S. G. Deshmukh- Biztantra Publication.
8. e-Procurement: From Strategy to Implementation- Dale Neef- Prentice Hall Publication.

# ADDITIVE MANUFACTURING

L-T-P  
3-0-0

## UNIT-I:

### **Introduction:**

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, **Direct and Indirect Processes:** Prototyping, Manufacturing and Tooling.

**Layer Manufacturing Processes:** Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.

## UNIT-II:

### **Development of Additive Manufacturing Technology:**

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems.

Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

## UNIT-III:

### **Additive Manufacturing Processes:**

Vat Photopolymerization, Materials, Reaction Rates, Photopolymerization Process Modelling, Scan Patterns, **Powder Bed Fusion Processes;** Material, Powder Fusion Mechanism, Process Parameters and Modelling, powder Handling, **Extrusion Based System;** Basic principles, plotting and Path Control, Bio extrusion, Other Systems, **Material Jetting;** Materials, Material Processing Fundamentals, Material Jetting Machines, **Binder Jetting;** Materials, Process Variations, BJ Machines, **Sheet lamination Processes;** Materials, Ultrasonic Additive Manufacturing, **Directed Energy Deposition Processes;** General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing-Structure-Properties Relationships, **Direct Write Technologies;** Ink-Based DW, laser Transfer DW, Thermal Spray DW, Beam Deposition DW, Liquid Phase Direct Deposition, Hybrid Technologies.

## UNIT-IV:

### **Design & Software Issues:**

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM.

**Software Issue for Additive Manufacturing;** Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL file Manipulation, Beyond the STL file, Additional Software to Assist AM.

## UNIT-V:

### **Material Design & Quality Aspects:**

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities

### **Applications:**

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

### **Books and References:**

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson, D Savid W. Rosen, Brent Stucker, Springer.
2. Additive Manufacturing, by- Amit Bandyopadhyay, Susmita Bose, CRC Press.

3. Rapid Prototyping: Principles and Applications, by - Chee Kai Chua, Kah Fai Leong, Chu Sing Lim.
4. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing by Ian Gibson and David Rosen.
5. Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewelry (Springer Series in Materials Science) by John O Milewski.
6. Additive Manufacturing: Advanced Manufacturing Technology in 3d Print Deposit by SabrieSoloman.
7. Advances in 3D Printing and Additive Manufacturing Technologies by David Ian Wimpenny and Pulak M Pandey.
8. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser.

# DEPARTMENTAL ELECTIVE-4

## OPERATIONS RESEARCH

L-T-P  
3-1-0

### UNIT-I:

#### **Introduction:**

Basic of Operation Research, Origin & development of Operation Research, Applications.

#### **Linear Programming:**

Introduction & Scope, Problem formulation, Graphical Method, Simplex methods, primal and dual problem sensitivity analysis.

### UNIT-II:

#### **Transportation Problem:**

Methods of obtaining initial and optimum solution, degeneracy in transportation problems, unbalanced Transportation Problem.

#### **Assignment Problem:**

Methods of obtaining optimum solution, Maximization problem, travelling salesman problem.

### UNIT-III:

#### **Game Theory:**

Two-person Zero sum game, Solution with/without saddle point, dominance rule, Different methods like Algebraic, Graphical and game problem as a special case of Linear Programming.

#### **Sequencing:**

Basic assumptions, n Jobs through 2-3 machines, 2 Jobs on m machines.

### UNIT-IV:

**Stochastic inventory models:** Single & multi period models with continuous & discrete demands, Service level & reorder policy.

**Simulation:** Use, advantages & limitations, Monte-Carlo simulation, Application to queuing, inventory & other problems.

### UNIT-V:

**Queuing models:** Characteristics of Queuing Model, M/M/1 and M/M/S system, cost consideration.

**Project management:** Basic Concept of network Scheduling, Rules for drawing network diagram, Applications of CPM and PERT techniques in Project planning and control; crashing of operations; resource allocation.

