Bharati Vidyapeeth
(Deemed to be University), Pune, India
College of Engineering, Pune
Department of Mechanical Engineering

Vision of the Department

To develop high quality Robotics and Automation Engineers through dynamic education to meet social and global challenges

Mission of the Department

- To provide extensive theoretical & practical knowledge to the students with well-equipped laboratories & ICT tools through motivated faculty members
- To inculcate aptitude for research, innovation and entrepreneurial qualities in students
- To acquaint students with ethical, social and professional responsibilities to adapt to the demands of working environment.

Name of Programme: B. Tech. Robotics and Automation Engineering

Programme Educational Objectives (PEOs)

- To fulfill need of industry and society with theoretical & practical knowledge
- To perform research, innovation, lifelong learning and continued professional development
- To fulfill professional ethics and social responsibilities

Programme Outcomes (POs)

The graduates will be able to

a. apply knowledge of mathematics, science and engineering fundamentals for solving complex engineering problems

b. identify the need, plan and conduct experiments, analyze data for improving the mechanical processes.

c. design and develop mechanical systems considering social and environmental constraints.

d. design and develop a complex mechanical system using research based knowledge, advanced mathematical, statistical tools and techniques.

e. use information technology (IT) tools for prediction and modeling of routine activities to enhance the work performance.

f. know social responsibilities while doing professional engineering practices.

g. familiarize with eco-friendly, sustainable and safe working environment.

h. take into account professional ethics while designing engineering systems.

i. work efficiently as a group leader as well as an individual.

j. communicate in written and verbal form with subordinates and supervisors.

k. apply project and finance management techniques in multidisciplinary environments.

l. take interest in higher education and update the knowledge.

B. Tech. Robotics & Automation Sem.-III

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	UE	IA	TW	TW & OR	TW & PR	Total	L	P TW/OR/PR	T	Total
1		Hydraulics & Pneumatics: Principals	4	2	-	60	40	-	50	-	150	4	1	-	5
2		Theory of Machines	4	2	-	60	40	-	50	-	150	4	1	-	5
3		Strength of Machine Components	3	2	1	60	40	25#	-	-	125	3	1	1	5
4		Electronic Circuits	3	2	-	60	40	25#	-	-	125	3	1	-	4
5		Embedded Systems[@]	4	2	-	60	40	25#	-	-	125	4	1	-	5
6		Data Structures and Algorithms	-	2	-	-	-	25#			25		1	-	1
7		MATLAB Programming	-	2	-	-	-	-	-	50	50	-	1	-	1
8		Vocational Course-I: Sensors, PLC & HMI: Basic Training	-	-	-		-	-	50	-	50	-	2	-	2
9		MOOC-I	-	-	-		-	-	-	-	-	-	-	-	2
10		Environmental Studies (Mandatory Course)[+]	-	-	-		-	-	-	-	-	-	-	-	-
	Total		**18**	**14**	**1**	**300**	**200**	**100**	**150**	**50**	**800**	**18**	**9**	**1**	**30**

#: Based on TW & internal oral examination; [@]Industry Taught Course-I; $ To be conducted in service centre after office hours: 4 hrs/week; + End sem. Exam. of 100 marks

B. Tech. Robotics & Automation Sem.-IV

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	UE	IA	TW	TW & OR	TW & PR	Total	L	P TW/OR/PR	T	Total
1		Design & Analysis of Machine Components	4	2	-	60	40	-	50	-	150	4	1	-	5
2		Digital Electronics[@]	4	2	-	60	40	25#	-	-	125	4	1	-	5
3		Power Electronics & Drives	3	2	1	60	40	-	50	-	150	3	1	1	5
4		Manufacturing Technology-I	3	2	-	60	40	50#	-	-	150	3	1	-	4
5		Automatic Control Systems	4	2	-	60	40	25#	-	-	125	4	1	-	5
6		Solid Modelling	-	4	-	-	-	-	-	50	50		2	-	2
7		Vocational Course-II: PLC, HMI & Automation: Advanced Training	-	-	-	-	-	-	50	-	50	-	2	-	2
8		Social Activities-I	-	-	-	-	-	-	-	-	-	-	-	-	2
9		Disaster Management (Mandatory Course)[+]	-	-	-	--	-	-	-	-	-	-	-	-	-
	Total		**18**	**14**	**1**	**300**	**200**	**100**	**150**	**50**	**800**	**18**	**9**	**1**	**30**

#: Based on TW & internal oral examination; [@]Industry Taught Course-II; $ To be conducted in service centre after office hours: 4 hrs/week; + End sem. Exam. of 100 marks

Designation of Course	**Hydraulics & Pneumatics: Principals**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics. 2. Engineering Physics. 3. Engineering Mechanics.
Course Objectives:-	To provide knowledge about 1. Properties of fluids, concepts of fluid statics, kinematics & dynamics. 2. Concepts of fluid power and pumps and its control. 3. Hydraulics and Pneumatics – Actuators and Circuits.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** properties of fluids and **analyze** concepts of fluid statics. 2. **Understand** concepts related to fluid kinematics and **analyze** practical problems. 3. **Understand** concepts related to fluid dynamics, flow through pipes and **analyze** practical problems. 4. **Understand** concepts related to fluid power system, Power units and accessories and **analyze** pump performances. 5. **Understand** concepts related to Control of fluid power and Control valves. 6. **Understand** concepts related to Hydraulics and Pneumatics – Actuators and Circuits and its application.

Course Contents

Unit 1	**Properties of Fluids & Fluid Statics**	**(8 Hrs.)**
Properties of Fluid:-Definition of fluid, concept of continuum, Density, Specific Weight, Specific Gravity, Dynamic Viscosity, Kinematic Viscosity, Newton's law of viscosity, types of fluid, Rheological diagram, Surface Tension, Capillarity, Compressibility, Vapour pressure, Classification of fluid. **Fluid Statics:** Hydrostatic law, Pascal's Law, Pressure at a point, Total Pressure, Archimedes Principle, Buoyancy and stability of floating and submerged bodies, Metacentric height.		
Unit 2	**Fluid Kinematics**	**(8 Hrs.)**
Description of fluid motion- Eulerian and Langragian approach, Types of flow (steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, Irrotational), Continuity equation in Cartesian co-ordinates, flow net, Control volume, Material derivative and acceleration.		
Unit 3	**Fluid Dynamics and Losses in Pipes**	**(8 Hrs.)**
Linear momentum Equation using differential Approach, Introduction to Navier-Stoke's Equation, Euler equation of motion, Derivation of Bernoulli's equation along a stream line, application of Bernoulli's equation to Pitot tube. **Losses in Pipes:** Energy losses through pipe-Major and Minor losses, Pipes in series and parallel, Darcy-Weisbach equation		
Unit 4	**Basics of Fluid Power and Pumps**	**(8 Hrs.)**
Components of fluid power system, advantages and limitations. Difference between electrical, pneumatic and fluid power systems. Seals, sealing materials. Types of pipes, hoses, material. Fluid conditioning through filters, strainers, sources of contamination and contamination control. **Power units and accessories:** Types of power units, reservoir assembly, sizing of reservoirs, constructional details, pressure switches, temperature switches. Accumulators: Types, selection procedure, applications of accumulators. ISO symbols for hydraulic and pneumatic Components		

Pumps: Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves

Unit 5	**Fluid Power Control**	**(8 Hrs.)**

Necessity of fluid control through pressure control, directional control and flow control valves.

Control valves:

i) Principle of pressure control valves, direct operated and pilot operated pressure relief valves, pressure reducing valve, sequence valve.

ii) Principle of flow control valves, pressure compensated and non-compensated flow control valves.

iii) Principle of directional control valves, types of directional control valves, two-way, three-way, four-way valves, check valve and shuttle valve. Open centre, close centre, tandem centre valves. Actuating devices- manually operated, mechanically operated, solenoid operated, pilot operated, lever operated.

Unit 6	**Hydraulic & Pneumatic Circuits**	**(8 Hrs.)**

Linear and rotary actuators: Types, construction and characteristics. Cylinder mountings, cushioning of cylinders.

Hydraulic & Pneumatic circuits: Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc.

Compressors: Types, principle of working and constructional details. Comparison of pneumatic with hydraulic power transmissions. Types of filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two pressure valve, quick exhaust valve and time delay valves. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low-cost automation and in industrial automation

Term Work: (Any 8 experiments needs perform during practical's)

1. Study of Pressure Measuring Devices.
2. Measurement of Viscosity using Redwood Viscometer
3. Stability of Floating Bodies and Optimum Loading Capacity.
4. Verification of Modified Bernoullis Equation.
5. Calibration of Venturimeter.
6. Calibration of Orificemeter.
7. Laminar and Turbulent Flow by Reynold's Apparatus.
8. Discharge over Notches.
9. Study of Minor Losses due to Pipe Fitting.
10. Study of flow control valves (Meter in, Meter out Circuits).
11. Study of ISO/JIC Symbols for hydraulic and pneumatic systems.
12. Following experiments to be done on hydraulic trainer
    a) Regenerative circuit b) Speed control circuit
    c) Sequencing circuit d) Traverse and feed circuit etc.
13. Following experiments to be done on pneumatic trainer
    a) Automatic reciprocating circuit
    b) Speed control circuit
    c) Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve
14. Design of simple hydraulic/pneumatic systems used in practice such as hydraulic clamp, jacks, dumper, forklift etc by using fluid simulation software's such as LVSIM®-HYD & PNEU, AUTOMATION STUDIO.
15. Study of accumulators/actuators/intensifiers/hydraulic and pneumatic power brakes.
16. Industrial visit to study Hydraulic / Pneumatic based Automation systems

Assignment:

Assignment Based on each unit.

