SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY

"DYANTEERTH', VISHNUPURI,

NANDED.

PROPOSED SYLLABUS FOR

T.E. (MECHANICAL ENGINEERING)

(CGPA)

w.e.f. 2016-17

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSIT, NANDED

Teaching & Examination Scheme for Third Year Mechanical Engineering

w.e.f. 2016-17

Sem - V

Sr. No	Subject	Teaching Scheme			Examination Scheme					Credits		
		Th	Pr/ Tut	Total	ESE	MSE	CE	ESE	Total	Th	Pr	Total
							Pr / WS					
M-301	Manufacturing Technology – II	04	02	06	80	20	30	70	200	03	1	4
M-302	Machine Design-I	04	02	06	80	20	30	70	200	03	1	4
M-303	Heat Transfer	04	02	06	80	20	30	70	200	03	1	04
M-304	Mechatronics - I	04	04	06	80	20	30	70	200	03	2	05
M-305	CAD-CAM	04	02	06	80	20	30	70	200	03	1	04
	Total	**20**	**10**	**30**	**400**	**100**	**150**	**350**	**1000**	**15**	**6**	**21**

Sem-VI

Sr. No	Subject	Teaching Scheme			Examination Scheme					Credits		
		Th	Pr/ Tut	Total	ESE	MSE	CE	ESE	Total	Th	Pr	Total
							Pr / WS					
M-306	Tool Engg.	04	02	06	80	20	30	70	200	03	1	04
M-307	Machine Design – II	04	02	06	80	20	30	70	200	03	1	04
M-308	Power Developing Devices	04	02	06	80	20	30	70	200	03	1	04
M-309	Mechatronics - II	04	04	06	80	20	30	70	200	03	2	05
M-310	Elective - I	04	-	04	80	20	-	-	100	03	-	03
	Total	**20**	**08**	**28**	**400**	**100**	**120**	**280**	**900**	**15**	**5**	**20**

CE – Continuous Evaluation **ESE – End Semester Exam**

MSE – Mid Semester Exam **Pr. – Practical**

Th – Theory **Tut – Tutorial** **W/S- Workshop**

Elective-I

1. DOM – Dynamics of Machine **2. PPE – Power Plant Engineering**

3. IE – Industrial Engineering **4. ACW-** **5. MEMS-**

TE (Mechanical) Part – I
CGPA

TE (Mechanical) Part – I
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Manufacturing Technology – II

Teaching Scheme	Examination Scheme	
Theory: 4 Hrs/Week	**(Theory)**	**MSE: 20 Marks**
Practicals: 2Hrs/Week		**ESE: 80 Marks**
		CE: 30 Marks
	(Practical)	**ESE: 70 Marks**

Course Objectives:

1. To understand process of cutting shaping.
2. To understand working principles for various machining processes.
3. To understand construction, working and applications of various machine tools.
4. To learn basic set up, working and applications of a few important non conventional machining processes to get hand on experience on various machine tools.

Course Outcomes:

1. The students will be able to understand the details about machines used in production.
2. The students will be able to understand the mechanics behind metal cutting.
3. The students will be able to understand the finishing and super finishing processes.
4. The students will be able to understand the Physics of material removal behind the various non-conventional machining processes.

Unit I **(** 6 Hours)

Machine Tools : Introduction, classification of machine tools, generation & forming, methods of generation surfaces, accuracy & finish achievable, basic elements of machine tools, support structures, guide ways, general work holding methods.

Metal Cutting: Types of cutting tools orthogonal and oblique cutting, mechanism of chip formation, types of chips, chip breakers, cutting tool nomenclature. Tool wear and tool failure, tool life effect of cutting parameters on tool life .

Unit II **(**6 Hours)

Lathe: Types of Lathe, construction of centre Lathe, tool holding and work piece holding devices, operations performed on Lathe. Attachments and Lathe accessories, cutting speed, feed, depth of cut and machining time calculations for Lathe. Construction and working of capstan and turret Lathes. Simple Problems on Machining time calculations.

Unit III (9 Hours)

Milling Machine: Classification, constructional features, milling cutter nomenclature, various milling operations. Milling cutters, cutter holding devices, milling machine attachments, cutting speed, feed, depth of cut and machining time calculation for milling machine. Simple problem on machining time calculations.

Shaping, Planning and slotter machines. Types, construction, operations

Unit IV **(**5 Hours)

Drilling Machine: Classification, constructional features, drilling machine parts, work holding work holding and tool holding devices. Twist drill geometry. Operations performed on drilling machine.

Boring machine: Horizontal, Vertical and jig boring machine, parts, tools and operations.

Unit V **(**10 Hours)

Grinding machine: types of abrasives, grain size, bonding process, grit, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machine (Center less, cylindrical and surface grinding) Dressing and truing of grinding wheels, marking system.

Surface finishing process: Lapping, honing, super finishing, polishing, buffing etc.

Gear manufacturing: Gear cutting processes – Gear hobbing, gear shaping, gear milling, gear shaving & gear grinding, construction & working of the machine.

Unit VI (6 Hours)

Non-Conventional machining processes:

Need for non conventional machining, principle, equipment & operations of Laser beam, Plasma Arc machining, Electro Chemical machining, electron discharge machining, ultra sonic machining, Abrasive jet machining, water jet machining.

Term Work:

1. Demonstration of various machine tools like Lathe, Drilling machine, milling machine, shaper, grinding machine etc.
2. Preparing jobs involving turning, taper turning, eccentric turning, drilling, thread cutting, milling, shaping, operations (Three Jobs)

Practical Examination:

Machining a complete job requiring operations like turning, drilling, boring, threading, milling/shaping

Text Book:

1. Hazara Choudhary – Workshop technology vol – II – media promoters and publishers Pvt. Ltd. Mumbai.
2. P. N. Rao – Manufacturing technology. Metal cutting and machine tools.

Reference Books:

1. P. C. Sharma – Production Engineering (Khanna Publishers)
2. R. K. Jain - Production Engineering (Khanna Publishers)
3. HMT Handbook - Production Technology (TATA McGraw Hill Publisher)
4. Chapman W. A. – “Workshop Technology” vol – I, II, III (Edward Arnold Publisher Ltd.)

T.E –MECHANICAL PART- I

CGPA

Machine Design- I

Teaching Scheme :
Lectures : 4 Hrs/Week
Practical : 2 Hrs/Week

Examination Scheme:
Theory :MSE : 20Marks
ESE : 80 Marks
CE : 30 Marks
(Pr).: ESE : 70 Marks

COURSE OBJECTIVE:

1. To familiarize the various steps involved in the Design process
2. To understand the principles involved in evaluating the shape and dimensions of a complete to satisfy function and strength requirements.
3. Students shall gain a thorough understanding of the different types of failure modes and criteria. They will be conversant with various failure theories and be able to judge which criterion is to be applied for a particular situation.
4. Student shall gain design knowledge of the different types of elements used in the machine design process, for e.g. fasteners, shafts, couplings etc. and will be able to design these elements for each application.

COURSE OUTCOMES:

1. Ability to analyze the stress and strain of mechanical components and understand, identify and quantify failure modes for mechanical part.
2. Ability to decide optimum design parameters for mechanical systems.
3. Ability to design mechanical system for fluctuating loads.
4. Acquire skill in preparing production drawing pertaining to various designs.

UNIT-1 **(06hrs)**

INTRODUCTION:

A) FUNDAMENTAL PRINCIPLES: Definition, Meaning Of Design, Mechanical Engineering design, Design procedure, Phases of design, Factor of safety, Selection of factor of safety.

B) GENERAL CONSIDERATION: Materials selection, Aesthetic and Ergonomic consideration, Value analysis, BIS System for steel designation, Plastics, Natural and Synthetic rubbers, regression, population combinations, Concurrent Engineering.

C) DESIGN OF COTTER AND KNUCKLE JOINT: Introduction, Cotter joint, Applications of the cotter joint, Types of cotter joint and their design, Introduction of knuckle joint, Applications of knuckle joint, Design procedure of knuckle joint.

UNIT-2 **(8 hrs)**

A) DESIGN AGAINST STATIC LOAD: Static Load, Stress, Strain, Stress Strain Relationship, Modes of failure, Failure of ductile materials, Failure of brittle materials, Stress due to bending moment, Stress due to torsional moment, Eccentric axial loading, Design of machine parts subjected to combined direct and bending stress.

