DEPARTMENT OF MECHANICAL ENGINEERING

Agenda:

The members of Board of Studies, Department of Mechanical Engineering, MLRITM, and Dundigal met on 29.09.2023 at 03:00 PM to discuss R22 syllabi of third & fourth B.Tech. Program in the Board room.

The following are the BoS members.

S. No.	Name & Details of Members	Designation	Category
1	Dr. G. Surya Prakash Rao	Professor & HOD	Chairman
2	Dr. K.Vijay Kumar Reddy	Professor , Dept of Mechanical, JNTUH, Hyderabad.	JNTUH, Nominee
3	Dr. A. Aruna kumari	Professor in Mechanical, JNTUH.	Subject Expert
4	Dr. P.Laxmi Narayana	Professor in Mechanical, Osmaina university, Hyderabad	Subject Expert
5	Mr. Kausik Agastyaraj	Team lead, Cyient,Hyderabad.	Expert from Industry
6	Dr. S.P.Jani	Assoc Professor, Dept of Mechanical, MLRITM.	Member
7	Mr.U. Sudhakar	Assoc Professor, Dept of Mechanical, MLRITM.	Member
8	K.Chaithanya	Assoc Professor, Dept of Mechanical, MLRITM.	Member
9	Mr.V.Ramudu	Business consultant, Accenture,Hyderabad	Post Graduate Alumnus

Resolution:

After thorough discussions the members of the committee finalized the R22 syllabi Of third & fourth B.Tech. Program.

The following members have attended the BOS meeting.

S. No.	Name & Details of Members	Designation	Signature
1	Dr. G. Surya Prakash Rao	Professor & HOD	
2	Dr. K. Vijay Kumar Reddy	Professor , Dept of Mechanical, JNTUH, Hyderabad.	
3	Dr. A. Aruna kumari	Professor in Mechanical, JNTUH.	
4	Dr. P. Laxmi Narayana	Professor in Mechanical, Osmania university, Hyderabad	
5	Mr. Kausik Agastyaraj	Team lead Cyient, Hyderabad.	
6	Dr. S.P. Jani	Assoc Professor, Dept of Mechanical, MLRITM.	
7	Mr. U. Sudhakar	Assoc Professor, Dept of Mechanical, MLRITM.	
8	Mrs. K. Chaithanya	Assoc Professor, Dept of Mechanical, MLRITM.	
9	Mr.V. Ramudu	Business consultant, Accenture,Hyderabad	

Date: 29/09/2023

Chairman, BoS

2270336: CAD & AMT

B.Tech. IV Year I Sem

L	T	P	C
3	0	0	3

PRE-REQUISITES:.

Course Objectives

1. To study about the CAD process and concept of geometric modelling
2. To study the concepts of wireframe modelling
3. To study the concepts related to surface modelling
4. To study the concepts of solid modelling
5. To study about geometric transformations techniques, data exchange formats and mechanical tolerance

Course Outcomes: At the end of this course, students will be able to

1. Understand the CAD process and geometric modelling concepts
2. Analyse the utility and application of wire frame modelling
3. Understand the concepts of surface modelling
4. Understand and apply the concepts of solid modelling techniques.
5. Understand graphics by using transformations and analyse the utility of data exchange formats with dimensioning and tolerances.

UNIT – 1 **CLASSES:10**

CAD Tools: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software.

Basics of Geometric Modelling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modelling facilities desired.

Geometric Modeling: Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curvewire, NURBS, Curve manipulations.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

- Understand importance of design concept. (L2)
- Understand the design process wireframe modeling. (L2)

UNIT –2 **- ICLASSES:09**

Surface Modeling: Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Spline surface, Blending surface, Surface manipulations.

Solid Modelling: Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Illustrate design procedures for various surfaces modeling method. (L2)
- Make use of those design procedures in solid modeling components.(L3)

UNIT – 3	CLASSES :09

Group Technology: Part families, Parts classification and coding. Production flow analysis, Machinecell design.
Computer aided process planning: Difficulties in traditional process planning, Computer aidedprocess planning: retrieval type and generative type, Machinability data systems.
Computer aided manufacturing resource planning: Material resource planning, inputs to MRP, MRPoutput records, Benefits of MRP, Enterprise resource planning, Capacity requirements planning

LEARNING OUTCOME:
After successful completion of the unit, students can
- Understand the grouping in various machine parts. (L2)
- Illustrate various Computer intergrated manufacturing method.(L3)

UNIT – 4	CLASSES :08

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.
Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro fabrication.

LEARNING OUTCOME:
After successful completion of the unit, students can
- Identify the different types of powder based AMT (L4)
- Apply the SLS & LENS Process (L5)

UNIT – 5	CLASSES :09

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.
Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.
Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

LEARNING OUTCOME:
After successful completion of the unit, students can
- Understand other than basic AMT method (L2)
- Apply the new method in Various application (L3)

V. Ramudu

TEXT BOOKS:

1. CAD/AMT Concepts and Applications / Alavala / PHI
2. CAD/AMT Principles and Applications / P. N. Rao / Mc Graw Hill

REFERENCE BOOK:

1. CAD/AMT/ Groover M.P/ Pearson
2. CAD/AMT/CIM/ Radhakrishnan and Subramanian / New Age
3. D.T. Pham and S.S. Dimov, Rapid Manufacturing,1stedition Springer.

