SEMESTER V

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	CME391	Design for Manufacturing	PCC	3	0	0	3	3
2.	CME380	Automobile Engineering	PCC	3	0	0	3	3
3.	CME399	Operational Research	PCC	3	0	0	3	3
4.	CME382	Composite Materials and Mechanics	PCC	3	0	0	3	3
5.	CME390	Thermal Power Engineering	PCC	3	0	0	3	3
PRACTICALS								
6.	MS3511	Metallurgy Laboratory	PCC	0	0	4	4	2
7.	MS3512	Industrial Training III	EEC	0	0	0	0	2
			TOTAL	**15**	**0**	**4**	**19**	**19**

SEMESTER VI

S. No.	Course Code	Course title	Cate Gory	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	MS3601	Instrumentation and Control Systems	PCC	4	0	0	4	4
2.	CME389	Design of Transmission System	PCC	3	0	0	3	3
3.	CME387	Non-traditional Machining Processes	PCC	3	0	0	3	3
4.	CME396	Process Planning and Cost Estimation	PCC	3	0	0	3	3
5.	CPR332	Finite Element Analysis	PCC	3	0	0	3	3
PRACTICALS								
6.	MS3611	Computer Aided Engineering Laboratory	PCC	0	0	4	4	2
7.	MS3612	Design and Fabrication Project	EEC	0	0	4	4	2
8.	MS3613	Industrial Training IV	EEC	0	0	0	0	2
			TOTAL	**16**	**0**	**8**	**24**	**22**

Attested

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Anna University, Chennai-600 025

Threading and feed box – Gear box - Head stock spindle - Tail stock spindle - Gear - Lead screw - Feed shaft - Spine shaft. – Exposure to metrological aspects of components used for lathes, pumps and motors.

CME391	DESIGN FOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To introduce economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2 To learn design consideration principles of forming in the design of extruded, stamped, and forged products.
3 To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
4 To learn design consideration principles of welding in the design of welded products.
5 To learn design consideration principles of assembly in the design of assembled products.

UNIT – I INTRODUCTION AND CASTING **9**

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.

UNIT – II FORMING **9**

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts.

UNIT – III MACHINING **9**

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts.

UNIT – IV WELDING **9**

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.

UNIT – V ASSEMBLY **9**

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2. Explain design consideration principles of forming in the design of extruded, stamped, and forged products.
3. Explain design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
4. Explain design consideration principles of welding in the design of welded products.
5. Explain design consideration principles of assembly in the design of assembled products.

TEXT BOOKS:

1. James G. Bralla, “Handbook of Product Design for Manufacture”, McGraw Hill, 1986.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

REFERENCES:

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Henry Peck, "Designing for Manufacture", Sir Isaac Pitman & Sons Ltd., 1973.
5. Matousek, "Engineering Design", Blackie & Sons, 1956.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	3	1								1	2	2	1
2	3	3	3	1								1	2	2	1
3	3	3	3	1								1	2	2	1
4	3	3	3	1								1	2	2	1
5	3	3	3	1								1	2	2	1
Low (1) ; Medium (2) ; High (3)															

CME380 **AUTOMOBILE ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

1 To study the construction and working principle of various parts of an automobile.
2 To study the practice for assembling and dismantling of engine parts and transmission system
3 To study various transmission systems of automobile.
4 To study about steering, brakes and suspension systems
5 To study alternative energy sources

UNIT – I VEHICLE STRUCTURE AND ENGINES **9**

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

UNIT – II ENGINE AUXILIARY SYSTEMS **9**

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT – III TRANSMISSION SYSTEMS **9**

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT – IV STEERING, BRAKES AND SUSPENSION SYSTEMS **9**

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS),electronic brake force distribution (EBD) and Traction Control.

UNIT – V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Recognize the various parts of the automobile and their functions and materials.
2. Discuss the engine auxiliary systems and engine emission control.
3. Distinguish the working of different types of transmission systems.
4. Explain the Steering, Brakes and Suspension Systems.
5. Predict possible alternate sources of energy for IC Engines.

TEXT BOOKS:

1. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.
2. Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.

