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(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2019-20)
MECHANICAL ENGINEERING (ME)

IV B. Tech – I Semester

S. No	Category	Course Code	Course Title	Contact Hours per week			Credits	Scheme of Examination (Max. Marks)		
				L	T	P		CIE	SEE	Total
THEORY										
1	PC	19APC0321	Metrology and Measurements	3	0	0	3	30	70	100
2	PC	19APC0323	Operations Research	3	0	0	3	30	70	100
3	PC	19APC0326	Automobile Engineering	2	0	0	2	30	70	100
4	PE		**Professional Elective III**	3	0	0	3	30	70	100
		19APE0307	Refrigeration & Air Conditioning							
		19APE0308	Finite Element Analysis							
		19APE0309	Computational Fluid Dynamics							
5	PE		**Professional Elective IV**	3	0	0	3	30	70	100
		19APE0310	Power Plant Engineering							
		19APE0311	Simulation Modelling for Manufacturing Systems							
		19APE0312	Advanced Mechanics							
6	HE		**Humanities Elective II**	2	0	0	2	30	70	100
		19AHE9906	Effective Technical Communication							
		19AHE9901	Technical Writing							
		19AHSMB03	Organizational Behaviour							
PRACTICAL										
7	PC	19APC0322	Metrology and Measurements Lab	0	0	2	1	30	70	100
8	PR	19APR0304	Socially Relevant Project (15 hr/sem)	0	0	0	0.5	50	-	50
9	PR	19APR0305	Industrial Training/Internship/Research Projects in National Laboratories / Academic Institutions	0	0	4	1.5	50	-	50
			Total	**18**	**0**	**7**	**19**	**370**	**490**	**800**

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APC0321	Metrology and Measurements	3	0	0	3

Course Outcomes:

CO: 1	Identify techniques to minimize the errors in measurement.
CO: 2	Identify methods and devices for measurement of length, angle, gear & thread parameters, surface roughness and geometric features of parts.
CO: 3	Understand working of lathe, shaper, planer, drilling, milling and grinding machines.
CO: 4	Comprehend speed and feed mechanisms of machine tools.
CO: 5	Estimate machining times for machining operations on machine tools

UNIT – I

LIMITS, FITS and TOLERNCES: Introduction, Definitions, fits and their types – unilateral and bilateral tolerance system, hole and shaft basis systems – interchangeability and selective assembly.
LIMIT GAUGES and GAUGE DESIGN: Plug, Ring, Snap, Gap, Taper gauges. Taylor‟s principle.
COMPARATORS: Principle of Measurement with Mechanical, Optical, Electrical, Electronic, Pneumatic comparators and their uses.

UNIT – II

Fundamental of measurement, basic terminology, fundamentals.
LINEAR MEASUREMENT: Length standard, ine and end & wavelength standards, slip gauges – calibration of the slip gauges, Dial indicator, micrometers, vernier height gauges.

UNIT – III

GEAR MEASUREMENT: Gear measuring instruments, Gear tooth profile measurement. Measurement of diameter, pitch, pressure angle and tooth thickness.
MACHINE TOOL ALIGNMENT TESTS: Requirements of Machine Tool Alignment Tests, Alignment tests on lathe, milling and drilling machine tools. Preparation of acceptance charts

UNIT – IV

MEASUREMENT OF DISPLACEMENT: Theory and constructionof various transducers to measure displacement - Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.
MEASUREMENT OF SPEED: Mechanical Tachometers - Electrical tachometers - Stroboscope, Noncontact type of tachometer
UNIT – V

MEASUREMENT OF FORCE, TORQUE, POWER: Standards and alibration, Basic methods of Force Measurement, Torque measurement on rotating shafts, shaft power measurement(dynamometers), Vibrating wire force transducers.
MEASUREMENT OF TEMPERATURE, PRESSURE, FLOW RATE:

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TEXT BOOKS:

1. Mechanical Measurements, Beckwith, Marangoni, Linehard, PHI, PE
2. Measurement systems: Application and design, Doeblin Earnest. O. Adaptation by Manik and Dhanesh, TMH,2012.
3. Engineering Metrology, R.K. Jain, Khanna Publishers, 20th edition, 2013.