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2270337: INSTRUMENTATION AND CONTROL SYSTEMS

B.Tech. IV Year I Sem

PRE-REQUISITES:-

L	T	P	C
3	-	-	3

COURSE OBJECTIVES

- Understanding the basic characteristics of a typical instrument. Identifying errors and their types that would occur in a instrument.
- Identifying properties used for evaluating the thermal systems.
- The concept of transducer and Various types and their characters of Engineering metrology and its practice which is having increasing importance in industry

COURSE OUTCOMES : After completion of the course the student is able to

- To identify and analyze various errors that would occur in instruments(L3).
- Identify the different displacement measurement techniques and temperature measurement techniques, used in industries (L4).
- To know the working principles of various instruments to measure level (L2).
- Students will be able differentiate between mechanical electrical tachometers.(L3)
- Student will be able select appropriate device for the measurement of parameters like humidity,strain,force and torque(L4)
- Suggest control systems for speed, position and control in practical applications(L4)

UNIT – 1 **CLASSES:6**

Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional description of measuring instruments – examples.Static and Dynamic performance characteristics – sources of errors, Classification and elimination of errors.

LEARNING OUTCOME:

1. Characteristics of instruments (L2)
2. Recognize various errors(L2)

V. Ramudu

UNIT – 2	CLASSES:13
Measurement of Displacement: Theory and construction of various transducers to measure displacement – Piezo electric, Inductive, capacitance. **Measurement of Temperature:** Various Principles of measurement-Classification: Expansion Type: Bimetallic Strip- Liquid in glass Thermometer; Electrical Resistance Type: Thermistor, Thermocouple, RTD; Radiation Pyrometry: Optical Pyrometer; **Measurement of Pressure:** Different principles used- Classification: Manometers, Dead weight pressure gauge. Tester (Piston gauge), Bourdon pressure gauges, Bulk modulus pressure gauges; Bellows – Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges, ionization pressure gauges, Mcleod pressure gauge.	
LEARNING OUTCOME: 1. Select appropriate instrument for measuring distance (L4) 2. Differentiate various working mechanisms manometers (L2)	

UNIT – 3	CLASSES :13
Measurement of Level: Direct methods – Indirect methods – Capacitive, Radioactive, Ultrasonic, Magnetic, Cryogenic Fuel level indicators – Bubbler level indicators. **Flow measurement:** Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer. **Measurement of Speed:** Mechanical Tachometers, Electrical tachometers, Non- contact type-Stroboscope **Measurement of Acceleration and Vibration:** Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle- Piezo electric accelerometer.	
LEARNING OUTCOME: 1. Classify various instruments for measuring level (L2) 2. Differentiate between mechanical electrical tachometers (L2)	

UNIT – 4	CLASSES :08
Stress-Strain measurements: Various types of stress and strain measurements - electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – Use of strain gauges for measuring torque, Strain gauge Rosettes. **Measurement of Humidity:** Moisture content of gases, Sling Psychrometer, Absorption Psychrometer, Dew point meter. **Measurement of Force, Torque and Power-** Elastic force meters, load cells, Torsion meters, Dynamometers.	
LEARNING OUTCOME : 1. Will be able to identify best practice to measure stress . (L3). 2. To determine humidity at a place (L2).	

V.R
V. Ramudu

UNIT – 5	CLASSES :06
Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems- Servomechanisms – Examples with block diagrams – Temperature, speed and position control systems	
LEARNING OUTCOME : 1. Classification of various control systems. (L2). 2. Difference between open and closed loop systems (L2).	
TEXT BOOK : 1. Instrumentation mechanical measurements and control by A.k.tayal,Galogtia publications/2nd Edition 2. Mechanical measurements & control byDr D.S.Kumar,metropolitan book co pvt ltd/1st Edition	
REFERENCE BOOK : 1. Control systems by A.nagoor kani,RBA Publications/1st Edition 2. Instrumentation Measurements and Analysis by B.C. Nakra, Tata mc grawhill Publishers/3rd Edition 3. Electric Measurements & Instrumentation byk K.Lal kishore,Pearson publications/1st Edition	

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2270338: FINITE ELEMENT METHOD

B.Tech. IV Year I Sem | **L T P C**
PRE-REQUISITES: MECHANICS OF SOLIDS | **3 - - 3**

COURSE OBJECTIVES:

The aim of the course is to provide the participants an overview on Finite Element Method, Material models, and Applications in material Engineering. At the end of the course, the participants are expected to have fair understanding of:

- Basics of Finite Element Analysis.
- Available material models for structural materials.
- Modeling of engineering systems .
- Importance of interfaces and joints on the behavior of engineering systems.
- Implementation of material model in finite element method and applications.
- Knowledge on

COURSE OUTCOMES : After completion of the course the student is able to

- Apply finite element method to solve problems in solid mechanics, fluid mechanics
- Formulate and solve problems in one dimensional structures including trusses, beams.
- Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, and axi- symmetric problems.
- Formulate FE characteristic equations in heat transfer applications
- Formulate FE characteristic equation for dynamic analysis.
- Knowledge on FEM softwares ANSYS,NASTRAN etc

UNIT – 1 **CLASSES:12**

Introduction:

Introduction to Finite Element Methods: General Procedure – Engineering Applications – Stress – strain relations and strain- displacement relations: Finite Elements: 1- Dimensional, 2 – Dimensional, 3-Dimensional Elements

One Dimensional Problems: 1-D Linear bar Elements - Finite element modeling, Coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions for bar element.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Explain the shape function concept and make use of it in solving one dimensional linear elements (L2).
2. Apply numerical methods on one dimensional bar elements for obtaining displacements, stresses, strains and reaction forces (L3).
3. Understand the concept of FEM and its engineering applications in various areas of study.(L2)

V. Ramudu

UNIT – 2	CLASSES:09
Analysis of Trusses: Derivation of Stiffness Matrix for Plane Truss, Displacement of Stress Calculations. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element, simple problems on Load Vector, Deflection.	
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Explain the shape function concepts on trusses and beams for enriching knowledge on stiffness matrixr (L2). 2. Apply numerical methods on truss and beam elements for obtaining displacements, stresses, strains. (L3). 3. Make use of shape functions for obtaining stiffness matrix and load vector on truss and beam elements.(L3)	