REFERENCES:

1. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.
2. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
3. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.
4. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart - Will Cox Company Inc, USA ,1978.
5. Newton, Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1989.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	2	1					1			1	1	2	1
2	2	1	2	1					1			1	1	2	1
3	2	1	2	1					1			1	1	2	1
4	2	1	2	1					1			1	1	2	1
5	2	1	2	1					1			1	1	2	1
Low (1) ; Medium (2) ; High (3)															

CME399 OPERATIONAL RESEARCH L T P C
3 0 0 3

COURSE OBJECTIVES:

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

1. To learn Selecting the constraints on the availability of resources and developing a model and rendering an optimal solution for the given circumstances.
2. To study Appraising the challenges in the transportation and production problems and furnishing a rational solution to maximize the benefits.
3. To learn Planning the purchase/ manufacturing policies, managing the spares/ stocks and meeting the customer demands.
4. To Analysing the queue discipline and exploring the avenues for better customer service.
5. To Investigating the nature of the project and offering methodical assistance towards decision making in maintenance.

UNIT – I **INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING** **9**

Operation Research: Definition – Models – Steps – Important topics – Scope - Tools. Linear Programing (LP): Introduction – Concept (Problem mix, Assumption, Properties) –Development (Problem formulation) – Problems in: Graphical method, Simplex methods, Big M method.

UNIT – II **TRANSPORTATION, ASSIGNMENT AND PRODUCTION SCHEDULING PROBLEMS** **9**

Transportation problems: Introduction, Model, Types – Problems in: Initial Basic (feasible) solution: Northwest Corner Cell method; Least Cost Cell method; Vogel's Approximation method and Optimal solution MODI (U-V) method. Assignment problems: Introduction,Types, Problems in Hungarian method. Production Scheduling problems: Introduction –Problems in Single Machine Scheduling: SPT; WSPT, EDD methods – Problems inJohnson's Algorithm: n job 2 machines, n job 3 machines.

UNIT – III **INVENTORY CONTROL MODELS & SYSTEMS** **9**

Inventory Control: Introduction, Models – Problems in Purchase and Production(Manufacturing) models with and without shortages – Theory on types of inventory control systems: P& Q, ABC, VED, FNS, XYZ, SDE and HML.

UNIT – IV **QUEUING THEORY** **9**

Queuing Theory: Introduction; Applications; Terminology, Poisson process and exponential distribution – Problems in Single Server and Multi Server Queuing Models –Case study on simulation using Monte Carlo technique.

UNIT – V **PROJECT MANAGEMENT AND REPLACEMENT MODELS** **9**

Project Management: Introduction; Guidelines for Networking AOA Diagrams – Problems in Critical Path Method (CPM) & Program Evaluation Review Technique (PERT) – Differences of CPM & PERT. Replacement Problems: Types – Problems in: Determination of Economic Life of an Asset – Problems in: Individual and Group Replacement Policies , Apply OR software

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the selection of the constraints on the availability of resources, develop a model and render an optimal solution for the given circumstances.
2. Explain the appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.
3. Explain plan the purchase/ manufacturing policies, manage the spares/ stocks, and meet the customer demands.
4. Analyze the queue discipline and explore the avenues for better customer service.
5. Investigate the nature of the project and offer methodical assistance towards decision making in maintenance.

TEXT BOOKS:

1. Pannerselvam R, "Operations Research", 2nd Edition, PHI, 2009.
2. Hamdy A. Taha, "Operations Research an Introduction", 10th Edition, PHI/Pearson Education, 2017.

REFERENCES:

1. Ravindran, Phillips and Solberg, "Operations Research Principles and Practice", 2nd Edition, Wiley India, 2007.
2. Srinivasan G, "Operations Research Principles and Applications", 3 rd Edition EEEPHI, 2017.
3. Sharma J K, "Operations Research Theory and Applications",5th Edition, Macmillan India, 2013.
4. Premkumar Gupta and D.S.Hira, "Problems in Operations Research", S.Chand,2009.
5. Wayne L. Winston, "Operations Research Applications and Algorithms", 4th Edition, Cengage Learning, 2004.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

1	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
2	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
3	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
4	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
5	2	3	3	2	2	1	1	1	1	1	2	2	2	2	2
Low (1) ; Medium (2) ; High (3)															