#### **Books and References:**

1. Operations Research: Principles and Practice, by- Ravindran, Phillips, Solberg, John Wiley & Sons.
2. Principal of Operation Research, by- Harvey M. Wagner, Prentice Hall.
3. Introduction to Operation Research, by- Gillett, McGraw Hill.
4. Operations Research - An Introduction, by- Hamdy A. Taha, Pearson India.
5. Operation Research, by- Wayne L. Winston, Thomsan Learning.
6. Problems in Operations Research by- Prem Kumar Gupta & D.S. Hira, S. Chand.
7. Operation Research Application and Algorithms, by- Wayne L Winston, Duxbury Press.
8. Operations Research, by Jha, McGraw Hill.
9. Operation Research, by Yadav & Malik Oxford University Press.

## MODELLING AND SIMULATION

L-T-P  
3-1-0

### UNIT-I:

Bioinformatics objectives and overviews, Interdisciplinary nature of Bioinformatics, Data integration, Data analysis, Major Bioinformatics databases and tools. Metadata: Summary & reference systems, finding new type of data online. Molecular Biology and Bioinformatics: Systems approach in biology, Central dogma of molecular biology, problems in molecular approach and the bioinformatics approach, overview of the bioinformatics applications.

### UNIT-II:

Basic chemistry of nucleic acids, Structure of DNA, Structure of RNA, DNA Replication, Transcription-Translation, Genes- the functional elements in DNA, Analyzing DNA, DNA sequencing. Proteins: Amino acids, Protein structure, Secondary, Tertiary and Quaternary structure, Protein folding and function, Nucleic Acid-Protein interaction.

### UNIT-III:

Perl Basics, Perl applications for bioinformatics- Bio Perl, Linux Operating System, mounting/unmounting files, tar, gzip / gunzip, telnet, ftp, developing applications on Linux OS, Understanding and Using Biological Databases, Overview of Java, CORBA, XML, Web deployment concepts.

### UNIT-IV:

Genome, Genomic sequencing, expressed sequence tags, gene expression, transcription factor binding sites and single nucleotide polymorphism. Computational representations of molecular biological data storage techniques: databases (flat, relational and object oriented), and controlled vocabularies, general data retrieval techniques: indices, Boolean search, fuzzy search and neighbouring, application to biological data warehouses.

### UNIT-V:

Macromolecular structures, chemical compounds, generic variability and its connection to clinical data. Representation of patterns and relationships: sequence alignment algorithms, regular expressions, hierarchies and graphical models, Phylogenetics. BLAST.

### Books and References:

1. D E Krane & M L Raymer, "Fundamental concepts of Bioinformatics", Pearson Education.
2. Rastogi, Mendiratta, Rastogi, "Bioinformatics Methods & applications, Genomics, Proteomics & Drug Discovery" PHI, New Delhi.
3. Shubha Gopal et.al. "Bioinformatics: with fundamentals of genomics and proteomics", Mc Graw Hill.
4. O'Reilly, "Developing Bio informatics computer skills", CBS.
5. Simulation Model Design & execution by Fishwick, Prentice Hall, 1995.
6. Discrete event system simulation by Banks, Carson, Nelson and Nicol.
7. Averill M. Law, W. David Kelton, "Simulation Modelling and Analysis", TMH.
8. Forsdyke, "Evolutionary Bioinformatics", Springer.



# COMPUTATIONAL FLUID DYNAMICS

L-T-P  
3-1-0

## UNIT- I:

### **Governing Equations and Boundary Conditions:**

Basics of computational fluid dynamics. Governing equations of fluid dynamics. Continuity, Momentum and Energy equations. Chemical species transport. Physical boundary conditions, Time-averaged equations for Turbulent Flow. Turbulent–Kinetic Energy Equations Mathematical behaviour of PDEs on CFD. Elliptic, Parabolic and Hyperbolic equations.