UNIT – 3	CLASSES :10
Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements and two dimensional four noded isoparametric elements.	
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Recall the fundamental structural concepts of stress-strain relations and strain displacements for solving 2D and 3D elastic problems. (L1) 2. Illustrate finite element modelling of triangular, axi-symmetric and four noded elements for obtaining shape functions of two dimensional elements. (L2) 3. Male use of shape functions for developing stiffness matrix of triangular, axisymmetric and four noded elements (L3)	

UNIT – 4	CLASSES :08
Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two-dimensional heat conduction analysis of thin plate.	
LEARNING OUTCOME : After successful completion of the unit, students will be able to 1. Explain the basics of heat transfer for 1D, fin and thin plate for developing mathematical models.(L2) 2.Apply numerical methods on heat transfer problems for developing thermal stiffness matrix and thermal load vector.(L3)	
UNIT – 5	**CLASSES :08**
Dynamic Analysis: Formulation of finite element model, lumped and consistent mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar. Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation and its techniques, introduction to softwares such as ANSYS, ABAQUS, NASTRAN	
LEARNING OUTCOME : After successful completion of the unit, students will be able to 1. Illustrate the concepts of stepped bar for obtaining the Eigen values and Eigen vectors of various structural problems. (L2) 2. Make use of modern tools such as ANSYS, NASTRAN for solving 3D structural and heat transfer problems (L3). 3. Understand the concept of mesh generation and its importance. (L2)	
TEXT BOOK : 1.Finite Element Methods: Basic Concepts and applications/Alavala/PHI/3rd Edition2.Introduction to Finite Elements in Engineering,/ Chandrupatla, Ashok and Belegundu /Pearson/4th Edition	
REFERENCE BOOK : 1.An Introduction to the Finite Element Method / Edition-4/J. N. Reddy/ Mc Graw Hill/4th Edition 2.Finite Element Analysis / SS Bhavikatti / New Age/3rd Edition 3.Finite Element Method/Dixit/Cengage/4th Edition 4.The Finite Element method in Engineering/Singiresu S.Rao/5th Edition	

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2270303: ELEMENTS OF ELECTRIC AND HYBRID VEHICLES
(Open Elective-III)

B.Tech. IV Year I Sem

L	T	P	C
3	0	0	3

PRE-REQUISITES: Basic knowledge of electrical engineering

COURSE OBJECTIVES

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

1. To understand the basic performance of conventional Vehicles
2. Describe the hybrid vehicles and their performance.
3. To understand the concept of electric traction
4. To understand the different possible ways of energy storage.
5. To understand the different strategies related to hybrid vehicle operation & energy management.

COURSE OUTCOMES:

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

1. Study the models to describe hybrid vehicles and their performance.
2. Understand the importance of hybrid vehicles
3. Analyse the design of electric trains
4. Implement the different possible ways of energy storage.
5. Adopt the different strategies related to hybrid vehicle operation & energy management.

UNIT – 1 INTRODUCTION

Conventional Vehicles: Basics of vehicle performance, vehicle power Source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand the performance of conventional Vehicles. (L2)
2. Understand the mathematical models to describe vehicle performance.(L2)

UNIT 2: INTRODUCTION TO HYBRID ELECTRIC VEHICLES:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

V. Ramudu

LEARNING OUTCOME:

After successful completion of the unit, students can

1. Understand theimportance of hybrid and electric vehicles. (L2)

Analyse the fuel efficiency.(L2)

UNIT 3: ELECTRIC TRAINS:

Electric Drive Trains: Basic concept of electric traction. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand the importance of hybrid and electric vehicles. (L2)
2. Analyse the fuel efficiency.(L2)

UNIT 4: ENERGY STORAGE:

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand the importance of hybridisation. (L2)
2. Understand the different energy storage devices.(L2)

UNIT 5: ENERGY MANAGEMENT STRATEGIES:

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies and implementation issues of energy management strategies.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand energy management strategies. (L2)
2. Understand the implementation issues of energy management.(L2)

V. Ramudu

TEXT BOOK:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

REFERENCE BOOK:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016

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2270359: REFRIGERATION AND AIRCONDITIONING
(Professional Elective-III)

IV Year I Sem
PRE-REQUISITE: THERMODYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To know the various methods of refrigeration and to introduce vapour compression.
- Refrigeration cycle, analysis and methods for improving performance.
- To know the operation of vapour absorption system.
- To know the various components of refrigeration system and their working principles.
- To design air conditioning systems by cooling load calculations.
- To know the various applications of refrigeration and air conditioning systems.

COURSE OUTCOMES:

- The students will get the knowledge about the principle of refrigeration, different methods of refrigeration. (L2)
- Able to know the various components of refrigeration system and their working principles.(L1)
- Able to understand what is meant by air conditioning and various psychrometric properties and
- processes and know the usage of Psychrometric chart.(L1)
- Know how to provide required environment to suit various needs of day to day requirements
- like comfort air conditioning, water cooling , storage of perishable food etc.,(L4)
- Able to understand cooling and heating loads in an air conditioning system.(
- Enable them to do simple design calculations and analysis of these systems.(L5)

UNIT – 1 BASIC CONCEPTS AND AIR REFRIGERATIONHOURS : 10

Introduction to refrigeration: Necessity and applications, UNIT ofrefrigeration and C.O.P, Mechanical refrigeration, types Reversed Carnot cycle ofrefrigeration.

Air Refrigeration: Bell Coleman cycle, Open and Dense air systems, Actualrefrigeration system. Necessity of aircraft refrigeration, Aircraft refrigeration systems-Types.

LEARNING OUTCOME :
At the end of this unit, the students will be able to

- Familiarize with the terminology associated withRefrigeration and Air conditioning.(L4)
- Illustration of bell coleman cycle and its working.(L3)

UNIT – 2 REFRIGERANTS AND VAPOUR COMPRESSION SYSTEMHOURS :10

Refrigerants: Refrigerants Classification, desirable properties, commonly usedrefrigerants, nomenclature, Alternate refrigerant.