B) DESIGN OF POWER SCREWS: Definition of power screw, Application, Forms of threads, Force analysis of square and trapezoidal threads, Self locking screw, Efficiency of square threaded screw, Efficiency of self locking screw, Collar friction torque, Overall efficiency, Design of screw nut, Differential and compound screws, Recirculating ball screw.

UNIT-3 **(6 hrs)**

A) DESIGN AGAINST FLUCTUATING LOAD: Definition, Stress concentration, Causes of stress concentration, Stress concentration factor, Reduction of stress concentration, Fluctuating stress, Fatigue failure endurance limit, S-N curve, Low cycle and High cycle fatigue.

Endurance Limit: Approximate estimation, Reversed stresses- Design for finite and infinite life, Cumulative damage in fatigue, Soderberg and Goodman lines, Modified Goodman diagrams, Gerber equation, Fatigue design under combined stresses.

UNIT-4 **(8hrs)**

DESIGN OF SHAFTS, KEYS AND COUPLINGS:

A) Shafts: Introduction, Shaft design on strength, Shaft design on torsional rigidity, ASME code for shaft design, Castigliano's theorem, Area moment method, Graphical integration method.

B) Keys: Definition, Types of keys and their design, Splines and their design.

C) Couplings: Definition, Muff coupling, Design of Muff coupling, Rigid flange coupling, Design procedure for rigid flange coupling, Bushed pin flexible coupling, Design for flexible coupling, design for lateral rigidity.

UNIT-5 **(6 hrs)**

DESIGN OF JOINTS:

A) **THREADED JOINTS**: Introduction, Definition, Basic types of screw fastening, Cap screws, Set screws, Eccentrically loaded bolted joints in shear, bolted joint under fluctuating load, Bolted joints with combined stresses.

B) **RIVETED JOINTS**: Introduction, Definition, Types, Methods of riveting, Types of rivet heads, Types of riveted joints, Strength of joint, eccentric loaded riveted joint.

C) **WELDED JOINTS**: Introduction, Definition, Types, Stresses in Butt fillet joints, Strength of welded joints, Eccentrically loaded joints, subjected to bending moment and fluctuating forces.

UNIT-6 **(06hrs)**

DESIGN OF SPRINGS:

Definition, Function, Application, Types, Terminology of helical spring, Stress and deflection equation, Series and parallel connections, Spring materials, Styles of ends, Static load design against fluctuating load, Optimum design of helical spring, Helical torsion spring, Multi leaf springs, Design of multi leaf spring, Nipping of leaf springs, Shot peening.

TERM WORK:

Two full imperial size sheets with the design problems as given below.

1. At least one problem of the following
   Cotter joint, (Differential joints), Knuckle joint.
2. At least one problem (Details and Assembly) out of Screw jack, Couplings etc.
3. Assignment on each unit

PRACTICAL/ORAL EXAMINATION:

It shall consist of Practical / Oral based on the above syllabus and Term work.

REFERENCE BOOKS:

1. Design of Machine elements –By V.B. Bhandari, Tata Mc Graw Hill Co.
2. Mechanical Engineering Design –By J.E. Shigley,Tata Mc Graw Hill Co.
3. Machine Design –By Pandey and Shah, Chalotar publishing house.
4. Design of machine elements –By M.F. Spotts, Prentice hall of India Ltd.

T.E (Mechanical) Part– I
C.G.P.A.

Heat Transfer

Teaching Scheme:		**Examination Scheme:**
Theory	**: 4 Hrs. /Week**	**Theory MSE - 20 Marks**
Practical	**: 2 Hrs. /Week**	**ESE - 80 Marks**
		CE - 30 Marks
		Pr. /Oral -ESE - 70 Marks

Course Objectives:

1. Study and analysis of heat transfer concepts applicable for steady state with and without heat generation and transient conditions.
2. To Train the students to identify, formulate and solve problems involving forced convection & natural convection heat transfer.
3. Students should learn the phenomena of heat transfer during phase change (boiling and condensation heat transfer)
4. The course provides practical exposure to the students in heat transfer equipments like heat exchanger, heat pipes, fins etc.

Course Outcomes:

1. Understand the modes of heat transfer and basic laws of heat transfer.
2. Analyze the problems involving steady state heat conduction with and without internal heat generation.
3. Develop solutions for transient heat conduction.
4. Understand and Evaluate heat transfer coefficients for natural and forced convection.
5. Analyze the heat exchanger and fins performance.
6. Calculate radiation heat transfer between black body and gray body surfaces.

Unit I: **(08Hrs)**

Introduction and Basic Concepts:

Importance of heat transfer in engineering, modes and Laws of heat transfer, Three dimensional heat conduction equation in Cartesian, cylindrical and spherical coordinates, thermal conductivity, thermal diffusivity.

One dimensional steady state heat conduction without heat generation:

Heat conduction in plane wall, cylinder, sphere, composite slab, composite cylinder, composite sphere, electrical analogy. Concept of thermal resistance, contact resistance, variable thermal conductivity, critical radius of insulation for cylinder and spheres, economic thickness of insulation.

Unit II: **(08Hrs)**

Steady state heat conduction with heat generation:

Heat conduction with uniform heat generation in plane wall, cylinder and sphere with different conditions.

Transient heat conduction:

Lumped system analysis, Biot and Fourier number, thermal time constant and response of thermocouple.

Unit III: **(08Hrs)**

Convection:

Mechanism of natural and forced convection local and average heat transfer coefficient, concept of hydrodynamic and thermal boundary layer.

Forced Convection:

Dimensional less numbers and their physical significance, empirical correlations for external and internal flow.

Natural convection:

Dimensionless numbers and their physical significance, empirical correlations for natural convection.

Unit IV: **(08Hrs)**

Boiling and Condensation:

Boiling heat Transfer, Pool boiling, Forced convection boiling, Condensations heat transfer, Film condensation, drop wise condensation.

Extended surfaces:

Types of fins, Governing equations for uniform cross section area, temperature distribution and heat transfer rate for infinitely long, adequately long with insulated end and short length fins, efficiency and effectiveness of fins, Error in temperature measurement.

Unit V: **(08Hrs)**

Heat Exchanger:

Classification and applications of heat exchanger, overall heat transfer coefficient, fouling factor, heat exchanger analysis-LMTD for parallel and counter flow heat exchanger, effectiveness-NTU method for parallel and counter flow heat exchanger, Introduction to compact heat exchanger, Heat pipe.

Unit VI: **(8Hrs)**

Radiation:

Fundamental of radiation, Laws of radiation- Plank's law, Kirchoffls law, Steafan-Boltzman law, Wien's displacement law, Lambert's cosine law. Radiation shape factor, Radiation exchange between surfaces, Radiation exchange between gray surfaces, Radiation shields.

List of Experiments:

The Term Work shall consist the record of **any eight** experiments out of the following list:

1. Determination of Thermal conductivity of Insulation Powder.
2. Determination of Thermal conductivity of Metal Rod.
3. Determination of heat transfer coefficient in Natural Convection.
4. Determination of heat transfer coefficient in Forced Convection.
5. Determination of heat transfer coefficient in temperature distribution, fin efficiency and effectiveness in Natural/Forced Convection.
6. Determination of heat transfer coefficient in effectiveness of parallel flow and counter flow heat exchanger.
7. Determination of heat transfer coefficient in Stefan Boltzman constant.
8. Determination of heat transfer coefficient in Emissivity of a grey surface
9. Determination of Critical thickness of insulation.
10. Determination of thermal conductivity of composite wall.
11. Thermocouple Calibration
12. Demonstration Heat Pipe

13. Study of boiling and condensation heat transfer.
14. Demonstration of Critical Heat Flux Apparatus.
15. Demonstration of Surface Condenser.

Text Books:

1. Heat Transfer, J.P. Holman, McGraw Hill Book Company, New Delhi.
2. A Text Book of Heat and Mass Transfer, S.P.Sukhatme, Univiesities Press.
3. Heat Transfer – A Practical Apporach, Yunus A Cengel, Tata McGraw Hill Publishing Company, New Delhi.

Reference Books:

1. Heat and Mass Transfer, P.K. Nag, Tata McGraw Hill Publishing Company, New Delhi.
2. Heat and Mass Transfer, R Yadav, Central Publishing House.
3. Heat and Mass Transfer, Dr. D.S. Kumar, S.K. Kataria and Son Publisher.
4. Heat and Mass Transfer, S.C. Arrora and S. Domkundwar, Dhanapat Rai and Sons Publication.
5. Fundamentals of Engineering Heat and Mass Transfer, New Age Science.