## UNIT -II:

### **Finite Difference Method:**

Derivation of finite difference equations. Simple Methods. General Methods for first and second order accuracy, solution methods for finite difference equations. Elliptic equations. Iterative solution Methods. Parabolic equations. Explicit and Implicit schemes. Example problems on elliptic and parabolic equations.

## UNIT- III:

### **Finite Volume Method (FVM) for Diffusion:**

Finite volume formulation for steady state One, Two- and Three-dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank. Nicolson and fully implicit schemes.

## UNIT -IV:

### **Finite Volume Method for Convection Diffusion:**

Steady one-dimensional convection and diffusion. Central, upwind differencing schemes properties of discretization schemes. Conservativeness, Boundedness, Transportive, Hybrid, Power-law, QUICK Schemes.

## UNIT- V:

### **Calculation Flow Field by FVM:**

Representation of the pressure gradient term and continuity equation. Staggered grid. Momentum equations. Pressure and Velocity corrections; Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k- $\epsilon$ ) models. High and low Reynolds number models.

### **Books and References:**

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, by Versteeg, Pearson, India.
2. Numerical Heat Transfer and Fluid Flow, by Patankar, Tayers & Francis.
3. Computational Heat Transfer, by Jaluriaans Torrance, CRC Press.
4. Computational Fluid Dynamics, by Anderson, Mc Graw Hill.
5. Computational Fluid Dynamics, by Chung, Cambridge University Press.
6. Computer Simulation of flow and heat transfer, by Ghoshdastidar McGraw Hill.
7. Introduction to Computational Fluid Dynamics, by Prodip Niyogi. Pearson India.
8. Computational Fluid Flow and Heat Transfer, by Muralidhar and Sundararajan, Narosa Publishing House.
9. Computational Fluid Dynamics: Principles and Applications, by Blazek, Elsevier Science & Technology.

## AUTOMATION AND ROBOTICS

L-T-P  
3-1-0

### UNIT- I:

#### **Automation:**

Definition, Advantages, goals, types, need, laws and principles of Automation. Elements of Automation. Fluid power and its elements, application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems, Role of Robotics in Industrial Automation.

### UNIT- II:

#### **Manufacturing Automation:**

Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines. Programmable Manufacturing Automation CNC machine tools, Machining centres, Programmable robots, Robot time estimation in manufacturing operations.

### UNIT- III:

#### **Robotics:**

Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Power Source. Robot anatomy, configuration of robots, joint notation schemes, work volume, manipulator kinematics, position representation, forward and reverse transformations, homogeneous transformations in robot kinematics, D-H notations, kinematics equations, introduction to robot arm dynamics.

### UNIT -IV:

#### **Robot Drives and Power Transmission Systems:**

Robot drive mechanisms: Hydraulic / Electric / Pneumatics, servo & stepper motor drives, Mechanical transmission method: Gear transmission, Belt drives, Rollers, chains, Links, Linear to Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Leadscrews, Ball Bearings.

#### **Robot end Effectors:**

Classification of End effectors – active and passive grippers, Tools as end effectors, Drive system for grippers. Mechanical, vacuum and magnetic grippers. Gripper force analysis and gripper design.

### UNIT- V:

#### **Robot Simulation:**

Methods of robot programming, Simulation concept, Off-line programming, advantages of offline programming.

#### **Robot Applications:**

Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Limitation of usage of robots in processing operation. Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference.

#### **Books and References:**

1. An Introduction to Robot Technology, by Coifet Chirroza, Kogan Page.
2. Robotics for Engineers, by Y. Koren, McGraw Hill.
3. Robotic: Control, Sensing, Vision and Intelligence, by Fu, McGraw Hill.
4. Introduction to Industrial Robotics, by Nagrajan, Pearson India.

5. Robotics, by J.J. Craig, Addison-Wesley.
6. Industrial Robots, by Groover, McGraw Hill.
7. Robotic Engineering - An Integrated Approach : Richard D. Klafter Thomas A.
8. Robots & Manufacturing Automation, by Asfahl, Wiley.