Vapour Compression Refrigeration: Working principle, essential components of plant,simple vapor compression refrigeration cycle, modifications, Use of P - h charts.

LEARNING OUTCOME :

At the end of this unit, the students will be able to

- Choose various types of refrigerants and its applications, global warming, Ozone depletion potential.(L4)
- Describe the analysis of sub cooled, super heat, sensible, latent heat and COP calculations, different types of refrigeration systems.(L2)

UNIT – 3 SYSTEM COMPONENTS AND VAPOUR ABSORPTION SYSTEM HOURS :10

System Components: Compressors-types, Condensers - classification, working,Evaporators - classification, working, Expansion devices - types, working.

Vapour Absorption System: Calculation of max COP, description and Workingof NH3-water system, Li-Br,H2O system, principle of operation of three fluidabsorption system and salient features.

LEARNING OUTCOME :

At the end of this unit, the students will be able to

- Design and understand the function of each of the major refrigeration system components: evaporator, compressor, condenser, and metering device.(L5)
- Study the working principles of vapor absorption systems.(L2)

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2270360: AUTOMOBILE ENGINEERING

(Professional Elective- III)

B.Tech. IV Year I Semester
Pre-requisites: Thermodynamics and Thermal Engineering-I

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To impart basic knowledge about the automobiles and their sub-systems. .
- To facilitate to understand the engineering principles to automotive parts.
- Improves ability to understand the different types of engines and automobile bodies.
- Familiarization with the automotive industry and its terminology.
- Develops an idea of utilization of resources duly reducing emission levels for achieving eco-friendly environment.

COURSE OUTCOMES :

- Analyze the basic lay-out of an automobile. (L4)
- Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems. (L2)
- Apply the principles of transmission, suspension. (L3)
- Analyze for latest developments in automobiles like steering and braking systems. (L4)
- Evaluate the recent emission stands in automobile fuels and safety systems. (L6)
- Develop a strong base for understanding future developments in the automobile industry. (L5)

UNIT – 1 **CLASSES:08**

Introduction And Fuel System: Layout of automobile – introduction chassis and body components. Types of Automobile engines. – Power unit – – engine servicing Fuel System: S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters – carburetor – types – air filters – petrol injection. Introduction to MPFI and GDI Systems. C.I. Engines: Requirements of diesel injection systems, types of injection systems, DI Systems IDI systems. Fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. Introduction to CRDI and TDI Systems.

LEARNING OUTCOME:

1. Describe The Types Of Automobile Engines.(L2)
2. Identify MPFI, GDI, CRDI & TDI Systems. (L4)

UNIT – 2	CLASSES:12

Cooling System: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling – pressure sealed cooling – antifreeze solutions. Ignition System: Function of an ignition system, battery ignition system, constructional features of storage, battery, auto transformer, contact breaker points, condenser, and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism. Electrical System: Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

LEARNING OUTCOME:

1. Explain Cooling System, Ignition System And Its Various Types. (L2)
2. Outline The Bendix Drive Mechanism. (L1)

UNIT – 3	CLASSES :10

Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, epicyclical gear box, over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, differential rear axles – types – wheels and tyres. Suspension System: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

LEARNING OUTCOME:

1. Discuss about types of clutches and its functions .(L2)
2. Write its detail of suspension systems its Objects.(L3)

UNIT – 4	CLASSES :10

Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder tandem master cylinder Requirement of brake fluid, Pneumatic and vacuum brakes. Steering System: Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

LEARNING OUTCOME :

1. Identify Different Types Of Brakes And Its Applications. (L4)
2. Compare Ackerman Steering Mechanism And Davis Steering Mechanism (L4)

UNIT – 5	CLASSES :08
Emissions from Automobiles: Pollution standards National and international – Pollution Control – Techniques – Need for alternate fuel: Availability and properties of alternate fuels, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels.	
LEARNING OUTCOME : 1. Demonstrate emission from automobile and its effect.(L3) 2. To study different types of Alternative fuels (L2)	
TEXT BOOK : 1. A Text Book Automobile Engineering–Manzoor, Nawazish Mehdi & Yosuf Ali, Second Edition. 2. Internal Combustion Engine Fundamentals, J.B. Heywood, McGraw Hill Co.1988,First Edition.	
REFERENCE BOOK : 1. A Text Book of Automobile Engineering by R K Rajput. Laxmi Publications (P) LTD, Second Edition. 2. Automotive Mechanics / Heitner 3. Automotive Engineering / Newton Steeds & Garrett 4. Automotive Engines / Srinivasan 5. A Text Book of Automobile Engineering By Khalil U Siddiqui New Age International	

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2270361: COMPUTATIONAL FLUID DYNAMICS
(Professional Elective-III)

B.Tech. IV Year I Sem

L	T	P	C
3	0	0	3

Pre-requisites: Basic principles of Kinematics and mechanics

COURSE OBJECTIVES

1. To apply the principles of Heat Transfer and Fluid Mechanics to formulate governing equations fo physical problems and to solve those using different numerical techniques.

COURSE OUTCOMES: After completion of the course the student is able to

1. Differentiate between different types of Partial Differential Equations and to know and understand appropriate numerical techniques. (L1)
2. Solve the simple heat transfer and fluid flow problems using different numerical techniques, viz., FDM. (L3)
3. Understand and to appreciate the need for validation of numerical solution. (L3)

UNIT – 1 **CLASSES:12**

Basic Aspects of the Governing Equations – Physical Boundary Conditions – Methods of solutions of Physical Problems – Need for Computational Fluid Dynamics – Different numerical/CFD techniques – FDM, FEM, FVM etc., - Main working principle - CFD as a research and design tool – Applications in various branches of Engineering Mathematical behavior of Partial Differential Equations (Governing Equations): Classification of linear/ quasi linear PDE – Examples - Physical Processes: Wave Equations and Equations of Heat Transfer and Fluid Flow – Mathematical Behavior - General characteristics – Its significance in understanding the physical and numerical aspects of the PDE – One way and Two Way variables – Well posed problems – Initial and Boundary Conditions Solution of Simultaneous Algebraic Equations: Direct Method – Gauss Elimination – LU Decomposition – Pivoting – Treatment of Banded Matrices – Thomas Algorithm Iterative Method: Gauss Seidel and Jordan Methods - Stability Criterion.