REFERENCE BOOKS:

1. Engineering Metrology, Mahajan, DhanpatRai, 2nd edition, 2013.
2. BIS standards on Limits & Fits
3. Fundamentals of Dimensional Metrology, Connie Dn, CENGAGE LEARNERS
4. Metrology & easurement by Anand K Bewoor, vinay A kulkarni, Mc GrawHill, 2013.
5. Instrumentation, measurement &analysis, B.C. Nakra &KKChoudhary, TMH, 6th edition, 2011

List of COs	PO no. and keyword	Competency Indicator	Performance Indicator
CO1	PO 1: Engineering knowledge	1.6	1.3.1
CO2	PO 5: Modern tool usage	5.2	5.2.2
CO3	PO 2: Problem analysis	2.5	2.1.2
CO4	PO 5: Modern tool usage:	5.2	5.2.2
CO5	PO 7: Environment and sustainability	7.4	7.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APC0323	Operations Research	3	0	0	3

Course Outcomes:

CO: 1 Able to create mathematical models of the real-life situations and capable of obtaining best solution using Graphical Method and Simplex Method
CO: 2 To implement the theory of duality for simplifying the solution procedure for certain LPPs, and solve the special cases of LPP and Assignment problems
CO: 3 Knowledge of choosing the best strategy out of the available strategies which is an essential skill for any business manager to successfully face the competition
CO: 4 Able to represent any project in the form of a network and estimate the parameters like Project Completion Time
CO: 5 Applying Dynamic Programming technique to solve the complex problems by breaking them into a series of sub-problems

UNIT – I

LINEAR MODELS

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis.

UNIT – II

TRANSPORTATION MODELS AND NETWORK MODELS
Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT – III

INVENTORY MODELS
Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT – IV

QUEUEING MODELS

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT – V

DECISION MODELS

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life

– Economic life– Single / Multi variable search technique – Dynamic Programming – Simple Problem.

Text Books:

1. Operations Research, Dr. C.Nadhamuni Reddy & Sri Gopal Krishna, Kurnool Publishers
2. Operation Research, J.K.Sharma,MacMilan, 5th edition, 2013.
3. Introduction to Operations Research, H.A.Taha, PHI, 9th edition, 2013

Reference Books:

1. Operations Research, A.M.Natarajan,P.Balasubramani,A. Tamilarasi,Pearson Education, 8th edition, 2011
2. Operations Research by R Panneerselvam, PHI, 2nd edition, 2012.
3. Operations Research, Wagner, PHI Publications , 2nd edition.
4. Operations Research, S.R.Yadav, A.K.Malik, Oxford, 2015

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APC0326	Automobile Engineering	3	0	0	3

Course Outcomes:

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

UNIT – I

VEHICLE STRUCTURE AND ENGINES

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

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

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, 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

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

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol 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.

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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

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APE0307	Refrigeration & Air Conditioning	3	0	0	3

Course Outcomes:

CO: 1 Illustrate the fundamental principles and applications of refrigeration and air conditioning system.
CO: 2 Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems.
CO: 3 Present the properties, applications and environmental issues of different refrigerants
CO: 4 Calculate cooling load for air conditioning systems used for various
CO: 5 Operate and analyze the refrigeration and air conditioning systems

UNIT – I

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP

UNIT – II

VAPOUR COMPRESSION REFRIGERATION SYSTEM:

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT – III

OTHER REFRIGERATION SYSTEMS:

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems.

UNIT – IV

PSYCHROMETRIC PROPERTIES AND PROCESSES

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT – V

AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

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TEXT BOOK:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010

Reference Books:

1. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2007
2. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
3. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APE0308	Finite Element Analysis	3	0	0	3

Course Outcomes:

CO: 1 Summarize the basics of finite element formulation.
CO: 2 Apply finite element formulations to solve one dimensional Problems.
CO: 3 Apply finite element formulations to solve two dimensional scalar Problems.
CO: 4 Apply finite element method to solve two-dimensional Vector problems.
CO: 5 Apply finite element method to solve problems on iso parametric element and dynamic Problems.