Text Books:

1. Dr. P.N. Modi and Dr. S.M. Seth, “Hydraulics and Fluid Mechanics including Hydraulic Machines”, Standard Book House.
2. Dr. R.K. Bansal, “Fluid Mechanics and Hydraulic Machines – l”, Laxmi Publication Pvt. Ltd., New Delhi.
3. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw Hill International Book Co.
4. Garde R. J. and Mirajgaonkar, Engineering Fluid Mechanics, Nem Chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.
5. Cengel & Cimbla Fluid Mechanics, TATA McGraw-Hill. 8. Irving Shames, “Mechanics of Fluid”, McGraw Hill Publication
6. Esposito A, Fluid Power with application, Prentice Hall
7. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
8. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
9. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference Book:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Yeaple, Fluid Power Design Handbook
4. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer’s Catalogues

Project Based Learning

Topics for the project based learning will be given by respective faculty member.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Theory of Machines**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Physics and Mathematics 2. Engineering Mechanics
Course Objectives:-	1. To develop competency in understanding of theory of different types of gear. 2. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications. 3. To develop the competency to analyse the velocity and acceleration in mechanisms using analytical and graphical approach. 4. To develop understanding of static and dynamic balancing and gyroscopic effect.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** the fundamental concept of Lower pair mechanisms and **apply** to real life and industrial applications. 2. **Understand** the basic concept of kinematic analysis and **evaluate** forces acting on reciprocating engine by graphical and analytical method. 3. **Understand** the concept of velocity and acceleration of any planar mechanism and **analyze** it graphically by using relative velocity - acceleration method and ICR method, Coriolis component of acceleration. 4. **Understand** the gear theory which will be the prerequisite for gear design. 5. **Apply** the principles of balancing of masses to various links, mechanisms and engines 6. **Apply** the principles of gyroscopic effects and stabilization on various transport vehicles.

Course Contents

Unit-I	**Mechanisms with Lower Pair**	**(08 Hrs.)**
Introduction, Pantograph, Straight line mechanisms- Exact and Approximate, Hook Joint, Double Hook's Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Theory and analysis of Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifiler suspension.		
Unit-II	**Inertial Forces in Reciprocating Parts**	**(08 Hrs.)**
Analytical method for displacement, velocity and acceleration analysis of slider cranks Mechanism. Klein's construction. **Dynamics of Reciprocating Engines:** Two mass statically and dynamically equivalent system, Correction couple, static and dynamic force analysis of reciprocating engine mechanism, Torque Exerted on crankshaft.		
Unit-III	**Kinematic Analysis of Mechanisms: Graphical Methods**	**(08 Hrs.)**
Relative Velocity Method: Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms. **Relative Acceleration Method:** Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms. **Coriolis component of acceleration.** **Instantaneous Centre of Rotation(ICR) Method** (limit to only 6 link mechanisms)- Kennedy's Theorem, Body and space centrode.		

Unit-IV	Gears	(08 Hrs.)
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and under cutting, Friction in gears. **Helical gears**: nomenclature, Center Distance. Worm & Worm wheel, Bevel gears, Spiral gears, Introduction to Gear Box, Electronic Gearing.		
Unit-V	**Balancing**	**(08 Hrs)**
Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and V-engines.		
Unit-VI	**Gyroscope**	**(08 Hrs.)**
Gyroscopes- Gyroscopic forces and Couples, Gyroscopic stabilisation for ship and Aeroplane, Stability of four-wheel drive vehicle moving on curved path, Stability of a two-wheel vehicle.		

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Compound Pendulum
2. Bifilar Suspension Method
3. Trifilar Suspension Method
4. Velocity and acceleration analysis using Graphical methods by Klein's construction
5. Velocity analysis using Graphical methods by ICR.
6. Velocity and acceleration analysis using Graphical methods by Polygon method.
7. Velocity and acceleration analysis using Graphical methods i.e., polygons involving Coriolis component.
8. To determine Corioli's Component of Acceleration at various speeds of rotation and water flow rates.
9. To draw conjugate profile for any general type of gear tooth
10. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using model.
11. To balance a system of masses revolving in a plane on a rotating shaft on V Lab
12. To verify the gyroscopic principles.

Assignments

Numerical and/or theory questions on each unit from previous year question papers of GATE/ESE Mechanical Engg. examinations.

Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Lower Pair Mechanism
2. Static and dynamic force analysis
3. Velocity and Acceleration analysis using graphical method.
4. Spur Gears
5. Balancing
6. Gyroscope

Reference Books

1. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, Delhi.

2. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms”, McGraw Hill, Inc.
3. Ghosh Amitabh and Malik A.K., “Theory of Machines and Mechanisms”, East-west Press.
4. Hall A.S., “Kinematics and Linkages Design”, Prentice-Hall.
5. Hartenberg and Denavit, “Kinematic Analysis and Synthesis of Mechanisms”.
6. Erdman, A. G. & Sandor, G.N., “Mechanism design, Analysis and synthesis”, Vol 1, Prentice –Hall of India.

Text Books

1. Rattan S. S., “Theory of Machines”, Tata McGraw Hill.
2. Ballaney P. L., “Theory of Machines”, Khanna Publishers, Delhi.
3. R. S. khurmi, “Theory of Machines’, S Chand Publication.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Demonstration model of Pantograph mechanism
2. Demonstration model of Automobiles steering gear mechanism in real life
3. Demonstration model of Ackerman and Davis steering gear mechanism and its comparison.
4. Demonstration models of exact straight line motion mechanism.
5. Demonstration o relative velocity and acceleration method and Klien’s construction in slider crank mechanism
6. Demonstration model Kennedy’s Theorom (Three centre in line)
7. Demonstration model to understand Coriolli’s Effect
8. Demonstration model of different types of gears
9. Chart to understand various terminology of spur gear
10. Demonstration model for failure modes of gear tooth.
11. Chart to understand different methods to avoid interference in spur gear.
12. Demonstration model of static and dynamic balancing.
13. Demonstration model of balancing of rotating masses.
14. Demonstration model of balancing of reciprocating masses.
15. Demonstration model of balancing V-Engine.
16. Demonstration model to understand gyroscopic effect in Ship, aeroplane and automobile.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Strength of Machine Components		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
Tutorial: - 01 Hours/ Week	Tutorial		01
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Mechanics 3. Engineering Science
Course Objectives:-	1. Understand simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical method. 3. Able to draw shear force and bending moment diagram and find slope and deflection of beam 4. Able to draw bending stress and shear stress diagram at different cross section in I, C and T section beam. 5. Able to find stresses in shaft in torsional, combined torsional and bending, combined torsional and axial loading. 6. Able to solve problems on strain energy and Euler's column.
Course Outcomes:-	On completion of the course, students will be able to 1. **Understand** the concept of simple stress and strain and apply to find it for simple component. 2. **Understand** the concept of principal stress analytical and graphical by Mohr's circle; and apply it to find stresses on any oblique plane inclined to principal plane. 3. **Understand** the concept of shear force and bending moment and apply it to find shear force diagram and bending moment diagram for any loading condition on simply supported beam and cantilever beam. 4. **Understand** the concept of slope and deflection and apply it to find for any loading condition on simply supported beam and cantilever beam by maculays double integration method 5. **Understand** the concept of pure bending and shear and apply it to find bending stress and shear stress diagram of I, C and T section of beam. 6. **Understand** the concept of column theory and strain energy and apply it for loading condition.

Course Contents

Unit-I	**Simple Stress and Strain**	**(06 Hrs)**
Load, Direct or normal stress ,Direct strain, Sign convention for direct stress and strain ,Elastic materials, Hooke's law, Modulus of elasticity - Young's modulus, Tensile test, Ductile materials, Brittle materials, Poisson's ratio, Application of Poisson's ratio to a two-dimensional stress system, Shear stress, Shear strain, Modulus of rigidity, Relationship Between E, G and K, Double shear, Allowable working stress -factor of safety, Load factor, Thermal stresses.		
Unit-II	**Principal Stresses, Theories of Failure**	**(06 Hrs)**
Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses, and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses. **Theories of Elastic failure:** Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.		

Unit-III	Shear Force and Bending Moment Diagram, Slope and Deflection	(06 Hrs)
Types of supports and beams, shear force (S.F.), bending moment (B.M.), S.F. and B. M. sign convention, S.F. and B.M. diagrams for beams carrying different loading conditions. Points of contra flexure, Relationship between S.F, B.M. and intensity of loading. Introduction, Simple bending theory, Neutral axis, Section modulus, second moment of area, Relationship between loading, S.F., B.M., slope and deflection, Double integration method, Macaulay's method for all loading conditions.		
Unit-IV	**Bending and Shear Stress in Beam**	**(06 Hrs)**
Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (rectangular, I, T, C) with respect to centroidal and parallel axes, bending stress distribution diagrams, moment of resistance and section modulus. **Shear stresses:** Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses, shear connection between flange and web.		
Unit-V	**Torsion**	**(06 Hrs)**
Simple torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, Section modulus, Torsional rigidity. Principal stresses, Strain energy in torsion, Variation of data along shaft length-torsion of tapered shafts, Power transmitted by shafts. Stresses in solid circular shaft- Torsional load only, bending load only, combined torsional and bending, Combined Torsion and axial loading.		
Unit-VI	**Euler's Columns and Strain Energy**	**(06 Hrs)**
Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula, safe load on columns. Strain energy: Strain energy due to axial load (gradual, sudden and impact), Strain energy due to self-weight.		

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Tension test for ductile materials
2. Tension test for brittle materials
3. Compression test for ductile materials
4. Compression test for brittle materials
5. Shear test for ductile materials
6. Shear test for brittle materials
7. Torsion test for ductile materials
8. Torsion test for brittle materials
9. Impact Test- IZOD and Charpy
10. Strain Gaugeand rosettes theory
11. Testing of hardness by Rockwell
12. Graphical simulation of
    a. Shear force and bending moment diagrams with different end conditions.
    b. Slope and deflection.
    c. Principal stresses through graphical and analytical method.