LEARNING OUTCOME:

1. Understanding of governing equations. (L1)
2. Knowledge on Mathematical behavior of Partial Differential Equations. (L2)

UNIT – 2 **CLASSES:8**

Finite Difference Method: Basic aspects of Discretization – Finite Difference formulae for first order and second order terms – Solution of physical problems with Elliptic type of Governing Equations for different boundary conditions - Numerical treatment of 1D and 2D problems in heat conduction, beams etc., - Solutions –Treatment of Curvelinear coordinates – Singularities – Finite Difference Discretization – Solution of 1D heat conduction problems in Heat conduction in curve linear coordinates.

LEARNING OUTCOME:

1. Understanding of Finite Difference Method. (L1)
2. Ability to analyze different boundary conditions. (L2)

UNIT – 3	CLASSES :10
FDM: Solution of physical problems with Parabolic type of Governing Equations – Initial Condition – Explicit, implicit and semi implicit methods – Types of errors – Stability and Consistency – Von Neumann Stability criterion– Solution of simple physical problems in 1D and 2D – Transient Heat conduction problems- ADI scheme - Simple Hyperbolic type PDE - First order and Second order wave equations – Discretization using Explicit method - Stability criterion – Courant Number – CFL Condition - Its significance - Treatment of simple problems	
LEARNING OUTCOME: 1. Ability to analyze the 1D and 2D problems. (L2) 2. Capability to apply different techniques to solve 1D and 2D problems (L3)	
UNIT – 4	**CLASSES :10**
Finite Difference Solution of Unsteady Inviscid Flows: Lax – Wendroff Technique – Disadvantages – Maccormack's Technique Fluid Flow Equations – Finite Difference Solutions of 2D Viscous Incompressible flow problems – Vorticity and Stream Function Formulation – Finite Difference treatment of Lid Driven Cavity Problem - Application to Cylindrical Coordinates with example of flow over infinitely long cylinder and sphere – Obtaining Elliptic Equations	
LEARNING OUTCOME: 1. Knowledge on different techniques to apply unsteady Inviscid flows. (L3)	
UNIT – 5	**CLASSES :08**
Finite Difference Applications in Fluid flow problems: Fundamentals of fluid Flow modeling using Burger's Equation – Discretization using FTCS method with respect to Upwind Scheme and Transport Property – Upwind Scheme and Artificial Viscosity Solutions of Navier Stokes Equations for Incompressible Fluid Flows: Staggered Grid – Marker and Cell (MAC) Formulation – Numerical Stability Considerations – Pressure correction method - SIMPLE Algorithm	
LEARNING OUTCOME: 1. Acquire the knowledge on FDA methods to fluid flow problems. (L2)	

TEXT BOOKS:

1. Computational Fluid Dynamics: The basics with applications/ John D Anderson/McGraw Hill Publications
2. Numerical Heat Transfer and Fluid Flow/ S.V. Patankar/ Mc Graw Hill

REFERENCE BOOKS:

1. Computational Fluid Flow and Heat Transfer / K Muralidharan and T Sudarajan/ Narosa Publishers
2. Computational Methods for Fluid Dynamics / Firziger & Peric/ Springer
3. Computational Fluid Dynamics/ Chung T. J./Cambridge/Second Edition.

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2270362: HYDRAULIC AND PNEMATICSS
(Professional Elective-III)

B.Tech. IV Year

Pre-requisites: Fluid Mechanics and Hydraulics Machinery

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COURSE OBJECTIVES

1. To know the concepts of hydraulics & pneumatics.
2. To learn the applications of hydraulics and pneumatics in automobiles.
3. To know the advantages and applications of Fluid Power Engineering and Power Transmission System.
4. Know the components of hydraulic and pneumatic circuits.
5. To learn the Applications of Fluid Power System in automation of Machine Tools and others Equipment's.

COURSE OUTCOMES: After completion of the course the student is able to

1. Understand the Properties of fluids, Fluids for hydraulic systems and distribution of fluid power. (L1)
2. Design and analysis of typical hydraulic circuits. (L4)
3. Identify the accessories used in fluid power system. (L2)
4. Filtration systems and maintenance of system. (L4)
5. Explain safe handling of hydraulic fluids, cylinders, control valves and hoses. (L3)

UNIT – 1: BASIC COMPONENTS OF HYDRAULICS **CLASSES:12**

Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. ISO symbols, energy losses in hydraulic systems. Applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis. Performance curves and parameters.

LEARNING OUTCOME:

1. To list the basic components required in hydraulic and pneumatic power systems. (L1)
2. Describe the basic working principle of hydraulic and pneumatic power systems. (L2)

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UNIT – 2: ACTUATORS AND VALVES	CLASSES:12
Hydraulic actuators, types and constructional details, lever systems, control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve Analysis and Design.	
LEARNING OUTCOME: 1. Distinguish between a single-acting and a double- acting hydraulic cylinders. (L2) 2. Understand and explain the construction, operation, and application of various pressure, control and flow control valves. (L1)	
UNIT – 3: HYDRAULIC CIRCUITS	**CLASSES :12**
Proportional control valves and servo valves. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Design and analysis of typical hydraulic circuits. Regenerative circuits, high low circuits, Synchronization circuits, and accumulator sizing.	
LEARNING OUTCOME: 1. To understand and appreciate the functions and applications of accumulators. (L2) 2. Describe the construction and operation of various accumulator circuits. (L4)	