UNIT – I

INTRODUCTION

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT – II

ONE-DIMENSIONAL PROBLEMS

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer.

UNIT – III

TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts – Quadrilateral elements – Higher Order Elements.

UNIT – IV

TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT – V

ISOPARAMETRIC FORMULATION

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software

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Text Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005

2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APE0309	Computational Fluid Dynamics	3	0	0	3

Course Outcomes:

CO: 1 Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems
CO: 2 Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems
CO: 3 Express numerical modeling and its role in the field of fluid flow and heat transfer
CO: 4 Illustrate the working concepts of thermal engineering
CO: 5 Improve the student's understanding of the basic principles of fluid mechanics

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 AND FINITE VOLUME METHODS FOR DIFFUSION

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

UNIT – III

FINITE VOLUME METHOD FOR CONVECTION DIFFUSION

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

UNIT – IV

FLOW FIELD ANALYSIS

Finite volume methods -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 – PISO Algorithms

UNIT – V

TURBULENCE MODELS AND MESH GENERATION

Turbulence models, mixing length model, Two equation (k-?) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

Text Books:

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1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition, 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill

References:

1. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
2. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa
4. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press

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CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APE0310	Power Plant Engineering	3	0	0	3

Course Outcomes:

CO: 1 Discuss the basic terminology and concepts involved in the power generation calcualtions.

CO: 2 Analyze the working and layout of steam power plants and the different systems comprising the plant and discuss about its economic and safety impacts

CO: 3 Combine concepts of previously learnt courses to define the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types

CO: 4 Discuss the working principle and basic components of the hydro electric plants and the economic principles and safety precautions involved with it.

CO: 5 Discuss and analyze the working principles of different non conventional sources involved in the power generation.

UNIT – I

Introduction To The Sources Of Energy – Resources and Development of Power in India. Layouts of Steam, Hydel, Diesel, MHD, Nuclear and Gas Turbine Power Plants - Combined Power Cycles - Comparison and Selection, Power Plant Economics and Environmental Considerations: Capital Cost, Investment of Fixed Charges, Operating Costs, General Arrangement of Power Distribution, Load Curves, Load Duration Curve. Definitions of Connected Load, Maximum Demand, Demand Factor, Average Load, Load Factor, Diversity Factor – Tariff - Related Exercises. Effluents from Power Plants and Impact on Environment – Pollutants and Pollution Standards – Methods of Pollution Control. Inspection And Safety Regulations.

UNIT – II

Steam Power Plant : Modern High Pressure and Supercritical Boilers - Analysis of Power Plant Cycles - Modern Trends in Cycle Improvement - Waste Heat Recovery, Fluidized Bed Boilers., Fuel and Handling Equipments, Types of Coals, Coal Handling, Choice of Handling Equipment, Coal Storage, Ash Handling Systems.

Steam Power Plant : Combustion Process : Properties of Coal – Overfeed and Under Feed Fuel Beds, Traveling Grate Stokers, Spreader Stokers, Retort Stokers, Pulverized Fuel Burning System And Its Components, Combustion Needs and Draught System, Cyclone Furnace, Design and Construction, Dust Collectors, Cooling Towers And Heat Rejection. Analysis of Pollution from Thermal Power Plants - Pollution Controls.CO2 Recorders

UNIT – III

Diesel Power Plant: Diesel Power Plant: Introduction – IC Engines, Types, Construction– Plant Layout with Auxiliaries – Fuel Storage Gas Turbine Plant : Introduction – Classification - Construction – Layout With Auxiliaries – Principles of Working Closed and Open Cycle Gas Turbines. Advantages And Disadvantages Combined Cycle Power Plants.

UNIT – IV

Hydro Electric Power Plant: Water Power – Hydrological Cycle / Flow Measurement – Drainage Area Characteristics – Hydrographs – Storage and Pondage – Classification of Dams

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and Spill Ways. Hydro Projects and Plant: Classification – Typical Layouts – Plant Auxiliaries – Plant Operation Pumped Storage Plants.