T.E. MECHANICAL – PART – I
CGPA

MECHATRONICS – I

Teaching Scheme:		**Examination Scheme:**	
Theory	**: 4 hrs/Week**	**(Theory ESE**	**: 80 Marks**
Practical	**: 2 hrs/Week**	**MSE**	**: 20 Marks**
		CE	**: 30 Marks**
		(Practical) ESE	**: 70 Marks**

COURSE OBJECTIVES:

1. Understand the key elements of Mechatronic system, representation into block diagram.
2. Understand principles of Sensors, their characteristics.
3. Understand Mathematical modeling of systems.
4. Study various actuators applicable to Mechatronic systems.
5. Study of Interfacing of different electronicand electro - mechanical devices.

COURSE OUTCOMES:

1. Develop the skill to identify the suitable sensor and actuator for a Mechatronic system.
2. Develop the skill required for interfacing the electronicand electro-mechanical systems.
3. Develop the skill to indigenously design and develop a Mechatronic system.
4. Develop the skill to model a complete automated electro-mechanical system.
5. Understand the working and use of hydraulic and pneumatic actuators.

Unit – I **(08Hrs)**

Introduction:

Introduction to control system &Mechatronics system, Basic building blocks of Mechatronic system, Block Diagram Representation of Open and Closed loop control system. Mechatronics key elements, Mechatronics in home, office and industry automation, Scope of Mechatronics, Advantages of Mechatronics, pre-requisites for Mechatronics.

Unit – II **(08Hrs)**

Mathematical Modeling of Systems

Introduction to transfer function ,properties ,Mathematical Modeling of Electrical, Mechanical, Fluid and Thermal systems, Grounded chair representation, Block diagramalgebra, rulesand Numerical

Unit – III **08Hrs)**

Sensors & Actuators:

Introduction to Mechatronics, Measurement characteristics: - Static and Dynamic

Sensors: Position Sensors: - Potentiometer, LVDT, Encoders; Proximity sensors:- Optical, Inductive, Capacitive; Motion Sensors:- Variable Reluctance; Temperature Sensor: RTD, Thermocouples; Force / Pressure Sensors:- Strain gauges; Flow sensors: -

Actuators: Stepper motor, Servo motor, Solenoids,DC motors : Principles of operation of DC motor, Modelling of DC, AC motors ,relays and types, Hydraulic and Pneumatic DC Valves cylinders symbols.

Unit – IV **(08Hrs)**

System Interfacing and Data Acquisition

Data Acquisition systems (DAQs), data loggers, supervisory control and data acquisition, interfacing requirements, buffers, handshaking, polling and interrupt, digital communication, parallel communication, serial communication interface, universal asynchronous receiver and transmitter (UART), peripheral interface device (PIA), analog interfacing, Component interconnection and impedance matching, interfacing sensors and motor drives with microcomputer system.

Unit – V **(08Hrs)**

Controllers-

Time response analysis of first and second order systems, Inputs and responses, standard Test signals, steady state errors Analysis of first and second order ,

Controllers: P, I, D, PD, PI, and PID control systems. Controller turning (Auto and manual) Ziglar Nicholas method, Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Microprocessor Control

Unit – VI **(08Hrs)**

Mechatronics and Studies:

Autonomous Mobile Robot, Wireless Surveillance Balloon, Firefighting robots, Cantilever beam vibration control using piezo sensors and actuators, Car engine management, pick and place robot, automatic camera, CNC Machine.

Term Work: It will consists of seven experiments/exercises as shown below.

1. Measurement of Load/Force using Load Cell *(Estimation of unknown weight using above voltage characteristics)
2. Measurement of Temperature: Thermocouple, Thermistor and RTD and comparative analysis (estimation of sensitivity)
3. Measurement of displacement using LVDT characteristics.
4. Interfacing of any Sensor with Data Acquisition System.
5. Experimental Demonstration of PID controllers.
6. Building a hydraulic circuit for speed control of diesel engine/turbine.
7. Study of different types of stepper motor.

Assignments: (Any Four)

1. Basic building blocks of Mechatronic.
2. Assignment on Mathematical modeling of Electrical , Mechanical, Fluid and Thermal systems
3. Assignment of Sensors.
4. Assignment on Data Acquisition.
5. Assignment on Controller P,I,D, PD, PI, and PID
6. Assignment on Case Studies (Any Two).

Reference Books:

1) Mechatronics by W Bolton Pearson Publishers
2) K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
3) Mechatronics by M D Singh and J G Joshi Prentice-Hall India
4) Mechatronics Systemsby S R Mujumdar McGraw Hill .
5) Mechatronic Sourcebook by Newton C Braga CENGAGE Learning.

6) Electrical Drives by N K De , P K Sen
7) Robotic Engineering by Richard D Klafter, Thomas A. Chmielewski, Michael Negin Prentice-Hall India.
8) Mechatronics Systems by Devidas Shetty, Richard Kolk CENGAGE Learning.
9) Mechatronics – Integrated Mechanical Electronic Systems. W.K.P. Ramchandran G.K.
10) Introduction to Mechatronics and Measurement systems –Michel B. Histand& David Alciatore, McGraw Hill.
11) Understanding Electro-Mechanical Engineering an Introduction to Mechatronics Kamm-PHI.
12) M.Gopal“ Modern Control System Theory”, Wiley Eastern Ltd, New Delhi.
13) K. Ogata, “ Modern Control Engieering”, 3rd ed. Prentice Hall of India (P) Ltd., New Delhi.
14) Nagrath Gopal, “ Control System Engineering-Principles and Design”, New Age Publishers.
15) Mechatronics – Mahalik TMH.
16) Mechatronics – HMT,TMH.

T.E. MECHANICAL – PART – I
CGPA

CAD/CAM

Teaching Scheme:		**Examination Scheme:**	
Theory	**: 4 hrs/Week**	**(Theory ESE**	**: 80 Marks**
Practical	**: 2 hrs/Week**	**MSE**	**: 20 Marks**
		CE	**: 30 Marks**
		(Practical) ESE	**: 70 Marks**

CAD

Course Objectives

1. To introduce field of Intelligent CAD/CAM with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To understand concepts of geometric modeling.
4. Provide theoretical background of CAD/CAM.
5. Introduce Rapid Prototyping techniques.

Course Outcome: A learner will be able to….

1. Identify proper computer graphics techniques for geometric modeling.
2. Transform, manipulate objects, store and manage data.
3. Prepare computer assisted part program and post process.
4. Prepare part programming applicable to CNC machines.
5. Use rapid prototyping and tooling concepts in any real life applications.

Unit-I:

Introduction - (4 Hrs)

CAD/CAM concepts, the product cycle and CAD/CAM, mathematical model of CAD/CAM, Automation and CAD/CAM, Benefits of CAD.

Unit-II:

Geometric modeling - (10 Hrs)

Need of solid modeling, study of different representation schemes in solid modeling, Wire frame modeling, surface modeling, and solid modeling, feature based modeling

(FBM), hybrid modeling, their merits and demerits. Generalized sweeps, boundary representation, constructive solid geometry (CSG) Mass, area, volume calculation.
Curves:-Introduction, Analytic Curves, Line, Circle, Parabolas, Hyperbolas, Ellipses, Conics, Synthetic Curves, Hermite, Cubic Spline, Bezier Curve, B-Spline Curve,
Surfaces:-Introduction, Surface Representation, Analytic Surfaces, Synthetic Surfaces, Hermite bicubic Surface, Bezier surfaces, B-spline Surfaces, Coons Surface.

Unit-III: Transformations- (**6Hrs)**
Introduction, 2D and 3D transformations, Formulation, Translation, Rotation, Scaling, Reflection, Homogenous Representation, Concatenated Transformation.
Projections: Orthographic, Isometric, and Perspective.

CAM

Unit-IV:
Introduction to NC/CNC- (6 Hrs)
NC/CNC applications, benefits, basic components, classification of NC/CNC machine tools, reference points, component dimensioning in NC/CNC. NC motion control modes, types of interpolation, axis designation in NC/CNC. Manual data input, use of subroutines and canned cycles, NC words, NC procedure, DNC.

Unit-V:
Part programming- (8Hrs)
CNC programming using G and M codes adoptable to FANUC controller for lathe and milling, Part programmers job, functions of a post processor, APT.

Unit-VI:
Rapid Prototyping- (6 Hrs)
Introduction to RP, Technology Description, Overview of RP, Benefits and Application.
RP Processes: Process overviews, STL file Generation, Classes of RP
systems: Stereo-lithography Approach (SLA), Selective Laser Sintering (SLS), Fused deposition modeling, Laminated object manufacturing, Laser powder forming, 3D printing. RP Applications.