UNIT – 4: BASIC COMPONENTS OF PNEUMATIC	CLASSES :09
Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits, accessories used in fluid power system, Filtration systems and maintenance of system. Components of pneumatic systems; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling;	
LEARNING OUTCOME: 1. To understand and appreciate the functions and applications of pressure intensifier. (L1) 2. Understand and explain the construction, operation, and application of air pressure regulator and flow control valve. (L5)	
UNIT – 5: CONTROL SYSTEMS AND APLLICATINS	**CLASSES :09**
Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will-dependent control, Travel-dependent control and Time dependent control, combined control, Program Control, Electropneumatic control and air-hydraulic control, Ladder diagrams. Applications in Assembly, Feeding, Metal working, materials handling and plastics working.	
LEARNING OUTCOME: 1. Understand the technology of fluidics and how fluidics is used to control fluid power systems. (L1) 2. Apply and design fluidic logic circuits for various fluid power systems. (L3)	

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TEXT BOOKS:

1. Fluid Power Control systems/ Pippenger, J.J., and R. M. Koff/ New York: McGraw Hill.
2. "Fluid Power Systems: modeling, simulation and microcomputer control"/ John Watton/ Prentice Hall International.

REFERENCE BOOKS:

1. Fundamentals of Fluid Power Control. / John Watton/ 1st Ed. Cambridge University Press, 2009
2. "Fluid Power with applications"/ Anthony Esposito / Pearson Education.

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2270386: CAD & AMT LAB

B.Tech. IV Year I Sem

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Pre-requisites: To give the exposure to usage of software tools for design and manufacturing to acquire the skills needed to analyze and simulate engineering systems.

COURSE OBJECTIVES

1. To impart the students with necessary computer aided design skills.
2. To impart the students with necessary computer aided analysis skills.
3. To analyze the various mechanical components.
4. Simulation of mechanical components.
5. To impart the knowledge on CNC programming

COURSE OUTCOMES : After completion of the course the student is able to

1. Able to solve simple problems using FEA software
2. Generate freeform shapes in part mode to visualize components
3. Create complex engineering assemblies using appropriate assembly constraints.
4. Develop G and M codes for turning and milling components.
5. Generate automated tool paths for a given engineering component.

LIST OF EXPERIMENTS :

1. Sketching: Development of part drawings for various components in the form of orthographic. Representation of dimensioning and tolerances.
2. Part Modelling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Study of parent child relation. Feature based and Boolean based modelling. Study of various standard Translators. Design of simple components.
3. Determination of deflection and stresses in 2D and 3D trusses and beams.
4. Determination of deflections, principal and Von-mises stresses in plane stress, plane strain and Axi-symmetric components.
5. Determination of stresses in 3D and shell structures (at least one example in each case)
6. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
7. Study state heat transfer analysis of plane and axi-symmetric components.
8. Review of CAD Modeling Techniques and Introduction to RP
9. Generating STL files from the CAD Models & Working on STL files
10. Modeling Creative Designs in CAD Software
11. Simulation in Catalyst Software.
12. Sending the tool path data to FDM RP machine

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2270387: INSTRUMENTION AND CONTROL SYSTEMS AND PRODUCTION DRAWING LAB

B.Tech. IV Year I Sem
PRE-REQUISITES: -

L	T	P	C
0	0	2	1

COURSE OBJECTIVES

1. Impart an adequate knowledge and expertise to calibrate instruments available in an Industry.
2. Impart knowledge on various working principles and design of Instruments.
3. Understand calibration of measuring instruments for temperature.
4. Understand the functioning of strain gauges for measuring pressure, load and vibrations.
5. Apply calibration of measuring instruments of flow and speed measurement.

COURSE OUTCOMES : After completion of the course the student is able to

1. Analyse errors, integrate and interpret different types of measurements (L3
2. Understand how physical quantities are measured and how they are converted to electrical or other forms.(L2)
3. Evaluate the measurement of speed in engineering applications and importance of speed measurement in instrumentation(L4).
4. Visualize the areas affected with pressure in equipment and calibrate the pressure measuring devices(L3).
5. Comprehend the level of liquid in any container and the various applications of measurement of flow (L4)
6. Able to analyse Instrumentation and Control systems and their applications of various industries(L4)

LIST OF EXPERIMENTS (A minimum of 10 experiments to be conducted)

1. Calibration of pressure gauges
2. Calibration of transducer for temperature measurements
3. Study and calibration of LVDT transducer for displacement measurements
4. Calibration of strain gauge
5. .Calibration of thermocouple for temperature measurements
6. . Calibration of capacitive transducer for angular displacement
7. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
8. Calibration of resistance temperature detector for temperature measurements
9. Study and calibration of Rota meter for flow measurement
10. Study and use of a Seismic pick up for the measurement of vibration
11. Study and calibration of McLeod gauge for low pressure
12. . Measurement And Control Of **Temperature Loop** Of A Process Using Resistance Temperature Detector With SCADA

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PRODUCTION DRAWING LAB

UNIT-I

Conventional representation of Materials - conventional representation of parts-screw joints, welded joints, springs, gears, electrical, hydraulic and pneumatic circuit's methods of indicating notes on drawings.

UNIT-II

Limits and Fits: Types of fits, exercises involving selection/interpretation of fits and estimation of limits from tables.

UNIT-III

Form and Positional Tolerances: Introduction and indication of the tolerances of from and position on drawings, deformation of runout and total runout and their indication.

UNIT-IV

Surface roughness and its indication: Definitions - finishes obtainable from various manufacturing processes, recommended surface roughness on mechanical components.

UNIT-V

Heat treatment and surface treatment symbols used on drawings. UNIT-VI

Detailed and Part drawings: Drawing of parts from assembly drawings with indications of size, tolerances, roughness, form and position errors

etc.