List of Assignments

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Simple stress and strain.
2. Principal stresses and strain.
3. Shear force and Bending moment diagram and slope and deflection
4. Stresses in beams, thick and thin cylinder
5. Torsion
6. Euler's column and strain energy method

List of Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Stresses in simple bar, Elastic modulus and two-dimensional stress systems.
2. Normal, tangential and resultant stresses on any oblique plane inclined to normal plane by analytical and graphical method.
3. Shaft diameter and factor of safety by using theories of failure.
4. Shear and bending moments on cantilever and simply supported beam and draw SFD and BMD.
5. Slope and deflection at any section between beams by using Macaulay's method.
6. Stresses in beam and draw shear stress diagram and bending stress diagram.
7. Shaft diameter and stresses when shaft subjected to torsion, bending combined torsional and bending, combined torsional and axial loads.
8. Euler's column theory and strain energy.

Textbooks

1. A textbook of strength of material by R.K.Bansal

Reference Books

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication
2. J. E. Shigley, Mechanical Engineering Design, McGraw Hill
3. R. Subramanian strength of Material
4. S Ramamrutham, Strength of Material
5. R.K Rajput, Strength of materials

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare demonstration model of cantilever beam for the study of deflection in it.
2. To prepare demonstration model of simply supported beam for the study of deflection in it.
3. To prepare demonstration model of fixed beam for the study of deflection in it.
4. To prepare demonstration model of Overhang beam for the study of deflection in it.
5. To prepare the chart on relation between E, G, K with derivation.
6. To prepare demonstration model for studying strain energy with consideration of various conditions like impact load, sudden load, gradual load.
7. To prepare the chart on various concepts used in Principal Stresses& planes.
8. To prepare the chart on concept use in Mohr's Circle method using graphically & analytically.
9. To prepare the chart on Rules and guidelines use for drawing SFD & BMD.
10. To prepare the chart on finding bending stress for I cross-sections.
11. To prepare the chart on finding bending stress for T cross-sections.
12. To prepare the chart on finding bending stress for C cross-sections.
13. To prepare the chart on concepts used in solid &hollow shafts.
14. To prepare the chart and demonstration model of Euler's formula for buckling load.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	**Electronic Circuits**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	1. Electronics Engineering Systems
Course Objectives:-	The objective of this course is to cover performance evaluation of various amplifiers by 1. Introducing a concept of the multistage amplifiers, parameter evaluation and related design aspects of multistage amplifiers with the help of derivations. 2. Teaching a concept of the feedback in the amplifiers, feedback topologies with the help of derivations and their advantages and disadvantages. 3. Gauging the efficiencies of various types of power amplifiers with the help of derivations. 4. Teaching a concept and design of the RC and LC oscillators with the help of derivations. 5. Analyze the biasing of BJT circuit and Amplifier 6. Classify different types of FET
Course Outcomes:-	On completion of the course, students will be able to 1. **Identify** applications of BJT 2. **Analyze** FET operations. 3. **Analyze** numerical to get values of the input impedance, output impedance, gain and bandwidth in a multistage amplifier. 4. **Analyze** numerical to get values of the input impedance, output impedance, gain and bandwidth of all the topologies in a negative feedback amplifier. 5. **Analyze** the efficiencies in power amplifiers. 6. **Analyze** numerical to get values of the oscillation frequencies of the RC and LC oscillators, and to design the oscillator for the given oscillations frequency.

Course Contents

Unit-I	**BJT Biasing**	**(06 Hrs)**
Need of biasing circuits, Analysis and design of BJT biasing circuits like fixed bias, collector to base bias, voltage divider bias, split-supply bias, Concept of DC load line, Concept of stability factor, Derivation of stability factor, Single stage amplifiers		
Unit-II	**Field Effect Transistor (FET) Biasing**	**(06 Hrs)**
Types of MOSFET, construction, VI characteristics, FET Biasing-Self Bias, Fixed Bias, Current Source Bias, JFET amplifiers-CS,CD and CG amplifiers, Application of MOSFET.		
Unit-III	**Multistage Amplifiers**	**(06 Hrs)**
Projectile Need of the Multistage amplifiers, Types of Multistage amplifiers-Cascade and Cascode, Cascade-Coupling methods, Frequency response, Parameter evaluation - Ri, Ro, Av, Ai & Bandwidth for general multi stage amplifier, Choice of the transistor configuration in cascade amplifier, Analysis & design of direct coupled, RC coupled (Low frequency, high frequency and medium frequency analysis), transformer coupled (Low frequency, high frequency and medium frequency analysis) amplifier. Darlington Amplifier, Design of Cascode amplifier.		
Unit-IV	**Feedback Amplifiers**	**(06 Hrs)**
Types of basic Amplifiers, Concept and types of feedback, Transfer gain with feedback, Negative feedback topologies with their block Schematics, Effect of negative feedback on Input impedance; Output impedance; Gain and Bandwidth with derivation, Analysis of one circuit for each feedback topology for input impedance, output impedance, gain and bandwidth.		

Unit-V	Power Amplifiers	(06 Hrs)
Need of Power amplifiers, classification; applications; advantages of power amplifiers - Class A, Class B, Class C, class D and Class AB. Operation of - Class A with resistive load; Transformer coupled class A Amplifier; Class B Push – pull; Class AB Complementary symmetry and Quasi – complementary. Efficiency analysis for Class A transformer coupled amplifier, Class B push – pull amplifier. Comparison of efficiencies of other configurations. Distortion in amplifiers; concept of Total Harmonic Distortion (THD).		
Unit-VI	**Oscillators**	**(06 Hrs)**
Concept of Positive feedback, Condition and principle of oscillations (Barkhausen criterion), Classification of oscillators, Design analysis of RC and LC oscillators, RC oscillators: Phase shift, Wien bridge Oscillators; LC Oscillators: Hartley, Colpitt's and Clap; Piezo-electric effect in crystals and Crystal Oscillator.		

List of Experiments:

1. To find the gain and bandwidth of a 2-stage CE RC coupled amplifier.
2. To find the gain and bandwidth of a 2-stage transformer coupled amplifier.
3. To find the gain of a direct coupled amplifier.
4. To find the gain and bandwidth of a voltage series negative feedback amplifier.
5. To find the gain and bandwidth of a voltage shunt negative feedback amplifier.
6. To find the gain and bandwidth of a current series negative feedback amplifier.
7. To find the gain and bandwidth of a current shunt negative feedback amplifier.
8. To study the response of a Class A direct coupled/ transformer coupled amplifier.
9. To study the response of a Class B power amplifier.
10. To find the oscillations frequency of the RC amplifiers-RC phase shift/ Wien bridge oscillator.
11. To find the oscillations frequency of LC amplifiers-Colpitt's Oscillator/Hartley Oscillator
12. To plot frequency response of tuned amplifiers.

List of Assignments: One assignment on each unit

Text Books:

1. S. Salivahanan and N Suresh Kumar, 'Electronic devices and circuits', Mc Graw Hill Education India Private Limited, Third Edition.

Reference Books:

1. Ramakant A.Gayakwad "Op-amps and Linear Integrated Circuit Technology"Fourth edition
2. Adel S. Sedra, Kenneth C. Smith " Microelectronic Circuits" Oxford series in Electrical and computer engineering

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

To prepare a demonstration model on:

1. Water Level Indicator.
2. LED Emergency Light.
3. Home Security System.
4. AC to DC converter.
5. Automatic Street Light controller
6. Rain Alarm
7. Flashing LED
8. Dancing Light
9. Voltage doubler.
10. Voltage regulator using Zener diode.
11. Reverse Current Protection using diode.

12. BJTs as a digital switch.
13. Cascode amplifier
14. Sine wave generator.
15. FET used as a Multiplexer.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	EMBEDDED SYSTEMS		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	Electronics Engineering Systems
Course Objectives:-	1. To familiarize students with architecture and features of typical Microcontrollers. 2. To learn interfacing of real world input and output devices and use Embedded C to interface the microcontrollers to various applications.
Course Outcomes:-	1. Use Hardware and software tools for microcontrollers. 2. Write programs using features of 8051 microcontroller. 3. Write programs using features of PIC microcontroller. 4. Develop interfacing of microcontrollers with real world devices.

Course Contents

Unit-I	**Introduction to Microcontrollers**	**(08 Hrs)**
Comparison of Microprocessor & Microcontroller. Difference between RISC & CISC architectures, Harvard & Von Neumann architectures. 8051 Microcontroller: architecture, family devices & its derivatives. Ports, registers, memory organization, Programming in Embedded C.		
Unit-II	**8051 Microcontroller features**	**(08 Hrs)**
Timers and its modes, Delay generation using timers, Serial Communication with RS232,Interrupt structure, Timers programming with interrupts, Programming in Embedded C.		
Unit-III	**Peripheral Interfacing With 8051**	**(08 Hrs)**
8051 based system design – Address decoding, data memory space Interfacing & Applications –LED, LCD, Stepper motor, DAC/ADC, Sensors, Keyboard. Programming in Embedded C.		
Unit-IV	**PIC Microcontroller**	**(08 Hrs)**
Comparison of Features of different PIC series, PIC 18F architecture, registers, memory Organization, oscillator options, BOD, power down modes and configuration bit settings, Port structure, interrupts & timers of PIC18F,All programs in embedded C.		
Unit-V	**Peripheral Interfacing With PIC-I**	**(08 Hrs)**
Interfacing of PIC18F with LED, Seven segment display, LCD and Keypad. Use of timers with interrupts, PWM generation. All programs in embedded C.		
Unit-VI	**Peripheral Interfacing With PIC-II**	**(08 Hrs)**
MSSP structure, CCP and ECCP, Study of UART, SPI, I2C, ADC. Interfacing serial port, ADC, RTC, EEPROM. Motor Control using PIC. All programs in embedded C.		