TERM WORK
It shall consists of assignments/ exercises on,
1. Study of any one CAD software, like AUTOCAD, SOLIDWORKS, IDEAS, PRO-E, UNIGRAPHICS, CATIA etc.
2. Sketching
3. Part modeling.
4. Drafting.

5. Assembly modeling.
6. Assignment on 3D transformations.
7. NC part programming
8. APT programming

PRACTICAL EXAMINATION:

It shall consist of practical/oral based on above syllabus and term work.

REFERENCES

1. Groover M. P. & Zimmer E. W.-CAD/CAM – Pearson Education
2. P.N. Rao -CAD/CAM, Principles & Applications-Tata McGraw Hill
3. T.K. Kundra- Numerical Control& Computer aided Manufacturing –TMH
4. P. Radhakrishnan - CAD/CAM/CIM –New Age International Ltd.Publishers New Delhi
5. Mathematical elements of computer graphics- Rogers, Adams- Tata McGraw Hill
6. CNC machines-B.S. Pabla, M. Adithan- Willey Eastern Ltd
7. “CAD/ CAM, Theory & Practice” by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
8. “CNC Machines” by B.S. Pabla and M. Adithan, *New Age International Publishers.*
9. “Numerical Control and Computer Aided Manufacturing” , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
10. “CNC Technology and Programming”, Krar, S., and Gill, A., *McGraw Hill publishers*11. “Rapid Prototyping” Chee Kai Chua World Scientific Publishing
12. “Rapid Prototyping: Principles and Applications” RafiqNoorani, Wiley
13. “Rapid Prototyping: Principles and Applications” C.K. Chua, K.F.Leong, C.S. Lim World Scientific Publishing
14. “Rapid Prototyping and Manufacturing” P. F. Jacobs, Society of Manufacturing Engineers.

TE (Mechanical) Part – II
CGPA

T.E. (Mechanical)- Part - II
CGPA

TOOL ENGINEERING

Teaching Scheme	**Examination Scheme**		
Theory: 4 Hrs/Week	**Theory:**	**MSE :**	**20 Marks**
Practical: 2 Hrs./Week		**ESE :**	**80 Marks**
		CE :	**30 Marks**
	Practical/Oral	**ESE :**	**70 Marks**

Course Objectives:

1. To introduce students to the design of dies for presswork.
2. To introduce students the importance of using Jigs and Fixtures in manufacturing.
3. To introduce students to the design practices of Jigs & Fixtures

Course outcomes:

After Studying the subject students will be able to know:

1. Selection of a die for a given component
2. Classify and explain various press tools and press tools operations
3. Selection of locating and clamping devices for given component.
4. Select and design jig and fixture for given component.

Unit-I:

Introduction to Press Tools: (04 Hrs.)

Dies, punches, types of presses, types of dies, simple, compound, combination & progressive dies, press tools for operations like blanking, piercing, drawing, shaving, trimming etc.

Unit-II:

Design of Die Set for Cutting Operations: (05 Hrs.)

Theory of metal cutting, cutting force & blank holding force estimation, punch & die clearance, scrap strip layout, design of punches, design of dies, pilots strippers, stock stops, finger stops, auto stops centre of pressure, selection of die set.

Unit-III:

Design of Drawing Die: (06 Hrs.)

Blank size determination, no. of draws, stage wise achievement of drawn component, stage wise components drawing, drawing radii & clearance, drawing force, defects in drawing.

Unit -IV:

Design of Bending Die: (05 Hrs.)

Bending methods, Estimation of bend radius, bend allowance, developed length, bending pressure, bottoming force, spring back effect in bending operation, spanking.

Unit- V:

Theory of Metal Cutting: (04 Hrs.)

Tool Geometry, Tool Signature, Chip Formation, Types of Cutting, Tool Wear and tool life, Surface Finish, Cutting Fluids, Machinability & Machinability Index, Forces in Cutting Merchant's Circle.

Unit- VI:

Introduction to jigs & fixtures: (04 Hrs.)

Necessity, basic concepts of jigs & fixture for different manufacturing processes.

Location & clamping system : Principles, types, applications, locating pins , pads, diamond pins, adjustable supports, Vee & post locators, Clamping system principles, types, screw clamp, strap, lever, hinge type, am operated, toggle clamps, centralizer & equalizer clamp, multiple clamping, quick acting clamp, pneumatically operated clamps.

Unit - VII:

Design Of Jigs: (06 Hrs.)

Principles of jig design, types of jigs : plate, template, box, channel, sandwich, latch, tumble, turn over jig etc.; types of bushes, selection of bushes & liners, construction of jigs & fixture bodies by using standard parts.

Unit - VIII:

Design Of Fixtures: (06 Hrs.)

Principles of fixture design, types of fixture-gang, straddle, vertical slot, sting milling fixture etc. selection of suitable type, design of milling fixtures, use of setting block, tennons, T bolt etc. Design of turning fixture for lathe.

Indexing System: Necessity, different indexing system for jigs & fixtures.

TERM WORK : Term work shall consist of following:

(i) Study of various elements of Jigs & Fixtures.

(ii) Design & drawing of two drilling / reaming Jigs (details of drawing on one full size Sheet showing tolerance & materials specification).

(iii) Design & drawing of two milling fixtures (details of drawing on one full size sheet showing tolerance & materials specification).

(iv) Design & drawing of one progressive die.

(v) Design & drawing of one drawing die.

REFERENCE BOOKS :

(i) Tool Design, Donaldson (TMH).

(ii) Tool Design, Pollock, Reston Publication Co. Inc.

(iii) An Introduction to Jigs & Tool Design, M.H.A.Kempster, (ELBS).

(iv) A Text Book of Production Engineering, P.C.Sharma, S.Chand.

(v) Hand Book of Die Design, Suchy (McGraw Hill).

(vi) Die Design Fundamentals, J.R.Paquin, R.E.Crowley, Industrial Press Inc.

(vii) Jigs & Fixtures, P.H.Joshi, TMH.

(viii) Techniques of Press Working of Metals by Eary & Reed.

(ix) CMTI Machine Tool Design Hand Book (TMH).

(x) Design Data Hand Book – P.S.G.College

T.E. (Mechanical) Part II

(CGPA)

MACHINE DESIGN - II

Teaching Scheme:
Lectures: 4 Hrs/Week
Practical: 2 Hrs/Week

Examination Scheme:
MSE : 20 Marks
ESE : 80 Marks
CE : 30 Marks
(Practical Exam) MSE: 70 Marks

COURSE OBJECTIVE:

5. To familiarize the various steps involved in the design process of mechanical drives such as belt, chain, rope and gear.
6. To understand the procedure of selection of machine elements from manufacturers catalogue.
7. To get knowledge of different types of bearings and their selection for a particular application.
8. Student shall apply design knowledge of the different types of elements used in the machine design process, for a design project.

COURSE OUTCOMES:

5. Design and analyze belts, brakes, clutches.
6. Understand gear drives and their applications; design procedure and introduction to gear design standard practices.
7. The construction, working, important features and selection process from manufacturers catalogue for rolling contact bearings
8. Analyze the pressure distribution and design of journal bearings.

Unit I: **(6Hrs)**

Design of Flexible Mechanical Elements:

Belts and their construction, Flat belts versus V- belts, Open and cross belt arrangement, Ratio of tensions, Centrifugal tension, Effect of centrifugal tension, Design of belts.

Power rating of belts, Maximum power condition, Selection of flat and V belts from Manufacturer's catalogue, Belt tensioning methods, Relative advantages and limitations of flat and V belts.

Chain drives, roller chains, polygonal effect, Rope drives: construction and specifications

Unit II: (7Hrs)

Friction Clutches and Brakes:

Friction Clutches:

Classification and selection of friction clutches, Torque transmitting capacities and design of single-plate, multi-plate, Cone and Centrifugal clutches, Types of friction materials,

Brakes :

Energy absorbed by brake, Design considerations in Pivoted block brake with short and long shoe, Band brake, Internal expanding shoe brake, Thermal considerations in brake design.

Unit III: (7 Hrs)

Gear Drives:

Classification of gears, Selection of types of gears, Gear trains

Spur Gears:

Basic tooth dimensions, Types of gear tooth failure, Desirable properties and selection of gear material, Constructional details of gear wheel, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation, Methods of gear lubrication,

Unit IV: (7Hrs)

Helical, Worm and Bevel Gear:

Helical Gears: Kinematics, tooth proportions, force analysis, strength analysis**.**

Bevel Gears: Straight tooth bevel gear kinematics, force analysis, strength analysis.