UNIT – V

Power from Non-Conventional Sources: Utilization of Solar Collectors- Principle of its Working, Wind Energy – Types of Turbines – HAWT & VAWT-Tidal Energy. MHD power Generation. Nuclear Power Station: Nuclear Fuel – Nuclear Fission, Chain Reaction, Breeding and Fertile Materials – Nuclear Reactor –Reactor Operation.

Types of Reactors: Pressurized Water Reactor, Boiling Water Reactor, Sodium- Graphite Reactor, Fast breeder Reactor, Homogeneous Reactor, Gas Cooled Reactor, Radiation Hazards and Shielding – Radioactive Waste Disposal

Text Books:

1. Arora S.C and Domkundwar S, "A Course in Power Plant Engineering", DhanpatRai, 2001
2. Nag P.K, "Power Plant Engineering". Third edition Tata McGraw- Hill ,2007.

References:

1. EI-Wakil M.M, Power "Plant Technology," Tata McGraw-Hill 1984
2. K.K.Ramalingam, "Power Plant Engineering ", Scitech Publications, 2002
3. G.R, Nagpal, "Power Plant Engineering", Khanna Publishers 1998
4. G.D.Rai, "Introduction to Power Plant technology" Khanna Publishers, 1995

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 1: Engineering knowledge	1.4	1.4.1
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APE0311	Simulation Modelling for Manufacturing Systems	3	0	0	3

Course Outcomes:

CO: 1 Students gain knowledge on various types of simulation and simulation languages steps in simulation and applications of simulation
CO: 2 Students gain knowledge on parameter estimation and hypothesis
CO: 3 Students can build simulation model and also can validation and verify model
CO: 4 Can Generation of random variants and variables
CO: 5 Applications of simulation and systems

UNIT – I

Introduction to System Simulation: Introduction to system simulation – Applications – Discrete and Continuous simulation – Simulation models – Simulation procedure – Simulation Examples – General Principles - Simulation software.

UNIT – II

Mathematical and Statistical Models: Review of basic probability and Statistics – Statistical models in simulation – Selecting input probability distributions

UNIT – III

Random-Number Generation: Properties of random numbers - Generation of Pseudo-Random numbers - Techniques for generating random numbers -Testing of Random numbers.

Random-Variate Generation: Inverse Transform techniques - Convolution method – Acceptance - Rejection techniques.

UNIT – IV

Input modelling: Data collection – Identifying the distribution with data- Parameter estimation - Goodness of fit tests – Selecting input models without data - Multi Variate and Time Series Input Models.

UNIT – V

Applications - Simulation modeling using ARENA: A packaging line, Modeling machine failures, Assembly operations Batch processing, production/Inventory system

Text Books:

3. Jerry banks, John S Carson, Barry L Nelson and David M Nicol (2013), Discrete Event System Simulation, 5th Edition, Pearson Education Asia.

References:

5. Averill M. Law (2014), Simulation modeling and analysis, 5th edition, McGraw-Hill Education.
6. W. David Kelton, Randall P. Sadowski, Nancy B. Zupick (2014), Simulation with Arena, 6th edition, McGraw-Hill Education.
7. Sheldon M. Ross (2012), Simulation, Academic Press, 5th Edition

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MECHANICAL ENGINEERING (ME)

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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MECHANICAL ENGINEERING (ME)

Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APE0312	Advanced Mechanics	3	0	0	3

Course Outcomes:

CO: 1 Study of elements of mechanisms in different geometry.
CO: 2 Study and construction of kinematics of plane motions
CO: 3 Design and determination of different mechanisms in advanced kinematics of plane motion.
CO: 4 Study and analysis of synthesis graphical method
CO: 5 Design of different functions and methods of graphical method and theorems.

UNIT I

Introduction: Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms-spherical trigonometry.