List of Experiments:

1. BCD to HEX, HEX to BCD conversion in 8051
2. Generate BCD up/ down counter in 8051.
3. Square wave generation using timers in 8051.
4. Serial Communication using 8051.
5. LCD interfacing with 8051.
6. Stepper motor interfacing with 8051.
7. Keyboard interfacing with 8051.

8. ADC/DAC interfacing with 8051.
9. Serial Communication using PIC.
10. LCD interfacing with PIC.
11. Stepper motor interfacing with PIC.
12. Keyboard interfacing with PIC.
13. Seven segment display interfacing with PIC.

List of Assignments: One assignment on each unit
Content Delivery Methods: Chalk & talk, Power point presentation

Text Books:

1. Mazidi, "8051 microcontroller & embedded system" 3rd Edition ,Pearson
2. Mazidi, "PIC microcontroller & embedded system" 3rd Edition ,Pearson

Reference Books:

1. Ajay V. Deshmukh, "Micro-controllers - Theory and Applications", Tata McGraw Hill.
2. Kenneth J. Ayala, "The 8051 Micro-controller – Architecture, Programming & Applications", Penram International & Thomson Asia, Second Edition.
3. John B. Peatman, "Design with PIC Micro-controllers", Pearson Education Asia, Low Price Edition.
4. 18F xxx reference manual

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

To prepare a demonstration model on:

1. Finger Print based attendance management system
2. LPG gas leakage detection system
3. Automatic motor control for filling water tank
4. Fire detection and alert system
5. Room temperature maintenance by automatically adjusting fan speed / AC
6. Home automation
7. Automatic maintenance of green house
8. Alcohol detection and alert family members in case of drunk and drive
9. Patient monitoring through GSM
10. Digital Notice board for college students
11. Line follower robot
12. Path follower robot
13. Public garden automation
14. Voting machine with digital display
15. Design Real Time Clock
16. Automatic City Street Lights control system

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Data Structures and Algorithms		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Practical:- 04 Hours/ Week	Term Work	25 Marks	01
	Total	**25 Marks**	**01**

Course Contents

Unit 1	**Introduction to Data structures and Algorithms**	**(8 Hrs.)**
Introduction to data structure, Data representation, Abstract Data types, Primitive data types, Data structure and data types, Differences between data types. Program design. Algorithms and different approaches to designing an algorithm, Complexity, Big O notation, algorithm analysis, recursion. Sorting Bubble sort, Selection sort, Quick sort, Merge sort, Insertion sort.		
Unit 2	**Analysis of Algorithms**	**(8 Hrs.)**
Asymptotic notations and their significance, Running time of an algorithm, Time-complexity of an algorithm, Performance analysis of an algorithm, Analysis of iterative and recursive algorithms, Master theorem (without proof).		
Unit 3	**Data Structures**	**(8 Hrs.)**
Importance of data structures, Arrays, Stacks, Queues, Linked list, Trees, Hashing table, Binary Search Tree, Heaps.		
Unit 4	**Search Trees and Multiway Trees**	**(8 Hrs.)**
Binary tree, Linked and array representation of Binary tree, Binary search tree, Operation: Searching of a Node in a Binary tree, Insertion of a node in binary tree, deletion from a binary tree. Threaded binary tree, Forest. AVL trees **Multiway Trees:** Issues in large dictionaries, m-way search trees, Btrees, search insert and delete operations, height of B-tree, 2-3 trees, sets and multisets in STL		
Unit 5	**Graphs Algorithms**	**(8 Hrs.)**
Definition, terminology, directed and undirected graphs, properties, connectivity in graphs, applications, implementation – adjacency matrix and linked adjacency chains, graph traversal – breadth first and depth first, minimum spanning tree (MST), single source shortest paths.		
Unit 6	**Algorithm Design Paradigms**	**(8 Hrs.)**
Divide and Conquer, Brute force, Greedy, Recursive Backtracking and Dynamic programming.		

Text Books:

1. "Data structure using C" ISRD group, TMH.
2. "Data Structure through C" ,Yashwant kanetkar, BPB Publication.
3. Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009.

Reference Books:

1. "Data structure using C" AM Tanenbaum, Y Langsam and MJ Augustein, Prentice Hall India.
2. "Data structure and Algorithm Analysis in C" Weiss, Mark Allen Addison Wesley.
3. "Data structure – A Pseudocode Approach with C", Richard F Gilberg Behrouz A. Forouzan, Thomson
4. "Let us C", Yashwant Kanetkar,BPB Publication.
5. SanjoyDasgupta, C.Papadimitriou and U.Vazirani , Algorithms, Tata McGraw-Hill, 2008.
6. A. V. Aho, J.E. Hopcroft and J. D. Ullman, Data Strucures and Algorithms, Pearson India, Ist Edition, 2006
7. Sara Baase, Allen Van Gelder, Computer Algorithms, Introduction to Design and Analysis, 3rd edition, Wesley Longman Publishing, 1999.

List of Experiments:

1. Extract the features based on various color models and apply on image and video retrieval
2. Arrays, loops and Lists
3. Stacks and Queues
4. Searching and Sorting

5. Linked List and operations
6. Brute force technique
7. Greedy Technique
8. Backtracking
9. Dynamic Programming
10. Trees and Tree Operations
11. BFS and DFS
12. Minimum Spanning Tree

Designation of Course	**MATLAB Programming**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: -02 hours/Week	Term Work & Practical	50 Marks	01
	Total	**50 Marks**	**01**

Course Prerequisites:-	Basic Mathematics
Course Objective: -	The goal of the course is that students should develop techniques for problem solving using a programming language.
Course Outcomes	Students should 1. **Understand** basics of MATLAB and **apply** that knowledge to write simple programs. 2. **Understand** the concept of arrays and functions and be able **apply** them in writing programs/solving problems. 3. **Understand** the concept of 2D graphics and be able **apply** them in developing 2D plots 4. **Understand** the concept of 3D graphics and be able **apply** them in developing 3D plots 5. **Apply** MATLAB knowledge to solve algebraic problems 6. **Understand** the concepts of GUI and **apply** them in creation of forms and objects

Course Contents

Unit-I	**Introduction to MATLAB**	**(04 Hrs.)**
MATLAB Introduction; Platform & Features; Advantages & Disadvantages; MATLAB Commands; MATLAB Environment; Working with Variables & Arrays Workspace, Variables, & Functions; MATLAB Data Types; Control Statements; if...end statement; if-else... end statement; MATLAB switch; Loops: for loop; while loop; break and continue		
Unit-II	**Arrays and Functions**	**(04 Hrs.)**
Matrices & Arrays; Multi-Dimensional Arrays; MATLAB Compatible Array; MATLAB Sparse Matrices; MATLAB M-Files; MATLAB Functions; Anonymous Function		
Unit-III	**Graphics I: 2D plots**	**(04 Hrs.)**
fplot(); Semilogx(); Semilogy(); loglog(); Polar Plots(); fill(); Bar(); errorbar(); barh(); plotyy(); area(); Pie(); hist(); stem(); Stairs(); compass(); comet(); contour(); quiver(); pcolor();		
Unit-IV	**Graphics I: 3D plots**	**(04 Hrs.)**
plot3(); fill3(); contour3(); surf(); surfc(); mesh(); meshz(); waterfall(); stem3(); ribbon(); sphere(); ellipsoid(); cylinder(); slice()		
Unit-V	**Algebra in MATLAB**	**(04 Hrs)**
Gauss & Gauss-Jordan Elimination; Eigenvalues & Eigenvectors; Symbolic Mathematics, Polynomials and Interpolation		
Unit-VI	**GUI in MATLAB**	**(04 Hrs.)**
Components, Containers, Callback		

Term Work

Term work shall consist of programs and assignments based on syllabus.

1. Introduction to MATLAB commands and Programming
2. Use of Arrays and functions in command prompt and programming
3. Generation of 2D graphs
4. Generation of 3D graphs
5. Solving algebraic problems using MATLAB
6. Creation of GUI forms and objects

Text Books

1. “Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers”, Rudra Pratap, Oxford University Press

Reference Books

1. “MATLAB and its Applications in Engineering”, Barbara Johnston, Prentice Hall of India, New Delhi.
2. " MATLAB: An Introduction with Applications ", Amos Gilet, Wiley Publication
3. " MATLAB Programming for Engineers ", Stephen Chapman, Cengage Learning India Pvt. Ltd.
4. " Fundamental Concepts of MATLAB Programming: From Learning the Basics to Solving a Problem with MATLAB (English Edition) ", Dr.Brijesh Bakariya, Dr.Kulwinder Singh Parmar, BPB Publications

Designation of Course	Vocational Course-I: Sensors, PLC & HMI: Basic Training		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
	Term Work & Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:-	Digital Electronics, Embedded systems, Power Electronics
Course Objectives:-	1. To introduce the student to the programmable logic controllers sensors. 2. To impart the knowledge of protocols & networking of PLCs 3. To introduce SCADA &DCS 4. To introduce HMI
Course Outcomes:-	1. **Understand** the general principles of sensors and transducers 2 **Understand** the requirements for networking of sensors 3. **Understand** the principle and working of advanced sensors 4. **Identify** the sensors for typical applications. 5. **Identify** the components of SCADA & DCS 6. **Identify** the components of HMI