UNIT-VII

Part Drawing using computer aided drafting by CAD software

TEXT BOOKS:

1. Froduction and Drawing - K.L. Narayana & P. Kannsiah! New Age Machine Drawing with Auto CAD- Pohit and Ghosh, PE

REFERENCES:

1. Geometric dimensioning and tolerancing James D. Meadows! B.S Publications intuworldupdates.org

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2280374: MECHANICAL WITH AI & ML
(Professional Elective VI)

B.Tech. IV Year II Sem

L	T	P	C
3	0	-	3

PRE-REQUISITES: Linear Algebra, Probability, Statistics, Logical Reasoning.

COURSE OBJECTIVES

The course is intended to

- ACQUAINT with fundamentals of artificial intelligence and machine learning.
- LEARN feature extraction and selection techniques for processing data set.
- UNDERSTAND basic algorithms used in classification and regression problems.
- OUTLINE steps involved in development of machine learning model.
- FAMILIARIZE with concepts of reinforced and deep learning
- IMPLEMENT AND ANALYZE machine learning model in mechanical engineering problems

COURSE OUTCOMES:

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

- DEMONSTRATE fundamentals of artificial intelligence and machine learning.
- APPLY feature extraction and selection techniques.
- APPLY machine learning algorithms for classification and regression problems.
- DEVISE AND DEVELOP a machine learning model using various steps.
- EXPLAIN concepts of reinforced and deep learning.
- SIMULATE machine learning model in mechanical engineering problem.

UNIT – 1 - Introduction to Artificial Intelligence **CLASSES:12**

Introduction to AI, Problem formulation, Problem Definition, Production systems, Control strategies, Search strategies, Problem characteristics, Production system characteristics, Specialized production systems, Problem solving methods, Problem graphs, Matching, Indexing and Heuristic functions, Hill Climbing, Depth first and Breath first, Constraints satisfaction — Related algorithms, Measure of performance and analysis of search algorithms.

LEARNING OUTCOME:

1. Understand the basics of problem AI. (L2)
2. Understand the basic Algorithms of AI. (L2)

UNIT – 2 - Introduction to Machine Learning **CLASSES:10**

Introduction and basic concepts – Need for machine learning – Types of machine learning – Supervised Unsupervised learning – Reinforced learning – Deep learning Versus Machine learning – Relation between - Machine Learning and Statistics-Machine learning methods based on time-Static learning-Dynamic learning - Function Approximation.

LEARNING OUTCOME:

1.Demonstrate fundamentals of artificial intelligence and machine learning. (L2)
2. Understand the basic algorithms of ML (L2)

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UNIT – 3 – Artificial Intelligence in Robotics	**CLASSES:10**
Reinforcement Learning- planning and search, localization, tracking, mapping and control- A* search algorithms- path smoothing algorithms - SLAM algorithm- Precision agriculture- Assistance robots-Robot Performance optimization-Case studies.	
LEARNING OUTCOME: 1. Understand the concept of AI Algorithm (L2) 2. Apply AI Techniques to Robotics. (L3)	
UNIT – 4 - Applications of Machine Learning in Industrial Sectors	**CLASSES :08**
Applications of machine learning in Industrial sectors - Energy sector: oil and gas - Basic materials sector: Chemicals and Basic resources - Industrials sector - Industrial manufacturing - Industry 4.0: Introduction - Industry smartization - Industry smartization; Component level case study - Industry smartization: Machine level case study - Industry smartization; Production level case study - Industry smartization: Distribution level case study - Machine Learning Challenges and Opportunities within Smart Industries	
LEARNING OUTCOME: 1.Understand the Applications of ML (L2). 2. Apply ML Algorithms to Industrial Sector (L3).	
UNIT – 5 - Application of Artificial Intelligence in Mechanical Manufacturing Industries	**CLASSES :08**
Fault diagnosis- Quality inspection- Improving the safety of working places- Material modeling and smart materials-Automobile engineering- building self-driving cars and autonomous vehicles, Auto parking-Machine learning in Machine Tools and Manufacturing Industries.	
LEARNING OUTCOME: 1. Understand the Applications of AI (L2). 2. Apply AI Algorithms to Manufacturing Industries (L3).	

TEXT BOOK :

1. Kaushik Kumar, Divya Zindani, Paulo Davim, Artificial Intelligence in Mechanical and Industrial Engineering , ISBN 9781003011248, CRC Press, 2021.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.

REFERENCE BOOK :

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2.Gebrail Bekda,Sinan Melih Nigdeli,Melda Yücel, "Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering (Advances in Computational Intelligence and Robotics)", 2019.
3. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA, DOI: 10.4018/978-1-5225-3035- 0,2022.ISBN13: 9781522530350

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2280372: INDUSTRIAL 4.0
(Professional Elective VI)

B.Tech. IV Year II Sem

L	T	P	C
3	0	-	3

PRE-REQUISITES: Basic knowledge of computer and internet

COURSE OBJECTIVES

The course is intended to

- Industry 4.0 components such as: automation, data exchanges, cloud, cyber-physical systems, robots.
- Convergence between consumer and industrial applications, evolution of connectivity technologies and data processing.
- Study how technology applications in Industry 4.0 will change industrial production
- Study how Industry 4.0 contributes to competitive advantages from a management perspective
- Strategize how businesses in different industries can benefit from Industry 4.0, in line with their needs and opportunities

COURSE OUTCOMES:

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

- Understand the basics of Industrial Revolution.
- Understand the basic concepts of Industry 4.0.
- Understand the Concepts of Industrial IOT in various sectors.
- Understand the applications of Industrial IOT.
- Understand the Business issues in Industry 4.0.