UNIT II

Advanced Kinematics of plane motion-I: The Inflection circle ; Euler – Savary Equation; Analytical and graphical determination of di; Bobillier's Construction; Collineastion axis ; Hartmann's Construction ;Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

UNIT III

Advanced Kinematics of plane motion - II: Polode curvature; Halls Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem; Carter –Hall circle; The circling – point curve for the Coupler of a four bar mechanism.

UNIT IV

Introduction to Synthesis-Graphical Methods - I: The Four bar linkage ;Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Roto center triangle ; Guiding a body through Four distinct positions; Burmester's curve.

UNIT V

Introduction to Synthesis-Graphical Methods - II: Function generation- General discussion; Function generation: Relative –rotocenter method, Overlay's method, Function generation-Velocity – pole method; Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

Text Books:

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill, 1962.
2. L. Sciavicco and B. Siciliano, Modelling and control of Robot manipulators, Second edition ,Springer - Verlag, London, 2000.

3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. East West Publishers.

Reference Books:

1. Allen S. Hall Jr., Kinematics and Linkage Design, PHI, 1964.
2. J. E Shigley and J. J . Uicker Jr., Theory of Machines and Mechanisms , McGraw-Hill, 1995.

List of COs	PO no. and keyword	Competency	Performance Indicator
CO 1	PO 1: Engineering knowledge	1.4	1.4.1
CO 2	PO 2: Problem analysis	2.1	2.1.3
CO 3	PO 4: Conduct investigations of complex problems	4.1	4.1.2
CO 4	PO 2: Problem analysis	2.1	2.1.2
CO 5	PO 1: Engineering knowledge	1.4	1.4.1

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19AHE9906	Effective Technical Communication	2	0	0	2

Course Outcomes:

CO: 1 To develop awareness in students of the relevance and importance of technical communication and presentation skills.
CO: 2 To prepare the students for placements
CO: 3 To sensitize the students to the appropriate use of non-verbal communication
CO: 4 To train students to use language appropriately for presentations and interviews

Unit 1: Information Design and Development- Different kinds of technical documents, Information development life cycle, Organization structures, factors affecting information and document design, Strategies for organization, Information design and writing for print and for online media.

Unit 2: Technical Writing, Grammar and Editing: Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style.

Unit 3: Self Development and Assessment: Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, taking notes; Complex problem solving; Creativity.

Unit 4: Technical Writing: Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.

Unit 5: Speaking with a purpose: Public speaking, Group discussion, Oral presentation, Interviews, Graphic presentation, Presentation aids, Personality Development

TEXT BOOKS/REFERENCES:

1. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004.

2. Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House, 2019.

3. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843).

4. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.

5. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.

6. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4).

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Course Outcomes

At the end of the course, students will be able to

1. Understand the importance of effective technical communication
2. Analyze non-verbal language suitable to different situations in professional life
3. Evaluate different kinds of methods used for effective presentations
4. Create trust among people and develop employability skills
5. Develop skills in speech composition**.**

List of COs	PO.No. and Key word
CO1	PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
CO2	PO12 : Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
CO3	PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
CO4	PO9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
CO5	PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19AHE9901	Technical Writing	2	0	0	2

Course Outcomes:

CO: 1 To acquaint students with a variety of forms of writing in science and technology;
CO: 2 Develop research skills;
CO: 3 Discuss and apply writing and formatting techniques

Unit -1

An Introduction to Technical Writing

Technical writing vs. General writing b. Purpose, importance and characteristics of technical writing, Objectives of technical writing: Clarity, conciseness, accuracy, organization, ethics, Audience recognition and involvement: High tech audience, low-tech. audience, gender neutral language

Unit -2

Memorandum

Objectives, difference between memos, letters and emails. Criteria and format for writing and memos, minutes & agenda

Unit -3

Letter Writing

Business letters- (Greetings, salutations, order, complaint, inquiry), Job-applications (Covering letters) Resume writing.

Unit – 4

Report Writing

Characteristics, types and writing of various reports: feasibility reports, inventory report, mishap report, progress report, laboratory report, Project report, clusters & link words.