Course Contents

Unit-I	**Fundamentals of Sensors**	**(8 Hrs)**
Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning.		
Unit-II	**Sensors and Networking**	**(8 Hrs)**
Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through-beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors. **Networking**: Networking of sensors, control of manufacturing process, tracking- the meantime between operations interventions, tracking the yield and mean process time, detection of machining faults, diagnostic systems, resonance vibration analyzer, sensing motor current for signature analysis, temperature sensing.		
Unit-III	**Advanced Sensor Technologies**	**(8 Hrs)**
Laser production, characteristics of lasers, types of laser sensors, bar code sensors, benefits of bar coding, transponder, RFID (Radio Frequency Identification), electromagnetic identifier, optical encoders, color sensors, sensing principles, color theory, unit color measurement, colour comparator, color sensing algorithm, fuzzy logic color sensor. fuzzy logic for optoelectronic colour sensor in manufacturing. **Sensors in Flexible Manufacturing Systems:** Vision sensors, image transformations, robot visual sensing tasks, detecting partially visible objects, sensors in flexible manufacturing.		
Unit-IV	**Sensors for Special Applications**	**(8 Hrs)**
A multi objective approach for selection of sensors in manufacturing, cryogenic manufacturing applications, semiconductor absorption sensors, semiconductor temperature detector using photoluminescence temperature detectors using point-contact, sensors in process manufacturing plants, measurement of high temperature, robot control through sensors, other sensors, collection and generation of process signals in decentralized manufacturing system.		
Unit-V	**SCADA & DCS**	**(8 Hrs)**
Role of SCADA in Industrial Automation, SCADA System Configuration, RTU, Communication, Introduction to DCS, Architecture of DCS, Input and output modules, communication module, Specifications of DCS.		
Unit-VI	**Human Machine Interface**	**(8 Hrs)**
Different Types of Operator Interfaces: Textual, Graphical, Data Handling With HMI, Configuration and Interfacing to PLC and PC, Communication Standards- DF1, Ethernet, DH45, RS232, RS485, Profibus.		

Text Books:

1. “Sensors & control systems in manufacturing.”, Sabnesoloman, Mc-Graw Hill book Company Network, 1994
2. “Mechatronics” ,W, Bolton
3. “Programmable Logic Controllers, Principles and Applications”; John W. Webb, Ronold A Reis, 5th Edition, Prentice Hall of India Pvt. Ltd

References Books:

1. “Sensor Technology Handbook”, Jon S. Wilson
2. “Mechanical measurement”, N.L. Buck & T.G.Buck,
3. “Sensors and Transducers”, Ian Sinclair

Designation of Course	**Design and Analysis of Machine Component**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Computer Aided Drafting and Visualization 2. Computer Aided Machine Drawing 3. Strength of Machine Components
Course Objectives: -	1. To study basic concepts of machine design. 2. To design and analysis different types of machine elements 3. To design of machine component for finite and infinite life and subjected to fluctuating load.
Course Outcomes: -	1. **Understand** the basic concept of machine design and **evaluate** dimensions of simple components. 2. **Understand** the fundamental concepts for design of shaft, keys and coupling and **evaluate** forces and dimensions. 3. **Understand** the concept of designing of Power Screws and Mechanical spring and **analyze** it for various applications. 4. **Understand** the basic concept of fluctuating loads and **Analyze** design of components under fluctuating loads. 5. **Understand** the concept of fasteners and threaded joints; and **analyze** when it is subjected to different loading conditions. 6. **Understand** the Design concept of welded & riveted joint;and **analyze** when it is subjected to different loading conditions.

Course Contents

Unit-I	**Introduction to Design and Design against Static Load**	**(08 Hrs)**
Introduction to Design: Need for component design, design process, Introductions to concurrent engineering, Design consideration for casting, forging & machined parts, hot & cold worked parts and welded assembly, Introduction to design for manufacture & assembly, **Design against Static Load:** Modes of failure, Factor of safety, Service factor, stress strain relationship, shear stress & strain, stress due to bending moment, Eccentric axial loading. Design of simple machine parts - Cotter joint, Knuckle joint and Levers, curved beam.		
Unit -II	**Shafts, Keys and Coupling**	**(08 Hrs)**
Introduction, Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, ASME Code for Shaft Design, Design of Hollow Shaft on Strength Basis, Design of Hollow Shaft on Torsional Rigidity Basis, Flexible Shafts **Keys**– saddle, sunk, feather, woodruff, square, flat, Kennedy key, key design, Types of keys, splines. **Couplings-** types of couplings, Design of rigid and flexible couplings.		
Unit-III	**Power Screws and Mechanical Spring**	**(08Hrs)**
Power Screws, Forms of Threads , Multiple Threaded Screws, Terminology of Power Screw, Torque Requirement—Lifting Load, Torque Requirement—Lowering Load, Self-locking Screw, Efficiency of Square Threaded Screw, Efficiency of Self-locking Screw, Trapezoidal and Acme Threads, Collar Friction Torque, Overall Efficiency, Coefficient of Friction, Design of Screw and Nut, Design of Screw Jack, Differential and Compound Screws, Re-circulating Ball Screw.		

Mechanical Spring: Types of Springs, Terminology of Helical Springs, Styles of End, Stress and Deflection Equations, Series and Parallel Connections, Design of Helical Springs, Concentric Springs, Helical Torsion Springs, Surge in Spring, Multi-Leaf Spring, Nipping of Leaf Springs, Shot Peening		
Unit-IV	**Design for Fluctuating Loads**	**(08 Hrs)**
Stress concentration factor and its Reduction, Stress concentration factor for various machine parts, Cyclic stresses, Fatigue and endurance limit, Notch sensitivity, Cumulative Damage in Fatigue, Design for finite and infinite life, Soderberg, Goodman, Modified Goodman& Gerber criteria.		
Unit-V	**Threaded Joints**	**(08 Hrs)**
Basic Types of Screw Fastening, Cap Screws &Setscrews, Bolt of Uniform Strength, Locking Devices, Terminology of Screw Threads, ISO Metric Screw Threads, Bolt under tension, Eccentrically Loaded Bolted Joints in Shear, Eccentric Load Perpendicular to Axis of Bolt, Eccentric Load on Base plate, Torque Requirement for Bolt Tightening, Dimensions of Fasteners, Design of Turnbuckle.		
Unit-VI	**Welded and Riveted Joints**	**(08 Hrs)**
Welded Joints- Welding Processes, Strength of Butt and Fillet Joints, Strength of Parallel Fillet Welds, Strength of Transverse Fillet Welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in the Plane of Welds, Welded Joint Subjected to Bending Moment and Torsional Moment, Welding Symbols **Riveted Joints**- Types of Rivet Heads and riveted Joints, Rivet Materials, Types of Failure, Strength Equations, Efficiency of Joint, Caulking and Fullering, Eccentrically Loaded Riveted Joint		

Term work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Symbolic representation of common machine components using Auto-CAD.
2. Design of machine components such as knuckle joint, cotter joint and lever (anyone) using CAD software.
3. Design of coupling system using CAD software.
4. Design of screw jack using CAD software.

Assignment

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Static loading
2. Design of shafts
3. Power screw
4. Mechanical springs
5. Design of fluctuating load
6. Design of threaded joints
7. Design of welded
8. Riveted joints.

Note: Design data book should be used extensively.

Textbooks

1. V. B. Bhandari, “Design of Machine Elements”, Tata McGraw Hill Publication Co. Ltd.
2. R. S. Khurmi And J.K. Gupta “Machine Design”, S Chand Publication.
3. Shigley J. E. and Mischke C. R., “Mechanical Engineering Design”, McGraw Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., “Design of Machine Elements”, Prentice Hall International.

Reference Books

1. Black P.H. and O. Eugene Adams, “Machine Design”, McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, “Machine Components Design”, West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G, “Theory and Problems of Machine Design”, Schaum’s Outline Series.
4. Sharma C. S. and Purohit Kamlesh, “Design of Machine Elements”, PHI LearingPvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., “Machine Design”, S.K Kataria and Sons
6. Gope P. C., “Machine Design: Fundamentals and Applications”, PHI LearingPvt. Ltd.
7. “Design Data- P. S. G.” College of Technology, Coimbatore.
8. V. B. Bhandari, “Design Data Book”, Tata McGraw Hill Publication Co. Ltd.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To develop Industrial/Real life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through shaft, Keys, coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
3. To develop a demonstration models of different types of couplings.
4. To develop a demonstration models of different types of keys.
5. To observe the system where transmission of power takes place through power Screws. (e.g. Lead screw of lathe, feed screws of machine tools, Clamping screws, Toggle Jack screw, etc.) Get the required information regarding effort, clamping force, etc., and selecting suitable materials design screw, nut and different simple components in assembly. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
6. To develop demonstration models of different types of springs.
7. To develop demonstration models of different types of threaded joints.
8. To develop demonstration models of different types of fasteners.
9. To develop demonstration models of different types of welded joints.
10. To develop demonstration models of different types of riveted joints.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	DIGITAL ELECTRONICS		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	Electronics Engineering Systems
Course Objective	1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems 2. To familiarize with the design of various combinational digital circuits using logic gates 3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits 4. To explain the various semiconductor memories and related technology 5. To introduce the electronic circuits involved in the making of logic gates 6. To introduce memory operation is PLA
Course Outcomes:-	The students should be able to- 1. Use digital electronics in the present contemporary world. 2. Design various combinational digital circuits using logic gates. 3. Do the analysis and design procedures for synchronous and asynchronous sequential circuits. 4. Use the semiconductor memories and related technology. 5. Use electronic circuits involved in the design of logic gates. 6. To understand characteristics of PLDs, Semiconductor memories and their applications

Course Contents

Unit 1	**Digital Fundamentals**	**(08Hrs)**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization		
Unit 2	**Combinational Circuit Design**	**(08Hrs)**
Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.		
Unit 3	**Synchronous Sequential Circuits**	**(08Hrs)**
Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.		
Unit 4	**Asynchronous Sequential Circuits**	**(08Hrs)**
Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.		
Unit 5	**Digital Integrated Circuits**	**(08 Hrs)**
Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in,		

noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS		
Unit 6	**PLDs & Semiconductor Memories: Programmable logic devices**	**(08Hrs)**
Study of PROM, PAL, FPGA,PLAs. Designing combinational circuits using PLDs. **Semiconductor memories** **C**lassification and characteristics of memory, different types of RAMs, ROMs and their applications, Double Data Rate RAMs.		