CME382 COMPOSITE MATERIALS AND MECHANICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To study the fundamentals of composite material strength and its mechanical behavior
2. To study the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
3. To study Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
4. To Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
5. To study the fundamentals of composite material strength and its mechanical

UNIT – I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramicand Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing:Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes

UNIT – II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT – III LAMINA STRENGTH ANALYSIS 9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT – IV THERMAL ANALYSIS 9

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations –Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

UNIT – V ANALYSIS OF LAMINATED FLAT PLATES 9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Summarize the various types of Fibers, Equations and manufacturing methods for

2. Derive Flat plate Laminate equations
3. Analyze Lamina strength
4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates

TEXT BOOKS:

1. Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRC press in progress, 1994, -.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw Hill, 1998

REFERENCES:

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
2. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber," Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	3	3		2	2					2	3		
2	2	2	2	2		2	2					2	3		
3	2	2	2	2		2	2					2	3		
4	2	2	2	2		2	2					2	3		
5	2	2	2	2		2	2					2	3		
Low (1) ; Medium (2) ; High (3)															

CME390 THERMAL POWER ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives

1 To study the fuel properties and arrive at proximate and ultimate analysis of fuels.
2 To study the different types of boilers and compute their performance parameters.
3 To study the performance parameters of an air compressor
4 To study the working principles of various refrigeration systems and perform cop calculations
5 To study the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads

UNIT – I FUELS AND COMBUSTION **9**

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value -Gross & Net Calorific Values

UNIT – II BOILERS **9**

Types and comparison, Mountings and Accessories. Performance calculations, Boiler trial.

UNIT – III AIR COMPRESSORS **9**

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors

UNIT – IV REFRIGERATION SYSTEMS **9**

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration.

UNIT – V PSYCHROMETRY AND AIR-CONDITIONING **9**

Psychrometric properties – Property calculations using Psychrometric chart and expressions. Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Evaluate the fuel properties and arrive at proximate and ultimate analysis of fuels.
2. Analyze different types of boilers and compute their performance parameters.
3. Evaluate the performance parameters of an air compressor
4. Apply the working principles of various refrigeration systems and perform cop calculations
5. Analyze the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads.

TEXT BOOKS:

1. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.
2. Ballaney. P, “ Thermal Engineering”, 25th Edition, Khanna Publishers, 2017

REFERENCES:

1. Ananthanarayanan P.N, “ Basic Refrigeration and Air-Conditioning”, 4th Edition, Tata McGraw Hill, 2013.
2. Arora, “ Refrigeration and Air-Conditioning”, 2nd Edition, Prentice Hall of India, 2010.
3. Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
4. Nag P.K, “ Basic and Applied Thermodynamics”, 2nd Edition, Tata McGraw Hill, 2010
5. Soman. K, “Thermal Engineering”, 2nd Edition, Prentice Hall of India, 2011

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1					1			1	2	1	1
2	3	2	1	1					1			1	2	1	1
3	3	1	1	1					1			1	2	1	1
4	3	2	1	1					1			1	2	1	1
5	3	1	1	1					1			1	2	1	1
Low (1) ; Medium (2) ; High (3)															

MS3511 METALLURGY LABORATORY **L T P C**

0 0 4 2

OBJECTIVES:

- To train the students in observation and interpretation of Microstructure of Engineering materials.
- To train students in Heat treatment, hardenability and surface treatment of Engineering Materials
- To train the students in testing of Foundry sand

LIST OF EXPERIMENTS:

1. Specimen preparation for macro – examination.
2. Specimen preparation for micro examination and study of Micro structure of –
    a) Carbon steel s(High, Medium, and Low)
    b) Cast Iron (Gray, White, Nodular, Malleable)
    c) Brass (70/30), Bronze (tin bronze), Al-Si alloy, cupro-nickel, Ti alloy.
3. Quantitative metallography – Estimation of volume fraction, particle size, size distribution, and shape.
4. Cooling curves
    a) Pure Metal (Pb or Sn)
    b) Alloy (Pb-Sn or Pb-Sb)
5. Heat treatments (carry out the following heat treatment and study the micro structure before and after heat treatments)
    a) Annealing
    b) Normalising
    c) Quench Hardening
    d) Tempering
6. Jominy End Quench Test
7. Foundry Sand testing
    a) Sieve analysis
    b) Strength of moulding sand
    c) Permeability of moulding sand
    d) Clay content of moulding sand
    e) Moisture content of moulding sand
8. Electro-chemical Test
    a) Electro deposition
    b) Electro-chemical etching test