Worm Gearing: Kinematics, tooth proportions, force analysis, strength analysis.

Introduction to AGMA gear design procedure.

Unit V:

Rolling contact bearings: (6Hrs)

Types of rolling contact Bearings, Static and dynamic load carrying capacities, Stribeck's equation, Equivalent bearing load, Load-life relationship, Selection of bearing life, Selection of rolling contact bearings from manufacturer's catalogue, Taper roller bearing, Design for cyclic loads and speed, Bearing with probability of survival other than 90%, Lubrication and mounting of bearings, Preloading of rolling contact bearings, Types of failure in rolling contact bearings – causes and remedies.

Unit VI:

Lubrication and journal bearings: (7Hrs)

Conditions of proper lubrication, Mechanism of dry friction, Petroff's law, Assumptions involved in Petroff's law, Hydrodynamic lubrication, How do hydrodynamic conditions develop in a bearing? McKee's equation, Thick and thin film lubrications, Stability of lubrication, Bearing modulus, Heat balance in journal bearing, Design of journal bearings, Sommerfeld number, Introducing hydrostatic bearings.

Reference Books

1. Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Pub. Co. Ltd.
2. Bhandari V.B. – "Design of machine elements" – Tata McGraw Hill Public Co. Ltd.
3. Hall-"Theory and problems of Machine Design"- SI Edition, Schaum's outline series.
4. Kulkarni S.G. – Machine Design- TMH Outline Series
5. Spott's M.F. and Shoup T.E. – "Design of Machine elements" – Prentice Hall International.
6. Black P.H. and O. Eugene Adams – "Machine Design" – McGraw Hill Book Co. Ltd.

Term Work:

1. Two imperial size sheet consisting of assembly and detailed component drawing with all specifications on any one design problem from the following
   Design of single plate/ multi plate/ centrifugal/ cone clutch assembly.
   Design of flat or V- belt drive
   Design of single stage or two stage gear box using spur/helical/bevel/worm gears.
2. Assignment on any of the four topics from the six units mentioned above consisting of theory and design numerical.

Practical examination:

It shall consist of oral based on above syllabus and term work.

T.E (Mechanical) Part-II
C.G.P.A.

Power Developing Devices

(I.C. Engines & Gas Turbine)

Teaching Scheme:
Theory Hrs: 4 hrs/Week
Practical Hrs: 2 Hrs/Week

Examination Scheme:
MSE - 20 Marks
ESE - 80 Marks
CE - 30 Marks
Pr/Oral - ESE - 70 Marks

Course Objectives:

1. To understand the basic working of SI and CI Engines and Air Standard cycles.
2. To understand the Fuel Supply system for SI and CI Engines.
3. To understand the Testing and Performance of SI and CI Engines.
4. To understand the Combustion Phenomenon of SI and CI Engines.
5. To understand the Performance and Analysis of Gas Turbine.

Course Outcomes:

The Learner is able to ---

1. Differentiate between SI and CI Engines.
2. Understand and explain Combustion of SI and CI Engines.
3. Plot and analyze Performance Characteristics of SI and CI Engines.
4. Explain Gas Turbine and its performance.

Unit-I: **(08 hrs.)**

Introduction to SI and CI Engines,

Basic components, Classification, working of Two Stroke/ Four Stroke Petrol/ Diesel Engine, Actual / Theoretical Valve Timing and P-V Diagrams .Otto cycle, Diesel cycle, Duel cycle, Variable Specific heat and its effect on above cycles.

Simple numerical Treatment to analyze performance of cycles. Emissions of SI and CI Engines, Pollution and its control.

Unit-II: (08 hrs.)

Requirements of Ignition system

, Battery, Magneto and advanced ignition system and their comparison, Petrol Injection system and Firing order.

Theory of Carburation, Simple Carburetor, Calculation of Air-Fuel ratio of Simple Carburetor with and without compressibility of air, (Numerical treatment).

Fuel Injection system, Requirements, Types of injection systems, Fuel pump and Fuel injector, Types of Nozzles.

Unit-III: (08 hrs.)

Combustion of SI and CI Engines,

Stages of combustion, variables affecting combustion stages of SI and CI engines. Normal and abnormal combustion, Knocking, its effect and its control for SI and CI engines. Combustion chamber design principles, Requirements, various types of combustion chambers like M – combustion chamber, Open and Swirl combustion chambers for SI and CI Engines.

Unit-IV: (08 hrs.)

Testing and performance of SI and CI Engines :

Measurement of IP, BP, Fuel consumption, Measurement of frictional power using Willians Line method and Morse test. Calculation of various efficiencies, Fuel Consumption and heat balance sheet for SI and CI engines (Numerical treatment).

Unit-V : (08 hrs.)

Governing of SI and CI engines:

Heat and miss method, Quality and Quantity governing, Lubrication of SI and CI engines: Purpose, Lubrication systems like wet sump, pressurized and semi pressurized Lubrication system. Cooling of SI and CI engines: Purpose, Methods of cooling Like Air, Water cooling systems, their comparison advantages and Disadvantages. Supercharging of SI and CI engines: Purpose, Types of Supercharging and Turbo charging, Limitations advantages and disadvantages. Alternative Potential

Engines: Wankel engine, advantages and disadvantages.

Unit-VI: (06 hrs.)

Gas Turbines:

Components of Gas turbine, Centrifugal and axial compressors, Prewhirl, Stalling and combustion chambers. Open and closed cycle Gas Turbine, Joule cycle, Means of improving efficiency and sp.work output like re-generation, re-heating, inter cooling and their comparison.(Numerical treatment).

List of Experiments: Term work shall consists of record of at least five experiments from Part-A and five experiments from Part-B.

Part-A: Study Experiments:

1. Study of Actual and theoretical Valve Timing diagrams for SI and CI Engines.
2. Study of Carburetor.
3. Study of Fuel pump and fuel Injector.
4. Study of Ignition system.
5. Study of Actual and theoretical P-V diagrams for SI and CI Engines.
6. Study of governing systems for SI and CI Engines.
7. Study of Lubrication systems for SI and CI Engines.
8. Study of cooling systems for SI and CI Engines.

Part-B: 1. Trial on Single/Multi cylinder Petrol Engine with variation of speed.

2. Trial on Single/Multi cylinder Petrol Engine with variation of Load
3. .Trial on Single/Multi cylinder Diesel Engine with variation of speed.
4. . Trial on Single/Multi cylinder Diesel Engine with variation of load.
5. Determination of Frictional power using Morse Test.
6. Determination of Frictional power using Willians Line Method.
7. Measurement of exhaust gas emissions of SI and CI Engines.
8. .Measurement of Calorific value of Fuels using Bomb calorimeter/ Orssat apparatus.

Practical Examination: It should consists of Pr./Oral based on above syllabus & Term Work.

References:

1. I.C. Engines by M.L. Mathur and Sharma, Dhanpat Rai Publications.
2. I.C. Enginers by V. Ganeshan, McGraw Hill Publicaitons.
3. Steam & Gas Turbines by R. Yadav, Central Publishing House.
4. I.C. engines by R.K.Rajput, Laxmi Publicaitons.
5. I.C. engines by P.W. Gill, J.M. Smith, Oxford & IBH Publicaitons.
6. I.C. engines by J.R. Heywood, MiGraw Hill Publications.
7. I.C. engines by Lester Clyde, Lichty, MiGraw Hill Publicaitons.
8. I.C. engines by E.F. Obert-Harper, Newyork Pubilcaitons.
9. I.C. engines by Damkondwar.
10. I.C. engines by Maleeve.
11. I.C. engines by Mohanty, Standard Book house.

T.E. MECHANICAL – PART – II
(CGPA)

MECHATRONICS – II

Teaching Scheme:	**Examination Scheme:**		
Theory: 4 hrs/Week	**Theory:**	**ESE**	**: 80 Marks**
Practical: 2 hrs/Week		**MSE**	**: 20 Marks**
		CE	**: 30 Marks**
	(Practical)	**ESE**	**: 70 Marks**

COURSE OBJECTIVES:

1. Understand key elements of industrial Pneumatic systems principal and components and circuit design
2. Understand key elements of industrial hydraulic systems principal and components and circuit design.
3. Understanding Electrical ,Mechanical Actuations and components Like switches relays etc. Also basis of application and selection of drives for various applications.
4. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial application.
5. Understand Advance control in Mechatronics and Robotics.