List of Experiments-

Term work shall consist of **Minimum Eight** Experiments.

1. Implementation of Boolean functions using logic gates
2. Study of characteristics of typical 74 TTL / 74 CMOS family like: fan in, fan out standard load , noise margin & interfacing with other families
3. Half, Full Adder and subtractor using gates and IC's
4. Code conversion using digital IC's
5. Function implementation using Multiplxer and Demultiplexer
6. Sequence generator using MSJK flip flop IC's
7. Study of counters : Ripple , Synchronous , Ring , Johnson , Up-down counter and its application
8. Study of shift registers : Shift left , Shift right , parallel loading and Pulse Train generator
9. Study of Full Adder using half adder
10. Study of 2 bit comparator
11. BCD Adder/Subtractor with Decoder driver and 7 segment display

Text Books/ Reference Books

1. M. Morris Mano and Michael D. Ciletti, “Digital Design”, 5th Edition, Pearson, 2014.

REFERENCE BOOKS

1. Charles H.Roth. “Fundamentals of Logic Design”, 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc, 2011
3. S.Salivahanan and S.Arivazhagan“Digital Electronics”, Ist Edition, Vikas Publishing House pvt Ltd, 2012.
4. Anil K.Maini “Digital Electronics”, Wiley, 2014.
5. A.Anand Kumar “Fundamentals of Digital Circuits”, 4th Edition, PHI Learning Private Limited, 2016.
6. Soumitra Kumar Mandal “ Digital Electronics”, McGraw Hill Education Private Limited, 2016.

Assignments:

At least ONE assignment on each unit

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Survey report of basic gates ICs 7432, 4011, 4050, 4070,4071,40106
2. Implement combinational logic Circuit of given Boolean Equation.
3. Implement Half Adderand Half Subtractor.
4. Implement Full Adder using two Half Adders
5. Build4-bit parallel Adder / Subtractor using IC.
6. Build Code Converters: Binary to Gray
7. Build Code Converters: Excess 3 to Binary)
8. Implement Two Bit Magnitude Comparator using IC 7485
9. Implement given combinational logic using MUX

10. Implement 7 segment decoder driver using IC 7447.
11. Build a Decade counterand Up-Down Counter.
12. Build a Shift Registers: SISO and SIPO
13. Implement the Johnson Counter and Ring Counter.
14. Survey Report on Static I/O and transfer Characteristic of TTL and CMOS.
15. Implement given Boolean Function using PLA.

(Function and Equation will be given by Subject Teacher)

Unit Tests

Unit Test-I	Unit-I,II,III
Unit Test-II	Unit-IV,V,VI

Designation of Course	**POWER ELECTRONICS AND DRIVES**		
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: 02 Hours / Week	Internal Assessment	40 Marks	
Tutorial: 01 Hour/Week	Tutorial		01
	Term work & Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	Construction, Working Principle & Application of AC and DC motors Introductions to Electronic Components SCR , Diodes etc
Course Outcomes:-	1. Explore the basic knowledge of the components and dynamics related to electrical drives and also basics of Voltage source converters. 2. Explore the basic knowledge of the components and also basics of Current source converters. 3. Perform and understand the operation of solid state control using Inverters. 4. Analyze and understand the DC Drives. 5. Understand the various Induction motor drives in various applications. 6. Explore the synchronous motor drives as per the industrial point of view.
Course Outcomes:-	The students should be able to- 1. **Understand** the different types of convertors. 2. **Understand** the basic concepts of matrix converter and CSC. 3. **Understand** the basic concepts multilevel Inverters. 4. **Understand** the basic concepts DC drives and **apply** it for different applications. 5. **Understand** the basic concepts of Induction motor drives and its different types. 6. **Understand** the basic concepts of Synchronous Motor Drives and **apply** it for different applications.

Course Contents

Unit 1	**Converters**	**(06 Hrs.)**
Voltage Source Converters: Review of 3-ph-full wave bridge converter, operation and harmonics, 3 level voltage source converters. PWM converter. Generalized technique of harmonic elimination and voltage control. Advanced modulation techniques (space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques. Converter rating.		
Unit 2	**Current source converters**	**(06 Hrs.)**
(i) Matrix Converter: 3×3 matrix converter, principle of working, mathematical treatment, comparison of matrix converter with multipulse converter. (ii) Self and Line commutated current source converter: Basic concepts of CSC, converters with self commutating devices.		
Unit 3	**Multilevel Inverters**	**(06 Hrs.)**
Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, switching device currents, D.C. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel inverters. Applications of multilevel Inverter: Reactive power compensation Back to back intertie system.		
Unit 4	**DC Drives**	**(06 Hrs.)**
Single phase and 3 phase converter drives. Four quadrant Chopper drives, closed loop control of DC motor, Permanent magnet DC motor drives, DC Servo drives, applications.		

Unit 5	Induction Motor Drives	(06 Hrs.)
3 phase induction motor control, stator voltage control/rotor voltage control, voltage and frequency control, current control, closed loop control of 3-phase induction motor. Soft starters, comparison of variable frequency drives, Speed control by static slip power recovery, induction motor servo drives, applications.		
Unit 6	**Synchronous Motor Drives**	**(06 Hrs.)**
Voltage and frequency control, closed loop control of synchronous motors. Synchronous motor servo drive with sinusoidal waveform, synchronous motor servodrive with trapezoidal waveform. Load commutated invertor drives, speed control of synchronous motors by cyclo-convertors, applications.		

LIST OF EXPERIMENTS: (Students should perform at least 08 experiments from the following list)

1. Gate Pulse Generation using R, RC and UJT.
2. Characteristics of SCR and Triac
3. Characteristics of MOSFET and IGBT
4. AC to DC half controlled converter
5. AC to DC fully controlled Converter
6. Step down and step up MOSFET based choppers
7. IGBT based single phase PWM inverter
8. IGBT based three phase PWM inverter
9. AC Voltage controller
10. Switched mode power converter.
11. Simulation of PE circuits

(1Φ&3Φsemiconverter, 1Φ&3Φfullconverter, dc-dc Converters, ac voltage controllers).

Text Books:

1. Bimal K Bose, Modern power electronics and AC drives, Pearson education asia
2. G. K. Dubey, Fundamentals of Electrical Drives CRC press 2002
3. Vedam Subrahmanyam Electric Drives: Concepts &Appl Tata McGraw-Hill
4. Power electronics convertors, applications and design, Ned Mohan, Tore M Undeland, William P Robbins, Wiley India Pvt. Ltd., 2009
5 E. Acha, Miller & Others, Power Electronic Control in Electrical Systems (Newnes, Oxford publication) – first Edition
6 M. H. Rashid Power Electronics, Prentice Hall of India Pvt. Ltd. New Delhi, (3rd Edition)
7. R Krishnan, Electric motor drives, modeling, analysis and control, PHI learning Pvt. ltd. 2001
8. S.K. Pillai, A first course in electrical drives, Newage international publishers. 2010

Reference Books and Papers:

1. E. H. Watanube, R.M. Stephen and Maurico Ardes "New Concepts of instantaneous active and reactive powers in Electrical systems with Generic loads" (IEEE transaction on Power Delivery Vol.8, no.2 April 1993, PP-697-703.
2. L. Benchaita, S. Sadaate and A. Salemnia – "A comparison of voltage source and current source shunt Active filter by simulation and Experimentation" (IEEE Transaction on Power Systems, Vol 14, No.2, May 99, PP 642-647.
3. H. Akagi, E.H. Watanabe and M. Aredes "Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press, New York.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Review paper on applications of Power electronic switches with and without Snubber (i) IGBT (ii) MOSFET
2. Modeling and system simulation of basic electrical circuits using MATLAB-SIMULINK/SCILAB
3. Modeling and System simulation of basic power electronic circuits using MATLAB-SIMULINK/SCILAB
4. Development of AC Source with Single Diode fed Resistive and Resistive-Inductive Load
5. Development of AC source with Single SCR fed Resistive and Resistive-Inductive Load
6. Modeling and System Simulation of SCR based full converter with different types of load using MATLAB-Simulink/SCILAB
7. Development of prototype of Full converter fed resistive load
8. Development of prototype of Full converter fed Resistive-Back Emf (RE) load at different firing angles
9. Development of prototype of Full Converter fed Resistive-Inductive Load at different firing angles
10. Development of prototype of Full converter fed DC motor load at different firing angles
11. Circuit Simulation of Voltage Source Inverter and study of spectrum analysis with and without filter using MATLAB/SCILAB
12. Development of prototype of Single phase square wave inverter
13. Development of prototype of Three phase sine PWM inverter
14. Generation of PWM gate pulses with duty cycle control using PWM peripheral of microcontroller (TI-C2000 family/ PIC18)
15. Design of Driver Circuit using IR2110
16. Design and testing of signal conditioning circuit to interface voltage/current sensor with microcontroller (TI-C2000 family/ PIC18)
17. Design of PI controller using OP-AMP
18. PCB design and fabrication of DC power supply using any PCB design software (open source- KiCAD/students version)

Unit Tests

Unit Test-I	Unit-I,II,III
Unit Test-II	Unit-IV,V,VI

Designation of Course	**Manufacturing Technology-I**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: 02 Hours/Week	Internal Assessment	40 Marks	
	Term work	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:-	The student should have basic knowledge of 1. Mechanical engineering system 2. Engineering materials 3. Advanced metallurgical technology
Course Objectives:-	The student should 1. To acquire the knowledge of Foundry Technology. 2. To acquire the knowledge of hot and cold working processes. 3. To acquire the knowledge of lathe, drilling, milling, and sheet metal operations.
Course Outcomes:-	The students should be able to– 1. **Understand** the pattern and mold making. 2. **Understand** the **v**arious casting processes and **apply** the best casting process for a specific product. 3. **Understand** the hot working and cold working processes and **apply** them in Manufacturing. 4. **Understand** different operations on lathe machine and **apply** them to create the job. 5. **Understand** different operations of drilling machine and milling machine and **apply** them to create the job. 6. **Understand** various sheet metal operations and **apply** them to create the job.