## **SEMESTER-VIII**

## **DEPARTMENTAL ELECTIVE-5**

### **NON-DESTRUCTIVE TESTING**

**L-T-P  
3-1-0**

#### **UNIT-I:**

##### **Introduction:**

Scope and advantages of NDT, Comparison of NDT with Destructive Testing, some common NDT methods used since ages, Terminology, Flaws and Defects, Visual inspection, Equipment used for visual inspection. Ringing test, chalk test (oil whitening test). Uses of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection.

#### **UNIT-II:**

##### **Tests:**

Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Test stations, Advantages, types of penetrants and developers, Zygo test, Illustrative examples and interpretation of defects. Magnetic particle Inspection – scope and working principle, Ferro Magnetic and Nonferromagnetic materials, equipment & testing. Advantages, limitations Interpretation of results, DC & AC magnetization, Skin Effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, Applications.

#### **UNIT-III:**

##### **Radiographic methods:**

Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering), Pair production, Beam geometry and Scattering factor.

X-ray radiography: principle, equipment & methodology, applications, types of radiations and limitations.  $\gamma$ -ray radiography – principle, equipment., source of radioactive materials & technique, advantages of  $\gamma$ -ray radiography over X-ray radiography Precautions against radiation hazards. Case Study - casting and forging.

#### **UNIT-IV:**

##### **Ultrasonic testing methods:**

Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Case Study – Ultrasonography of human body.

#### **UNIT-V:**

##### **Special NDT Techniques:**

##### **Eddy Current Inspection:**

Principle, Methods, Equipment for ECT, Techniques, Sensitivity, advanced ECT methods. Application, scope and limitations, types of Probes and Case Studies. Introduction to Holography, Thermography and Acoustic emission Testing.

##### **Books and References:**

1. Non-Destructive Testing and Evaluation of Materials, by- Prasad, McGraw Hill Education.
2. Practical Non-destructive Testing, by- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Woodhead Publishing.

3. Non-Destructive Testing Techniques, by- Ravi Prakash, New Age International.
4. Nondestructive Testing Handbook, by Robert C. McMaster, American Society for Nondestructive.
5. Introduction to Nondestructive Testing: A Training Guide, by- Paul E. Mix, wiley.
6. Electrical and Magnetic Methods of Non-destructive Testing, by- J. Blitz, springer.
7. Practical non destructive testing by Raj, Baldev.
8. Basics of Non-Destructive Testing, by Lari& Kumar, KATSON Books.

## ADVANCED WELDING

L-T-P  
3-1-0

### UNIT-I:

**Introduction:** Welding as compared with other fabrication processes, Importance and application of welding, classification of welding processes, Health & safety measures in welding.

**Welding Power Sources:** Physics of welding Arc, Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators.

**Physics of Welding Arc:** Welding arc, arc initiation, voltage distribution along the arc, arc characteristics, arc efficiency, heat generation at cathode and anode, Effect of shielding gas on arc, isotherms of arcs and arc blow.

**Metal Transfer:** Mechanism and types of metal transfer in various arc welding processes.

### UNIT-II:

#### Welding Processes:

Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electro gas and Electroslag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwave welding.

### UNIT-III:

#### Heat Flow Welding:

Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

### UNIT-IV:

#### Repair & Maintenance Welding:

Hardfacing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

**Weldability:** Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium. Micro & Macro structures in welding.

### UNIT-V:

#### Weld Design:

Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.

#### Books and References:

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principles and Practices, by- Edwards R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, Khanna Publishers.
4. Welding Technology Fundamentals by William. A. Bowditch.
5. Welding Technology by N K Srinivasan.
6. Welding Engineering and Technology by R S Parmar.
7. Modern Welding Technology by Howard B Cary and Scott Helzer.
8. Welding Handbooks (Vol. I & II).