TOTAL: 60 PERIODS

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	1	3	-	-	-	3	-	-	3	1	1	
2	3	1	1	1	3	-	-	-	3	-	-	3	1	1	
3	3	3	3	3	3	-	-	-	3	-	-	3	3	3	
4	3	3	3	3	3	-	-	-	3	-	-	3	3	3	
5	3	3	3	3	3	-	-	-	3	-	-	3	3	3	
Low (1) ; Medium (2) ; High (3)															

MS3512 **INDUSTRIAL TRAINING III** **L T P C**

(PRODUCT DEVELOPMENT AND QUALITY SYSTEMS) **0 0 0 2**

Total product knowledge, reverse engineering and quality system skill (Mini Project- I), Detailed constructional knowledge of product assembly, sub assembly, components, Sequential assembly and disassembly procedure, capturing of all geometrical dimensions, drawings, tolerances, fits,

form error, material of construction and to understand the product development skills for lathes, drilling machines, submersible pumps, mono block pumps& electric motors - Comparison of design construction of other makes for above products and analysis -To develop any new product with innovation & creativity - Report preparation, presentation and evaluation -Awareness of TQM, ISO9000, ISO14000 and other standards etc. - Process capability studies – Rejection analysis – Six sigma applications – Calibration needs – Calibration authorities – Records – Charts – Applications – Form error understanding and verification- Case studies in quality systems.

MS3601	INSTRUMENTATION AND CONTROL SYSTEMS	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

1 To impart knowledge on measurements and variables
2 To introduce different parameters in environment and measuring techniques
3 To familiarise the working principle of temperature, pressure, vibration and flow measurement sensors.
4 To teach the control system principle and build times response of different system

UNIT I TRANSDUCER VARIABLES AND MEASUREMENT SIGNALS 10

Three stages of generalized measurement system – mechanical loading – static characteristics of instruments- factors considered in selection of instruments – commonly used terms, error analysis and classification – sources of error – frequency response – displacement transducers – potentiometer, strain gauge – orientation of strain gauge, LVDT – variable reluctance transducers, proximity sensors, capacitance transducers, tacho generator; smart sensors, integrated sensors, radio telemetry, torque measurements, precision systems like video discs and drives, laser printer etc

UNIT II VIBRATION AND TEMPERATURE 9

Elementary accelerometer and vibrometer – seismic instrument for acceleration – velocity measurement, piezo electric accelerometer, temperature measurement-liquid in glass thermometer, pressure thermometer, resistance temperature detector, themcouples and thermopiles, thermistor, total radiation pyrometer, optical pyrometer – temperature measuring problem in flowing fluid.

UNIT III PRESSURE AND FLOW MEASUREMENT 9

Manometer, elastic transducer, elastic diaphragm transducer – pressure cell, bulk modulus pressure gauge – Mc Leod gauge – thermal conductivity gauge, calibration of pressure gauge, flow measurement – turbine type meter, hotwire anemometer, magnetic flow meter; liquid level sensors, light sensors, selection of sensors.

UNIT IV CONTROL SYSTEM PRINCIPLE 16

Basic elements of control systems – open loop and closed loop control – elements of closed loop control system – introduction to sampled data, digital control and multivariable control systems. Elements of lead and lag compensation, elements of proportional, integral - derivative (PID) control.

MODELLING OF SYSTEMS: Mathematical Model for mechanical and electrical system - Transfer function – transfer function of hydraulic and pneumatic elements – flapper valve. Transfer function of D C Generator, DC servomotor and AC servomotors, tacho generators, gear trains, potentiometers, synchros – Transfer function of closed loop systems: determination of transfer function for position control, speed control system, temperature control system – block diagram reduction and signal flow graph