Course Contents

Unit 1	**Pattern and Mould Making**	**(06 Hrs.)**
Introduction to casting, Foundry Layout, Foundry departments and sections, Pattern and pattern making, Design and allowances for patterns, Colour codes for patterns, Storage of patterns. Moulding sand and core sands, Sand control test, Core and core making –Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making-Moulding Methods, Moulding processes, Design of Gating System.		
Unit 2	**Sand Casting and Die Casting Practice**	**(06 Hrs.)**
Sand Casting Practice: Melting furnaces and their selection, Cupola furnace, Induction melting furnaces, Advantages, Limitations, applications, pouring practice and equipment's, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings. Die Casting Practice: Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits and limitations.		
Unit 3	**Hot and Cold Working Processes**	**(06 Hrs.)**
Hot Working Processes: Principle rolling, forging - drops, press, upset. Rolling, forging- extrusion, drawing, spinning, Angle of Contact of rolling, effect of hot working. Cold Working Processes: Cold rolling, swaging, forges extrusion- forward backward impact. Roll forging, tube drawing, wire drawing, spinning, shot peening, high energy rate forming, Stresses in wire drawing operations.		
Unit 4	**Introduction to sheet metal Working**	**(06 Hrs.)**
Introduction to machines in sheet metal Industry: shearing machine, bending machine, circular profile cutting machines. Rivets and its different parts, Punching, blanking, shearing, bending, and piercing. Punch & Die tolerance and clearance. Introduction to Dies: Simple Dies, Compound Dies, Progressive Dies. Types of presses.		

Unit 5	Theory of Metal Cutting	(06 Hrs.)
Introduction of Lathe, function, types, construction, accessories, operations, thread cutting, single and multi-start thread cutting different tools, tool materials, Tool Geometry- Single Point cutting tool, Tool Wear and Tool Life, Mechanics of Metal cutting- Merchant's Circle Diagram, concept of speed, feed, depth of cut. Introduction to Boring Machines- general arrangement and nature of work done.		
Unit 6	**Drilling Milling and Grinding Machines**	**(06 Hrs.)**
Drilling Machines: Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. Types of drills, reaming process. Milling Machines: Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Dividing head, methods of indexing, Introduction to grinding Machines.		

Assignments:

1. Pattern and Mould Making.
2. Sand Casting and Die Casting Practice.
3. Hot Working processes and Cold Working Processes.
4. Turning, boring related process.
5. Drilling Machines.
6. Milling Machines.
7. Rivets and its different parts.
8. Punch & Die tolerance and clearance.

List of Experiments: (Any Eight)

1. Moulding and core sand testing (Clay content test, moisture content test etc.).
2. Strength of Green sand mould and greens sand core.
3. Mold Making Practice.
4. Job on drilling, reaming, tapping.
5. Casting of component by using green sand molding / Die casting.
6. Individual job on center Lathe.
7. Study of dividing indexing mechanism on milling machine.
8. Gear cutting job on Milling Machine.
9. Study and demonstration of Grinding Machines.
10. Job on sheet metal working.

Text Books:

1. O. P. Khanna, A text book of Foundry Technology, Dhanpat Rai and Sons
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
3. G. R. Nagpal, Tool Engineering and Design, Khanna Publishers
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
5. Hajra Chaudhari, Workshop Technology, Vol.-II
6. Roy A. Lindberg, Process & Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
8. HMT Handbook, Production Technology, TMH

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Working model of all types of patterns
2. Different types of gates in casting process
3. Different types of runners layout
4. Design and working model of gating system for any simple mechanical component
5. 2D model for detailed sand casting process
6. 2D model for detailed die casting process
7. Selection criteria, detail specifications, brands available in market and cost comparison of pressure and gravity die casting machine
8. Selection criteria, detail specifications, brands available in market and cost comparison of shell moulding
9. Selection criteria, detail specifications, brands available in market and cost comparison of centrifugal casting
10. Selection criteria, detail specifications, brands available in market and cost comparison of rolling machines
11. Selection criteria, detail specifications, brands available in market and cost comparison of wire drawing
12. Selection criteria, detail specifications, brands available in market and cost comparison of forging machine
13. Design and working model of simple die
14. Design and working model of compound die
15. Design and working model of combination die
16. Design and working model of progressive die
17. Selection criteria, detail specifications, brands available in market and cost comparison of lathe machine
18. Selection criteria, detail specifications, brands available in market and cost comparison of drilling machine
19. Selection criteria, detail specifications, brands available in market and cost comparison of milling machine
20. Selection criteria, detail specifications, brands available in market and cost comparison of CNC machine

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**AUTOMATIC CONTROL SYSTEMS**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites: -	1. Mathematics & Science 2. Basic Electrical Engineering. 3. Sensors and Measurement System.
Course Objectives: -	1. Familiarization with Control System Principles and Applications of Control System. 2. Calculate and Estimate the Stability Measures, Time Response Measures from the Analysis of Mathematical Models of Some Simple Engineering Systems. 3. Develop Data Acquisition System using Controllers and apply it for Industrial Automation Application.
Course Outcomes: -	The students should be able to 1. Understand the basic concepts of automatic control systems 2. Obtain an overall transfer function of control system by using block diagram algebra methods 3. Determine the time and frequency response of control systems 4. Determine the (absolute) stability of a closed-loop control system using Routh-Hurwitz's stability criterion. 5. Apply fundamentals of PID controllers and use it in industrial automation 6. Select and use control system components for industrial automation.

Course Contents

Unit-I	**Introduction to Automatic Control systems**	**(08 Hrs.)**
Open Loop system, Closed Loop system, Conversion of an Open Loop system to a Closed Loop system, Servo Mechanism, Feed Forward Systems, Adaptive Control Systems, Classification of Control Systems, the design process. Transfer Function, Concept of Poles & Zeros of a Transfer Function, Properties of Transfer Function, Transfer Function of Basic Devices; Mathematical Modelling of Mechanical and Electrical Systems. Mechatronics System & Its Examples, Mechatronics System Components.		
Unit-II	**Block Diagram Representation**	**(08 Hrs.)**
Block Diagram Definitions, Generating a Block Diagram from a Physical System, Canonical Form, Rules for Block Diagram Reduction, Reduction of Block Diagram, Reducing to Unity Feedback Systems, Examples on Block Diagram Reduction.		
Unit-III	**Time Response and Frequency Response Analysis**	**(08 Hrs.)**
Time response of control system, standard test signal, Time Response, Analysis of First and Second order system, Time Domain specifications. Step response of second order system. Steady-state errors, static error constants, steady state, analysis of different type of Systems using step. Ramp and parabolic inputs, Frequency Response Specification, Co-relation between Time and Frequency Domain		
Unit-IV	**Stability Analysis**	**(08 Hrs.)**
Stable system, Unstable System, Marginally Stable System, Time Response of Poles, Hurwitz Stability Criterion, Routh Stability Criterion, Routh Criterion Special Cases, Relative Stability, Application of Routh's Criterion.		
Unit-V	**Controllers**	**(08 Hrs.)**
Introduction to Controllers, Control System Parameters, Controller Modes, Control Actions, Types of		

Controllers-ON-OFF Controller, Proportional Controller (P-Controller), Proportional + Integral Controller(P-I Controller), Proportional + Derivative Controller (P-D Controller), Proportional +Integral+ Derivative Controller (P-I-D Controller), Effect of Proportional, Integral, and derivative control on the Time Response of the System		
Unit-VI	**Control System Components**	**(08 Hrs.)**
Data Acquisition: Elements of a Data Acquisition and Control System, Overview of the Input/Output Process, Analog to Digital (A/D) Conversion, Digital to Analog (D/A) Conversion, Data Acquisition Case Studies. Variable Frequency Drive, Servomotor. **Switches:** Construction, symbolic representation, working, application of Toggle switch, Slide switch, DIP switch, Rotary switch, Thumbwheel switch, Selector switch, Push button, Drum switch, Limit switch, Temperature switch, Pressure switch, Level switch, Flow switch. **Relays:** Construction, working, specifications/selection criteria and applications of electromechanical relay, Reed relay, hermetically sealed relay, Solid state relays. **Contactors:** Construction, working, specifications and applications of contactors. Comparison between relay& contactor.		