## THERMAL TURBOMACHINES

L-T-P  
3-1-0

### UNIT-I:

Brief history of turbo machinery, introduction to blowers, pumps, compressors, steam & gas turbines, turbojet, Review of laws of thermodynamics & SFEE in reference to turbomachinery, Energy transfer in turbo machines, Euler's equation, Definition of various efficiencies, preheat factor, Reheat factor, Blade classification, Blade terminology, Cascade testing, Velocity diagrams for axial and radial turbomachinery and pumps.

### UNIT-II:

#### **Centrifugal compressors:**

Principle of operation, work done and pressure rise, Velocity diagram for centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient, Diffuser, degree of reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, Centrifugal Compressor characteristic curves.

#### **Axial flow compressor:**

Principle of operation and working, Energy transfer, Velocity diagram for axial compressor, Factors affecting stage pressure ratio, Blockage in compressor annulus, Degree of reaction, 3-D flow, Design process, blade design, calculation of stage performance, Axial compressor performance characteristic curves.

### UNIT-III:

#### **Axial flow turbines:**

Elementary theory of axial flow turbine, Energy transfer, Velocity diagram, Types of blades, Vortex theory, Choice of blade profile, pitch and chord, Estimation of stage performance, Characteristic curves.

### UNIT-IV:

**Steam turbines:** Constructional details, working of steam turbine.

**Pumps:** Classification of Pumps, Main components, indicator diagram and modification due to piston acceleration, Performance characteristics, Cavitation and its control, Miscellaneous types of pumps.

**Radial flow turbines:** Elementary theory of radial flow turbines, Enthalpy- Entropy diagram, State losses, Estimation of stage performance, Performance characteristics.

### UNIT-V:

**Gas Turbine Starting & Control Systems:** Starting ignition system, Combustion system types, Safety limits & control.

**Turbine Blade cooling:** Different cooling techniques, Types of coolants, Comparative evaluation of different cooling techniques.

**Mechanical Design consideration:** Overall design choices, Material selection, Design with traditional materials.

### **Books and References:**

1. Gas turbine theory: Cohen & Rogers, Addison Wesley Longman Ltd.
2. Turbine, Compressors and Fans, S.M. Yahya, Tata Mc Graw Hill.
3. Gas Turbine- Ganeshan, Tata Mc Graw Hill.
4. Thermal Turbomachines, by Singh, Wiley.
5. Fundamentals of Turbomachinery, by Venkanna, PHI, India.
6. Turbo Machine by S L Dixon.
7. Turbines, Compressors & Fans by Yahya.
8. Fundamentals of Turbomachinery by Venkanna, PHI, India.

## ENERGY CONSERVATION AND MANAGEMENT

L-T-P  
3-0-0

### UNIT -I:

Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.

### UNIT -II:

Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

### UNIT -III:

Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.

### UNIT -IV:

Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration & Air Conditioning systems, Cooling Towers, DG sets.

### UNIT-V:

Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.

### Books and References:

1. Witte L.C., Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988.
2. Callaghan P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
4. Energy Management and Conservation by K V Sharma and P Venkataseshaiyah
5. Energy Management and Conservation Handbook (Mechanical and Aerospace Engineering Series) by Frank Kreith and D Yogi Goswami
6. Energy Conversion and Management by Giovanni Petrecca
7. World Energy Resources: International Geohydroscience and Energy Research Institute by Charles Brown
8. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at [www.energymanagertraining.com](http://www.energymanagertraining.com)).



## DEPARTMENTAL ELECTIVE-6

### TOTAL QUALITY MANAGEMENT (TQM)

L-T-P  
3-0-0

#### UNIT -I:

##### **Quality Concepts:**

Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design.

##### **Control on Purchased Product:**

Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

##### **Manufacturing Quality:**

Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims.

#### UNIT -II:

##### **Quality Management:**

Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, reduction programme.

##### **TQM Principles:**

Leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

#### UNIT -III:

##### **Tools and Techniques:**

Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Control chart, flow chart).

##### **Control Charts:**

Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts, P-charts and C-charts.

#### UNIT -IV:

##### **Defects Diagnosis and Prevention:**

Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

#### UNIT -V:

##### **ISO and its concept of Quality Management:**

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors, Auditing, Taguchi method, JIT in some details.