COURSE OUTCOMES:

1. Student shall understand Basic component and design of pneumatic systems.
2. Student shall understand Basic component and design of HYDRULIC systems.
3. Student To understand the signal conditioning phenomenon, necessity, and outline.
4. Student to understand concept of PLC its industrial use, application to Mechatronics.
5. Student shall Development of PLC ladder programming and implementation of real life system Hydraulics+Pneumatics + Electrical Electronics +Plc .

Unit 1:

Electronics elements In Mechatronics (06)

Digital To analog Converter ,and analog to Digital Converter ,Multiplexers Introduction to Bipolar Transistor ,MOSFET,SCR and their Use In Mechatronics Operational

Amplifiers :Introduction & Characteristics Voltage follower, Gain 100,Amplifier for Transducers, oscillator ,voltage comparator, IC 555 Timer & its Use.

UNIT 2 :

Electrical & Mechanical Actuating systems and Drives (08)

Brief Recall of stepper Motor, AC and DC Motor, stepper motors

Speed control : Ac Motor pole changing ,stator Frequency Variation DC speed control by Ward Leonard, Buck boost Method .

Servo drives: Operating Principle, Basics, configuration, types characteristics advantages of stepper motor used in Mechatronics .

Drives and industrial Applications: synchronous, induction and DC drives, control system, Application in Roiling Mill, Machine Tool Drives such as Lathe, Drill, Milling, shaping ,Textile and Paper Mill .

Unit –3

Industrial Hydraulics (10)

Introduction, Typical Hydraulic Power pack system, Types of pump, Accumulators with applications like damping, leakage& vehicle suspension, Intensifiers with application electrically operated power intensifier Automatic reciprocating intensifiers

Construction of hydraulic cylinder types, mounting method, system calculation for speed acceleration ,pressure ,cylinder thrust (Numerical),cushioning of cylinders,

Industrial Circuits :Need of Direction pressure and Flow control ,Types of pressure control Valves such as Pressure relief ,safety ,sequence ,unlading pressure reducing counter balance ,fuse

Design and study of Circuits such as Regenerative, control of single acting spring return, double acting ,fast extending regenerative ,speed control (Meter in meter out Bleed off),sequencing ,synchronizing circuit for riveting machine automatic reciprocating ,fail safe ,hydraulic press circuits ,circuit for unloading of pump .

Unit – 4

Industrial Pneumatics (10)

Layout of pneumatic system ,symbols ,Air preparation with drier ,FRL unit ,filter review of Pneumatic valves Direction Control valves,3/2,4/2,5/2 various method of actuation pedal lever, pushbutton ,solenoid .Time delay valve, on return valves as check ,shuttle, quick exhaust Speed control valves ,cylinders single ,double, tandem ,rotary rod less ,telescopic ,

Basic Pneumatic circuits :control of single acting ,double acting cylinders ,speed control ,safety circuit ,cylinder cycle timing ,start up interlock ,sequence circuits, cushioning. Low cost pneumatic Application such as clamping, measurement and inspection, work feeding Circuit drawing for given conditions with single cylinder such as press fit in, automatic bus doors, load lifting and placing.

Unit - 5

Programming Logic Controllers (08)

Programmable Logic Controllers, Basic Structure , Input / Output Processing , Program ming,Mnemonics , Timers, Internal relays and counters,Shift Registers, Master and Jum p Controls, Data Handling, Analogs Input / Output, Selection of a PLC.

Unit- 6

Advance application of Mechatronics (06)

Advance application: Sensors for condition monitoring with examples ,Mechatronic control in automated manufacturing ,artificial intelligence in Mechatronics, artificial neural network & its Quality control application ,fuzzy logic ,micro sensors in Mechatronics Micro pressure, thermal flow humidity ,displacement .

Reference Books:

1. Mechatronics by W Bolton, Pearson Education Publications.
2. Pneumatics systems- Principles and Maintenance by S R Mujumdar, McGraw Hill Education Publications.
3. Hydraulics and Pnuematics by S. ILANGO, PHI learning Publications.
4. Electrical drives by N K DE,P.K SEN, PHI learning Publications.

5. Oil Hydraulic system by S R Mujumdar, McGraw Hill Education Publications.
6. Mechatronic sourcebook by Newton C Braga, CENGAGE Learning.
7. Mechatronic systems by Devdas Shetty ,Richard Kolk, CENGAGE Learning.
8. Product Manual of corporate by Manufacturers example FESTO,SMC.

List of experiments (Min. 7 Practicals out of below enlisted)

(It is Desirable for Institutes to have simulation software for Hydraulic, pneumatic, PLC ladder Logic etc)

1.Physical Demonstration of Pneumatic and Hydraulic system component such as cylinder ,various valves, connecters ,F R L unit ,accumulator etc (All component must be separate, not connected in circuit ,student shall physically handle all component and make observation) Wherever possible dismantle and assemble items like valves cylinder ,strainer etc

(A Museum of such component can be established).

2. Following experiments to be done on pneumatic trainer/software simulation :

a. Automatic reciprocating circuit

b. Speed control circuit, Pneumatic circuit involving shuttle valve/ quick exhaust valve

3. Following experiments to be done on hydraulic trainer/software

a. Regenerative circuit

b. Speed control circuit

4.Test on liner/rotary actuator(pneumatic and hydraulic both) using Simulation software /Trainer kit

5. Hydraulic system Maintenance, reconditioning (Expected to discussion via power point presentation with case studies)

6. Maintenance and trouble shooting in Pneumatic circuits (Expected to discussion via power point presentation with case studies)

7.PLC control system: - ladder logic implementation on small model with input output with example such as Tank level control etc /Any appropriate example
8. Demonstration of Bottle Filling System /any appropriate system using PLC system

9. Demonstration & study characteristics of Operational AMPLIFIER using electronic circuit

10 .Generation of various hydraulic and Pneumatic circuits on Simulation software .

Assignments (Min. 05 Assignments out of following Discussions on below mentioned Topic shall be discussed during practical sessions)

1. Assignment on ISO symbols for different components of Hydraulic and Pneumatic system

2. Assignment on different types of actuators used in Pneumatic and Hydraulic system

3. Assignment on Design of simple hydraulic systems used in practice such as copy turning attachment, hydraulic clamps, jack, dumper, forklift etc.

4. Assignment on Design of simple pneumatic systems used in practice such as braking system, vibrator, drilling, chisel etc.

5. Assignment on any systematic case studies of PLC system for any application with input output logic construction selection of PLC, Specification, and costing etc

6. Obtaining Any Pneumatic /Hydraulic component manufacturers catalogue and observing with product specification, types of products, costing etc

7. Preparing Power point Presentation for Various topics by different Groups of student Robot ,control system Applications in manufacturing industry .CD of PPT shall be attached to Assignment Book.

8.Working and use of IC 555 timer in Mechatronics : a case study report

Note :The above list of experiment and assignments are Indicative reference The teacher may additional provide practical and assignments as per necessity By self judgment /assessment

T.E. (Mechanical) Part-II
CGPA

El.-I (01) Dynamics of Machines

Teaching Scheme:- **Examination Scheme:**
Lectures 4 Hrs/week **ESE: 80 Marks**

MSE: 20 Marks

Course Objectives:

1. To understand the concept of balancing of rotating and reciprocating masses.
2. To understand the force analysis of reciprocating engine.
3. To study different types of gear trains.
4. To understand the concept of vibrations, single degree of freedom systems and the forced vibrations.
5. To study different types of Governors and its functions.

Course Outcome:-

After completion of the course, the student will be able to:

1. Apply mathematical principles to perform dynamic force analysis on machine components.
2. Establish methods for balancing of machine components.
3. Analyze free vibration of various systems.
4. Analyze forced vibration of various systems.

UNIT-I

Balancing of Rotating Masses :- **(06Hrs)**

Balancing of rotating masses, static and dynamic balancing, determination of balancing masses in two plane balancing, balancing of internal combustion engines, balancing of in-line engines, firing order.

UNIT-II

Balancing of Reciprocating masses: **(06 Hrs)**

Twin and radial engines, forward and reverse crank method, balancing of rotors, swaying couple, Hammer-blow & Variation of Tractive force.

UNIT-III **(08 Hrs)**

Kinetic Analysis of Mechanisms

Inertia force & torque, D' Alembert's principle, Dynamically equivalent system, force analysis of reciprocating engine mechanisms.

UNIT-IV

Gear Trains **(04 Hrs)**

Types of gear trains- simple, compound, epicyclic, reverted gear train, Tabular method for finding the speeds of elements in epicyclic gear train.