Term Work:

Term work shall consist record of minimum 8 experiments from the following;

1. Analysis of following control system parameters using software like MATLAB/SIMULINK
    a. Plot the pole-zero configuration in s-plane for the given transfer function
    b. Stability analysis of given control system using Routh-Hurwitz's criterion
    c. Determine the transfer function for given closed loop system in block diagram representation.
    d. Plot unit step response of given transfer function and find peak overshoot, peak time, rise time and delay time.
2. To study the basic Open and Closed Loop Control system
3. To study the Water Level Control Using Industrial PLC
4. Determination of step & impulse response for a first order unity feedback system
5. Study of P, P+I, P+D, P+I+D control actions using any Trainer Kit / Simulation Software.
6. Study of A/D and D/A Converters.
7. Study the functions and applications of variable frequency drive (VFD).
8. Study the functions and applications of AC servomotor.
9. Study of various switches, Relays and Contactors.
10. Study of Data Acquisition System and Interfacing of sensors with computer using DAQ Cards
11. Identification of different control system components in PLC based mini assembly cell

Text Books/Reference Books:

1. K. Ogata, Modern Control Engineering, Prentice Hall of India, 3rd edition, 1998
2. I.J. Nagarath and M. Gopal, Control Systems Engineering , New Age International (P) Ltd.
3. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw-Hill Companies, 1997.
4. Stainslaw H. Zak, Systems and Control , Oxford Press, 2003.

5. M. Gopal Modern Control System Theory, New Age International Publishers, 2nd edition, 1996.
6. W. Bolton, "Mechatronics", Pearson Education.
7. Ramchandran K. P., Vijyaraghavan G. K., Balasundaram M. S., "Mechatronics: Integrated Mechanical Electronic Systems", John Wiley & Sons, 2008.
8. Kumar D. S., "Mechanical Measurement & Control", Metropolitan Book Co. Pvt. Ltd. New Delhi, 2007
9. Singh M. D. and Joshi J. G., "Mechatronics", 3rd Edition, Prentice Hall, New Delhi, 2009.

Project Based Learning

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. Prepare a simple circuit for Open Loop Control systems for any Engineering application
2. Prepare a simple circuit for Closed Loop Control systems for any Engineering application
3. Prepare a simple working model which depicts an application of Mechatronics System
4. Generate a Block Diagram Algebra for any Mechanical System using Block Diagram Algebra rules.
5. Prepare Mathematical Model of any simple Mechanical Systems using MATLAB
6. Prepare a MATLAB Code to find the Time Response of Control system.
7. Solve the any Control system Characteristics equation for Stability Analysis using MATLAB
8. Prepare a simple control industrial application using Proportional Controller using any simulation software
9. Prepare a simple model which depicts the application of PID Controller using any simulation software
10. Prepare a circuit which depicts the operation of Analog to Digital Converter
11. Prepare a circuit which depicts the operation of Digital to Analog Converter
12. Identify Mechatronics Systems from Day-to-Day Applications and mention all the system components used
13. Prepare a simple circuit which depicts application of different Switches
14. Prepare a simple circuit which depicts application of different Relays
15. Prepare a simple circuit which depicts application of different Contactors
16. Prepare a simple Data Acquisition System and Interfacing of sensors with computer for temperature sensors
17. Prepare a simple Data Acquisition System and Interfacing of sensors with computer for Load Cell
18. Prepare a Model to control water level in Tank

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Solid Modelling**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Practical:- 04 Hours/Week	Term Work & Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites: -	1. Computer Aided Drafting and Visualisation 2. Computer Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of CAD modelling. 2. To develop the skills in Reading and Interpretation of Engineering Drawings. 3. To familiarize students with modeling Software to Crate 2D and 3D model, Assembly, Drafting and Sheet metal modelling.
Course Outcomes: -	The students will be able to 1. **Understand** the concepts of CAD modelling. 2. **Creating** 3D machine components using Modeling Software. 3. **Creating** Assembly of machine components using Modeling Software. 4. **Creating** surface model of Automobile Components using Modeling Software. 5. **Creating** detail drawing and generating Bill of Material using Modeling Software. 6. **Understand** the basic concepts of Sheet metal Modelling and **Create** a machine component using modeling Software.

Course Contents

Unit-I	**Introduction to CAD**	**(08 Hrs.)**
Introduction to CAD and CAE Features, Various products available for Product Design, Simulation, Communication modeling Graphical User Interface - Feature manager design tree, Callouts, Handles, Confirmation corner, mouse buttons, keyboard shortcuts, Command Manager. Sketch Entities, Sketch Tools, Block, Relation and Dimensioning.		
Unit-II	**Basic Part Modelling**	**(08 Hrs.)**
Part Modelling Tools, Creating Extrude features, Creating Revolve features, Creating Swept features, Creating Loft features, Creating Reference, Creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern and advanced modelling tools.		
Unit-III	**Assembly modelling**	**(08 Hrs.)**
Introduction to Assembly Modelling & Approaches, Applying Advanced Mates and Mechanical Mates, Manipulating Components, Creating Pattern, Creating Explode Views.		
Unit-IV	**Surface Modelling**	**(08 Hrs.)**
Surface Modelling tools Creating Extrude, Revolve, Swept, loft, Boundary surface. Inserting Planar Surface, Offset Surface, Radiate Surface. Extending a surface, Surface fill, Ruled Surface, Trimming Surface, Mid surface, Replace Face, Delete face, Un-trim surface, Knit surface, Thickening a Surface, Move Face.		
Unit-V	**Drafting of Mechanical Systems**	**(08 Hrs.)**
Generating Views, Creating Dimensions, Inserting Annotations and Bill of Materials.		
Unit-VI	**Sheet Metal Modelling**	**(08 Hrs.)**
Constructing the base flange and miter Flange, addition of an Edge Flange, closing corner, Adding Jog, Unfolding the bends, Adding hem and vent.		

Term Work

Term work shall consist of A-3/A4 size printouts of the problems solved in practical's using Solid Works Software.

1. Sketcher drawings
2. Part modelling
3. Parametric Modelling
4. Assembly Modelling
5. Exploded view of Assembly
6. Surface Modelling
7. Drafting of Mechanical Systems
8. Sheet metal modelling

Text Books

1. Kuang-Hua Chang, "Motion Simulation and Mechanism Design with MODELING Motion 2018", SDC Publishers, 2018

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw Hill, Publishing Co. 2009.
2. Rao P. N., "CAD/CAM", Tata McGraw Hill.
3. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
4. Martenson, E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, DavorJuricic, Thomas J. Krueger, "Engineering & Computer Graphics Workbook Using Modeling 2014", SDC Publication, 2014.
6. John Willis, Sandeep Dogra, "MODELING 2019: A Power Guide for Beginners and Intermediate User", published by CADArtifex, 2019.

End Semester Practical/Oral examination:

1. Practical examination duration is Two hours, based on the Term work.
2. Questions provided for practical examination should contain minimum five and not more than ten parts.
3. Evaluation of practical examination to be done based on the performance of students work in laboratory.

***Oral examination should also be conducted to check the knowledge of conventional and Solid Works drawing.**

Designation of Course	Vocational Course-II: PLC, HMI & Automation: Advanced Training		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
	Term Work & Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites: -	C Programming
Course Objectives: -	1. To introduce the functions of given industrial automation system. 2. To introduce input-output devices in PLC. 3. To introduce HMI and PLC interfacing
Course Outcomes: -	1. Understand the functions and characteristics of given industrial automation system 2. Interface the given I/O device with appropriate PLC module 3 .Understand working of HMI 4. Indentify HMI hardware and software. 5. Interface PLC & HMI. 6. Understand the control panels of various industry HMIs

Course Contents

Unit-I	**Introduction to Industrial Automation**	**(08 Hrs.)**
Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of automation system, description of each component, Types of automation system:-Fixed, programmable, flexible, Different systems for Industrial automation: PLC, HMI, SCADA, DCS, Drives		
Unit-II	**PLC Programming and Applications**	**(08 Hrs.)**
PLC I/O addressing, PLC programming Instructions : Relay type instructions, timer instructions: On delay, off delay, retentive. Counter instructions, Up. Down. High speed, Logical instructions, Comparison Instructions, Data handling Instructions. Arithmetic instructions, PLC programming language-Functional Block Diagram (FBD). Instruction List, Structured text, Sequential Function Chart (SFC), Ladder Programming, Simple Programming examples using ladder logic: Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions PLC based applications: Motor sequence control, Traffic light control, elevator control, Tank level control, conveyor system, Stepper motor control, reactor control		
Unit-III	**Human Machine Interface (HMI)**	**(08 Hrs.)**
History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving . The computer: Devices, Memory, processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms, Security Features of HMI		
Unit-IV	**HMI Selection and programming**	**(08 Hrs.)**
HMI Interfacing Considerations, HMI Hardware Selection, HMI Software Selection, HMI Ergonomics, Configuring System Communications, Security Delta HMI programming: Communication to PLC Tags, Alarms, Trends, DataLog Screens, Animation. Download / upload Making Applications Download & Upload the Programs Creating Alarm Messages Communication with PLC Fault Finding and Trouble Shooting		
Unit-V	**PLC & HMI**	**(08 Hrs.)**
Communications - PLC to HMI, operator station design, Operator Interfaces Types, Textual, Graphical, animation, Interlocking tagging, HMI assembling and Wiring, HMI Data Handling		
Unit-VI	**HMI in Industries**	**(08 Hrs.)**
Role of HMI in Industries, Hardware & Architecture Source & Sink Concepts Wiring different field devices to PLC, Siemens KTP 600 Basic color PN (Key Touch Panel), Siemens TP177A DP (Touch Panel), Delta DOP-B07S411 (Touch Panel), Mitsubishi GS Series, HMI/SCADA development for the Pressure Control Station.		

Text Books:

1.Frank D. Petro Zella, “Programmable logic controller” McGraw – Hill Publications, 1998
2.PanelView32 and RSView32 Programming Guides, Rockwell Automation

References Books:

1.John B. Peatman, PIC programing, McGraw Hill International, USA, 2005
2.Programmable Logic Controllers, Principles and Applications: John W. Webb, Ronold A Reis, 5th Edition, Prentice Hall of India Pvt. Ltd
3. Stuart A. Boyer, SCADA supervisory control and data acquisition, ISA Publication