##### **Books and References:**

1. Total Quality Management, by Dale H. Besterfield, Pearson India.
2. Beyond Total Quality Management, Greg Bounds, McGraw Hill.
3. Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.

4. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
5. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
6. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
7. Total Quality Management by Mukherjee, P.N.
8. TQM in New Product manufacturing, H. G. Menon, McGraw Hill.

## **GAS DYNAMICS AND JETPROPULSION**

**L-T-P**  
**3-1-0**

### **UNIT -I:**

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow.

### **UNIT-II:**

Isentropic flow through variable area ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, choked flow, Area-Mach number relations for isentropic flow.

### **UNIT -III:**

Non-isentropic flow in constant area ducts, Rayleigh and Fano flows, Normal shock relations, oblique shock relations, isentropic and shock tables.

### **UNIT -IV:**

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

### **UNIT -V:**

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, spaceflights.

### **Books and References:**

1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, "Understanding Aerospace Chemical Propulsion", Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol. I & II, John Wiley, 1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

## DESIGN OF TRANSMISSION SYSTEMS

L-T-P

3-0-0

### UNIT -I:

#### **Flexible transmission elements:**

Design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets.

### UNIT -II:

#### **Gear transmission:**

Speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.

### UNIT -III:

#### **Straight bevel gear:**

Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears.

### UNIT -IV:

#### **Gear box:**

Geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box - Design of multi-speed gear box for machine tool applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications.

### UNIT -V:

#### **Cam design, types:**

Pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake.

#### **Books and References:**

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3. Design of transmission systems by Eamanamurthy and S Machandran.
4. Electrical Power Transmission System Engineering: Analysis and Design” by Turan Gonen.
5. Experimental Stress Analysis for Materials and Structures (Springer Series in Solid and Structural Mechanics)” by Alessandro Freddi and Giorgio Olmi.
6. Radio Frequency Transmission Systems: Design and Operation” by Jerry Whitaker.
7. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.

## THEORY OF ELASTICITY

L-T-P

3-0-0

### UNIT-I:

#### **Basic Equations of Elasticity:**

Definition of Stress and Strain: Stress – Strain Relationships – Equations of Equilibrium, Compatibility Equations, Boundary Conditions, Saint Venant's principle – Principal Stresses, Stress Ellipsoid – Stress Invariants.

### UNIT-II:

#### **Plane Stress and Plane Strain Problems:**

Airy's Stress Function, Bi-Harmonic Equations, Polynomial Solutions, Simple Two-Dimensional Problems in Cartesian Coordinates Like Bending of Cantilever and Simply Supported Beams.

### UNIT-III:

#### **Polar Coordinates:**

Equations of Equilibrium, Strain – Displacement Relations, Stress – Strain Relations, Airy's Stress Function, Axis – Symmetric Problems, Introduction to Dunder's Table, Curved Beam Analysis, Lamé's, Kirsch, Michell's And Boussinesque Problems – Rotating Discs.

### UNIT-IV:

#### **Torsion:**

Navier's Theory, St. Venant's Theory, Prandtl's Theory on Torsion, Semi- Inverse Method and Applications to Shafts of Circular, Elliptical, Equilateral Triangular and Rectangular Sections. Membrane Analogy.

### UNIT-V:

#### **Introduction to Theory of Plates and Shells:**

Classical Plate Theory – Assumptions – Governing Equations – Boundary conditions – Navier's Method of Solution for Simply Supported Rectangular Plates Levy's Method of Solution for Rectangular Plates Under Different Boundary Conditions.

#### **Books and References:**

1. Wang, C. T., "Applied Elasticity", McGraw – Hill Co., New York, 1993.
2. Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw – Hill, New York, 1978.
3. Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991.
4. Barber, J. R., "Elasticity", Kluwer Academic Publishers, 2004.
5. Theory of elasticity by S.Timoshenko.