UNIT-V **(10 Hrs)**

Vibrations

Basic concepts & definitions, vibration measuring instruments, free & forced vibrations, Types of damping.

Single Degree of Freedom Systems

Free vibrations with & without damping (Torsional &Transverse), over, under & critical damping, damping factor, logarithmic decrement, equivalent viscous damping.

Forced Vibrations

Forced vibrations with viscous damping, magnification factor, frequency response curves, vibration isolation and transmissibility, whirling of shafts and critical speeds.

UNIT-VI **(06 Hrs)**

Governors:

Introduction, types of governors- Porter, Proell & Hartnell governor. Sensitivity, hunting of governor, stability of governor effort & power of governor, controlling force diagram for porter governor, coefficient of insensitiveness.

Term Work:-

Full imperial size sheets/Assignments on static, Dynamic force analysis and balancing**.**

List of Experiments (any eight)

1. Problems on Epicyclic gear train using tabular method.
2. Determination of M.I.by Bi-filar suspension with universal vibration apparatus.
3. Balancing of rotary masses.
4. Balancing of reciprocating masses.
5. Study of vibration measuring instrument.
6. Determination of natural frequency of vibration of simple structures.
7. Experiment on whirling of shaft's.
8. Study of gear train models.
9. Find out the frequency of damped torsional vibration of single rotor system with universal vibration apparatus.

Reference Books:-

1. S.S.Rattan," Theory of Machine," Tata McGraw Hill Publishing Co.Ltd.,New Delhi 4th Edition,2005.
2. R.Venchatachalm,2014,Mechanical Vibrations, PHI Publication,1st Edition.
3. P.L.Ballaney," Theory of Machines & Mechanism,"Khanna publishers, New Delhi 21st Edition.
4. Thomos Bevan," The Theory of Machines," CBS Publshers and distributers, New Delhi, 1st edition,Reprint2005.
5. J.E.Shigley, J.J.Uicker," Theory of Machines & Mechanism,"McGraw Hill Publication-New Delhi, 2nd Edition.

T.E. (Mechanical) Part – II
C.G.P.A.

EL-I (02) Power Plant Engineering

Teaching Scheme: **Examination Scheme:**
Theory: 4 Hrs./Week **Theory –MSE - 20 Marks**
ESE – 80 Marks

Course Objectives:

1. To develop an ability to apply knowledge of Mathematics and Thermal Sciences
2. To develop an ability to design a system component and processes to meet the desired needs of Power Plant.

Course Outcomes:

1. Ability to have adequacy with design, erection and development of Power Plant.
2. Optimization of Power Plants with respect to available resources.

Unit-I: **(08 Hrs)**

Thermal Power Plant:

General layout of Modern Thermal Power Plant, Site selection, present status of thermal Power plant in India, Supercritical, Supercharged and fluidized bed combustion boiler, Coal storage, coal handling systems, feeding and burning of pulverized fuel, ash handling system, steam jet ash handling system, dust collector- mechanical dust collector and electrostatic precipitator

Unit-II: **(08 Hrs)**

Rankine and Binary Vapor cycle:

Rankine cycle, working , thermodynamic analysis, effect of operating parameter- boiler pressure, condenser pressure and superheating, Binary vapor cycle.

Steam Turbine:

Principle of operation of steam turbine, classification, compounding of impulse turbine- velocity, pressure and velocity-pressure compounded impulse turbine.

Unit- III: **(08 Hrs)**

Reheating and Regenerative Feed Heating Cycle:

Regenerated feed heating cycle and its representation on T-S and H-S diagram, types of feed heating arrangements, Optimum feed water temperature, advantages and disadvantages over a simple Rankine Cycle, feed heater, direct contact heater, surface heater, deareator. Reheating of steam in thermal power plant and its representation on T-S and H-S diagram, advantages and disadvantages over simple Rankine Cycle.

Unit–IV: **(08 Hrs)**

Nozzle:

Types of nozzle, equation of continuity, SFEE of nozzle, effect of friction on the velocity of steam, nozzle efficiency, mass flow rate through nozzle, throat pressure for maximum discharge, critical pressure ratio, general relationship between area, velocity and pressure, supersaturated flow, effect of back pressure.

Cooling Tower:

Introduction, types of cooling tower, assessment of cooling tower, design of cooling tower, Mechanism of heat transfer in cooling tower, Morkel Method.

Unit-V: **(08 Hrs)**

Nuclear Power Plant:

Principles of nuclear energy, nuclear reactions, nuclear reactors, pressurized water reactor, boiling water reactor, CANDU, Waste disposal and safety of nuclear power plant.

Unit-VI: **(08 Hrs)**

Environmental Impact:

Introduction, different pollutants due to thermal and nuclear power plant, their effects on human health, Environmental control of different pollutant such as particulate matter, oxides of sulphur, nitrogen, global warming, thermal and nuclear power plant's pollution of water and its control.Pollution norms of Thermal Power Plant as per Indian Standard.

Reference Books:

1. Power Plant Engineering, McGraw Hill Publications, New Delhi, E.I. Wakil.
2. Power Plant Engineering, McGraw Hill Publications, New Delhi, P,K.Nag.
3. Steam and Gas Turbine, Central Publishing House, Allahabad, R. Yadav.
4. Power Plant Engineering, DhanpatRai and Sons, New Delhi, Damkondwar and Arora.
5. Power Plant Engineering, Standard Book House, New Delhi, D.K. Chavan and G.K. Phatak.
6. Steam and Gas Turbines and Power Plant Engineering, Central Publishing House, Allahabad, Dr. R. Yadav.

T.E. (Mechanical) Part-II
C.G.P.A.

EL-I (03) Industrial Engineering

Teaching Scheme: **Examination Scheme:**
Theory: 4 Hrs./Week **Theory –MSE -- 20 Marks**
ESE – 80 Marks

Course Objectives:

To introduce students:

1. The concept of integration of various resources.
2. To acquire the knowledge of complex processes or system required to accomplish the tasks.
3. To acquaint various ways to eliminate waste of time, money, material and energy that do not generate the value.
4. The various cost accounting systems.
5. The various mental fatigue at work place.

Course Outcomes:

After studying the subject students will be able to:

1. Identify the specific areas for a particular job execution in manufacturing business organization.
2. Know the key areas having chance of waste occurrence and its reduction possibilities.
3. Optimize resource utilization.
4. Carryout cost estimation and analysis.
5. Find their convenience to do the job.

Unit-I: **(06 Hrs)**

Introduction to Management and Organisation:

Definition and concept of Management, Organisation and Administration, Principles and functions Management, Design of Organisation structure and typical types of Organisations.Theory X , Theory Y and Classical, Neo-Classical Theory. Organisational Behavior.

Unit – II: **(08 Hrs)**

Introduction to Departments:

Production: Introduction to various resources like Men, Machine, Money and time, Definition of Production and Definition of Productivity, forecasting.

Materials: Introduction to inventory and inventory control, E-tendering, price quoting, purchase order formats, Design of warehouse facility.

Personnel: Recruitment and Training, Designing Training Programs.

Finance: Sources of Finance, Banking and Role of RBI

Marketing: Marketing and sales, Market research techniques, Market mix.

Research and Development: Only descriptive part of Research Methodology curiosity and problem notification.

Unit – III: **(08 Hrs)**

Work, Motion, Time and Method Studies:

Productivity and work study, Work measurement and work sampling, Principles of motion economy, SIMO Chart, Micro- Motion study, Steps in time study, recording the information and rate of working, Process chart, Multi activity chart and flow process chart.

Unit –IV: **(06 Hrs)**

Industrial Psychology:

Outline of discipline of anatomy, Physiology and Psychology with respect to ergonomics, Building blocks such as anthropometry and biomechanics, Job evaluations, merit rating and incentive schemes, Stress management.

Unit – V

Facility Design: : **(06 Hrs)**

Facility location factors and evaluation of alternate locations. Types of plant layout and their evaluation. Computer aided layout design techniques. Material handling systems.

Unit – VI:

Industrial Business Practices and legal aspects: (06 Hrs)

Introduction to: Factory Acts, Workers compensation acts, Insurance policies, Formulation of counseling committees, Indian Apprenticeship Act, International Business Practices.

Assignments based on above Syllabus:

1. One Seminar presentation of selected from syllabus with it's practical significance.
2. One assignment on Design of Organisation in a live situation.
3. One assignment on Designing of Training Programme or E-tendering or Design of Warehouse Facility.
4. By taking suitable live product preparation of process or Multi-activity or Flow-process chart.
5. Carrying out complete job evaluation of suitable live example.
6. Complete computer aided lay out Design for given Industry.