Unit - 5

Graphic representation of Technical Data, SOP writing, Promotional Writings

Technical Brochure designing, Content writing for Websites (For promotional and troubleshooting purposes), Writing Fliers and Newsletters.

References:

1. Sharon J. Gerson and Steven M. Gerson, Technical writing – process and product, Pearson Education Asia
2. Andrea J. Ratherford, Basic Communication Skills for Technology, Pearson Education Asia
3. Pfeiffer, W.S. and T.V.S. Padmaja. Technical Communication. Pearson.
4. Muralikrishna and Sunita Mishra. Communication Skills for Engineers. Pearson
5. CharlesW.Knisely and KarinI.Knisely.Engineering Communication. Cengage

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List of Cos	PO no. and keyword
CO 1	PO9: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
CO 2	PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
CO 3	PO10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
CO4	PO10- Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
CO5	PO10- Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19AHSMB03	Organizational Behaviour	2	0	0	2

Course Outcomes:

CO: 1 Understand the nature and concept of Organizational behavior.
CO: 2 Familiar with the motivational theories.
CO: 3 Able to understand leadership theories and qualities.
CO: 4 Learn about group dynamics

UNIT-I

Organizational Behavior - Introduction to OB - Meaning and definition, scope - Organizing Process – Making organizing effective - Understanding Individual Behavior – Attitude - Perception - Learning - Personality Types.

UNIT-II

Motivation and Leading - Theories of Motivation - Maslow's Hierarchy of Needs - Hertzberg's Two Factor Theory - Leading - Leading Vs Managing.

UNIT-III

Leadership – Introduction, Traits Theory–Managerial Grid - Transactional Vs Transformational Leadership - Qualities of good Leader - Evaluating Leader - Women and Corporate leadership.

UNIT – IV

Group Dynamics - Types of groups - Determinants of group behavior - Group process – Group Development - Group norms - Group cohesiveness - Small Groups - Group decision making - Team building - Conflict Management- organization change and development, stress management.

TEXT BOOKS:

1. Luthans, Fred, "Organisational Behaviour" , McGraw-Hill, 12 Th edition 2011
2. P Subba Rao, Organisational Behaviour, Himalya Publishing House 2017.

REFERENCES BOOKS:

1. Aswathappa, "Organisational Behaviour", Himalaya, 2009.
2. Robbins, P.Stephen, Timothy A. Judge, "Organisational Behaviour", Pearson 2009.
3. Nelson, "Organisational Behaviour", Thomson, 2009.
4. McShane, "Organizational Behaviour", TMH 2009.

List of COs	PO no. and keyword	Competency Indicator	Performance Indicator

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Year: IV **Semester : I** **Branch of Study : ME**

Subject Code	Subject Name	L	T	P	Credits
19APC0322	Metrology and Measurements Lab	0	0	2	1

Course Outcomes:

CO: 1 Identify techniques to minimize the errors in measurement.
CO: 2 Identify methods and devices for measurement of length, angle, gear & thread parameters, surface roughness and geometric features of parts.
CO: 3 Understand working of lathe, shaper, planer, drilling, milling and grinding machines.
CO: 4 Comprehend speed and feed mechanisms of machine tools.
CO: 5 Estimate machining times for machining operations on machine tools

Any 6 experiments from each section

Section A:

1. Measurement of bores by internal micrometers and dial bore indicators.
2. Use of gear teeth vernier calipers and checking the chordal addendum and chordal height of spur gear.
3. Alignment test on the lathe and milling machine
4. Study of Tool makers microscope and its application
5. Angle and taper measurements by Bevel protractor, Sine bars, spirit level etc.
6. Thread measurement by Two wire/ Three wire method.
7. Surface roughness measurement by Talysurf instrument.
8. Use of straight edge and sprit level in finding the flatness of surface plate.

Section B:

1. Calibration of Pressure Gauges
2. Calibration of transducer or thermocouple for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Study and calibration of capacitive transducer for angular measurement.
5. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
6. Study and calibration of a rotometer for flow measurement.
7. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
8. Study and calibration of Mcleod gauge for low pressure.