References:

1. Industrial Engineering and Management by O.P. Khanna (Dhanpat Rai& Sons).
2. Industrial Organisation and Management by Banga Sharma.
3. Ergonomics at work by Murrell.
4. Plant layout and Material Handling by James M. Apple, John Wiley & Sons.
5. Facility layout and location –An analytical approach by Richard L, Francis H John, A. White Printice Hall.
6. Modern Production/Operation Management by Elwood S. Butta, RakeshK.Sarin, John Wiley & Sons.
7. Introduction to Work Study-ILO, Geneva and Oxford & IBH Pub. Co. Pvt. Ltd.

T.E. (Mechanical) Part – II
C.G.P.A.

EL-I (04) Advanced Casting and Welding

Teaching Scheme:
Theory: 4 Hrs. /Week

Examination Scheme:
Theory- MSE - 20 Marks
ESE - 80 Marks

UNIT – I: **(07 Hrs)**

Casting Design:

Heat transfer between metal and mould, Design considerations in casting, designing for directional solidification and minimum stresses, principles and design of gating and risering.

UNIT - 2:

Casting Metallurgy: **(07 Hrs)**

Solidification of pure metal and alloys- Shrinkage in cast metals, progressive and directional solidification, Degasification of the melt-casting defects , Castability of steel, Cast Iron, Al alloys, Babbitt alloy and Cu alloy.

UNIT – 3:

Recent Trends in Casting and Foundry Layout: **(10 Hrs)**

Shell molding, Precision investment casting, CO_2 molding, Centrifugal casting, Die casting, and Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes.

Casting defects & their remedies: Shaping faults arising in pouring, inclusions and Sand defects, gas defects, Shrinkage defects during solidification in liquid phase, Contraction defects, Dimensional errors, Compositional errors and segregation.

Foundry Layout: Layout of mechanized foundry, sand reclamation, material handling in foundry pollution control in foundry.

UNIT-4:

Welding Metallurgy: (08 Hrs)

Heat affected Zone and its characteristics – Weld ability of steels and cast iron. Hydrogen embrittlement, heat transfer and solidification- analysis of stresses in welded joints, pre and post welding heat treatment, welding defects and remedies.

UNIT- 5:

Recent Trends in Welding: (08 Hrs)

Friction welding, Friction stir welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding , Electron beam welding, Laser beam welding, Plasma welding, Electro slag welding, Hybrid twin wire active TIG, MIG welding, Submerged Arc welding, Modern brazing and soldering techniques, Under water welding.

UNIT-6:

CAE of Welding and Casting: (08 Hrs)

Design of weldment, application of finite element method in welding, Determination of distortion in weldments, Modeling of temperature distribution-case studies. Design for casting, application of finite element method in casting-determination of hot spots, location of turbulence and other defects, modeling of flow in molds, modeling of heat transfer of heat transfer in castings-case studies, Use of 3-D printing in pattern making.

Term Work: It shall consist of any three assignments:

(1) Design of pattern layout for a given component.
(2) Design of gating system for a given component.
(3) Design of foundry Layout for the given case.
(4) Detailed study of Heat affected zone in welding.
(5) Industrial visit to a modern Foundry/Fabrication unit.

References:

1) Manufacturing Processes, B.H.Amstead, Philip F.Ostwald and Myron L. Begman, John Wiley and sons.
2) Advanced Manufacturing Processes, G F Benidict, Marcel Dekar Publisher

3) Principles of metal Castings, Heine, Loper and Rosenthal (TMH).
4) Principles of Foundry Technology7, P L Jain (TMH)
5) Klas Weman, Welding Processes, Handbook, 2003.
6) Howard B Cary, Modern Welding Technology , Prientice Hall.
7) ASM handbook"Casting" ASM International.
8) L M Gourd, "Principles of welding Technology",ELBS:E Arnold, London, 2nd Edition, 986.
9) Raj Shankar, Bhandari,"Welding Technology for Engineers" Narosa PublicationHouse Pvt. Limited.
10) S.V. Nadkarni, "Modern Arc Welding Technology",Oxford and IDH publishing co.Pvt. Ltd. New Delhi-2010.

CGPA

EL-I (05) MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

Teaching Scheme	**Examination Scheme**
Theory: 4 Hrs/Week	**MSE: 20 Marks**
	ESE: 80 Marks

Course Objectives

The syllabus of MEMS is designed with a view of providing the following to the students:

1. Basics of MEMS technology.
2. Fundamental Devices and Processes for MEMS, Transducers and Actuators.
3. Micro fluidic devices and materials like Bio MEMS and Biomaterials.
4. MEMS Packaging and Assembly, MEMS device simulation.

Course Outcomes

At the end of course, the student will able to

1. Apply fundamental concepts of MEMS to solve real life engineering problems.
2. Identify problems and suggest suitable MEMS material/ Devices/Process to get the . Requisite Solution for a given application.
3. Apply advanced MEMS techniques to solve future engineering problems.

Unit I: (04 Hrs)

Introduction:

Introduction: history of MEMS, market for MEMS, overview of MEMS processes, properties of silicon, a sample MEMS process. Basics of Micro technology: definitions and terminology, a sample process, lithography and etching. Micromachining: subtractive processes (wet and dry etching), additive processes (evaporation, sputtering, epitaxial growth).

Unit II: (05 Hrs)

Fundamental Devices and Processes

Fundamental Devices and Processes: basic mechanics and electrostatics for MEMS, parallel plate actuators, comb drives. CMOS MEMS: CMOS foundry processes,

coupled IC/MEMS technologies, MEMS post-processing, applications. Clean room Lab Techniques: clean rooms, gowning procedures; safety, fire, toxicity; acids and basis; photolithography.

Unit III: (11 Hrs)

Transducers and Actuators

Thermal Transducers: Electrotherm alactuators,MicroOptoElectroMechanical Systems (MOEMS): micro scanners, digital mirror display, optical switches, other micro-optical devices. Micro machined mechanical sensors: Accelerometers, Basic accelerometer concepts, Force- balanced accelerometer concepts, Strain guage accelerometers, capacitive accelerometers, Gyroscopes, Pressure sensors, Piezo resistive pressure sensors, Capacitive pressure sensors.

Electrostatic actuators : Actuation mechanisms, Electrostatic actuation, Parallel plate actuators, Torsional electrostatic actuators, Electrostatic comb drives, Electrostatic cantilever actuators, Electrostatic linear micro motors(scratch drive), Electrostatic rotary micro motors

Unit IV: (08 Hrs)

Microfluidic devices and Materials

Microfluidic devices: Introduction, Basic fluid properties and equations, Types of flow, Bubbles and particles in microstructures, Capillary forces, Fluidic resistance, Fluidic capacitance, Fluidic inductance, Flow channels, Bulk micro machined channels, Surface micro machined channels, Valves and Pumps.

BioMEMS and Biomaterials: gas chromatography systems and electrophoretic systems. Wireless MEMS: mechanical and electrical resonators, Q-factor, switches, filters.

Unit V:

MEMS Packaging, Assembly and Future of MEMS (07 Hrs)

MEMS Packaging and Assembly: micro assembly: serial and parallel, Deterministic and stochastic; micro grippers; packaging techniques.

The Future of MEMS: BioMEMS - neural implants, gene chips, diagnostic Chips;

MEMS in space; mechanical computers; invisible and ubiquitous Computing.

Unit VI:

MEMS Simulation. (05 Hrs)

MEMS device simulation: Design and Layout using CAD tools, L-Edit Technology files, Cross-sections, Drawing, Design Techniques (MEMS-Pro): MEMS physical layout, Solid modeling and 3-D tools, MEMS verification, 3-D analysis, MEMS simulation, MEMS optimization principles.

Reference books:

1. Marc Madou, "Fundamentals of Micro fabrication", CRC Press, 1999.
2. Gary S. May, Simon M. Sze, " Fundamentals of Semiconductor Fabrication", John Wiley & Sons, 2004.
3. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Aatre, "Micro and Smart Systems", John Wiley & Co.Indian Edition, New Delhi, 2010.
4. Tai Ran Hsu, "MEMS & Microsystem Design and Manufacture", Tata McGraw Hill, New Delhi 2002.
5. Julian W. Gardner and Vijay K. Varadan, "Microsensors, MEMS, and Smart Devices", John Wiley & Sons Ltd, 2001.
6. S. Senturia, *Microsystem Design*, Kluwer 2000
7. G. Kovacs,*Micromachined Transducers Sourcebook*, McGraw-Hill 1998.