UNIT – 1 - Introduction to Industry 4.0 **CLASSES:09**

The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - The Journey so far: Developments in USA, Europe, China and other countries - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

LEARNING OUTCOME:

1. Understand the basics of Industrial Revolution. (L2)
2. Understand the basic concepts of Industry 4.0. (L2)

UNIT – 2 - ROAD TO INDUSTRY 4.0 **CLASSES:09**

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services - Smart Manufacturing Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics

LEARNING OUTCOME:

1.Understand the Concept of IOT (L2)
2. Demonstrate fundamentals of IOT (L2)

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UNIT – 3 – IIOT	**CLASSES:09**
Fourth Revolution – Sustainability assessment of Manufacturing Industry – Lean Production system – Smart and connected business perspective – smart factories – cyber-physical systems – collaboration platform and PLM.	
LEARNING OUTCOME: 1. Understand the concept of Fourth Revolution (L2) 2. Apply IOT Techniques to various Industry. (L3)	
UNIT – 4 - Applications	**CLASSES :09**
Inventory Management and Quality Control – Plant security and safety – Facility management – oil, chemical and Pharmaceutical Industry – Milk processing and packaging industries.	
LEARNING OUTCOME: 1.Understand the Applications of IOT (L2). 2. Apply IOT Applications to Industrial Sector (L3).	
UNIT – 5 – BUSINESS ISSUES IN INDUSTRY 4.0	**CLASSES :09**
Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world.	
LEARNING OUTCOME: 1. Understand the business issues of industry 4.0 (L2). 2. Understand the future scope of industry 4.0 (L2).	

TEXT BOOK :

1. Christoph Jan Bartodziej, "The Concept Industry 4.0 – An Empirical Analysis of Technologies and Application in Production Logistics", Spinger Gabler, 2015.
2. Alasdair Gilchrist, "Industry 4.0 – The Industrial Internet of Thigs", Springer Link, 2016.

REFERENCE BOOK :

1. The Fourth Industrial Revolution by Klaus Schwab, World Economic Forum
2. Internet of Things: A Hands-On Approach by Arsheep Bahga and Vijay Madisetti, University Press.
3.Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.

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2280373: AUTOMATION IN MANUFACTURING

(Professional Elective VI)

B.Tech. IV Year II SEM

L	T	P	C
3	0	-	3

PRE-REQUISITES: None

COURSE OBJECTIVES:

- Lower Cost and Improve Time-to-Market
- Automation investment life-cycle analysis
- Empowered teams of talented employees
- Partnering with automation suppliers
- On-line process analysis
- Procedural process control
- Information integration and data warehousing

COURSE OUTCOMES: At the end of the course, the student will be able to

- Illustrate the basic concepts of automation systems (L3)
- Analyze the production Concepts and Mathematical Models (L4)
- Describe the importance of automated material handling and storage systems (L1)
- Analyze various automated flow lines, Explain assembly systems and line balancing methods(L4)
- Analyze the transfer lines and their applications (L4)
- Interpret the importance of Automated Assembly Systems (L3)

UNIT – 1 **CLASSES:10**

Numerical control, Elements of NC system, NC part programming:
Methods of NC part programming, manual part programming, Computer assisted part programming, Computerized part program, CNC, DNC and Adaptive Control Systems.

LEARNING OUTCOME:

After successful completion of the unit, students can able to

- Understand the NC programming (L1)
- Post processing of CNC, DNC and ACS (L3)

UNIT – 2 **CLASSES:09**

Introduction to Automation: Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies.

Introduction to Material Handling: Overview of Material Handling Equipment, Considerations in Material Handling System Design, the 10 Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems. Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems.

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LEARNING OUTCOME:
After successful completion of the unit, students can able to understand
- Design the Material Handling and storage systems (L5)
- Analysis the Material Transport Systems (L4)

UNIT – 3 **CLASSES :09**

Manual Assembly Lines: Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines, Line balancing problem, largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, Considerations in assembly line design.

LEARNING OUTCOME:
After successful completion of the unit, students can able to understand
- Design of material handling systems (L5)
- Describe automated storage and retrieval systems (L3)

UNIT – 4 **CLASSES :08**

Transfer lines: Fundamentals of Automated Production Lines, Storage Buffers, and Applications of Automated Production Lines. Analysis of Transfer Lines with no Internal Storage, Analysis of Transfer lines with Storage Buffers.

LEARNING OUTCOME:
After successful completion of the unit, students can able to understand
- Demonstrate the automated production lines (L3)
- Analysis of transfer lines (L4).

UNIT – 5 **CLASSES :09**

Automated Assembly Systems: Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, Multi-Station Assembly Machines, Single Station Assembly Machines, Partial Automation.

LEARNING OUTCOME:
After successful completion of the unit, students can able to understand
- Describe Assembly Systems (L1)
- Design of assembly systems (L5)

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TEXT BOOK:

1. Automation, Production systems and computer integrated manufacturing, Mikel P. Groover/ Pearson Eduction. 1st Edition.

2. CAD CAM: Principles, Practice and Manufacturing Management / Chris Mc Mohan, Jimmie Browne / Pearson edu. (LPE) 1st Edition.

REFERENCE BOOK:

1. Automation, Buckinghsm W, Haper& Row Publishers, New York, 1961
2. Automation for Productivity, Luke H.D, John Wiley & Sons, New York, 1972.

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2280371: FUZZY LOGIC & ARTIFICIAL NEURAL NETWORKS
(Professional Elective VI)

B.Tech. IV Year II Sem

L	T	P	C
3	0	-	3

PRE-REQUISITES: Set Theory, Logic, and Engineering Mathematics, Programming Skills.

COURSE OBJECTIVES

The course is intended to

- Understand the fuzzy relations and functional diagram.
- Familiarize fuzzy logic controller and design of fuzzy logic controller.
- Understand the architecture of neural networks.
- Understand the different schemes of neural networks to fuzzy logic.
- Implement the neuro-fuzzy control to different systems.

COURSE OUTCOMES:

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

- Demonstrate the fuzzy relations and functional diagram.
- Apply the fuzzy logic to different cases.
- Apply kohenen self-organising maps to different neural networks.
- Develop neural networks to fuzzy logic for different schemes.
- Apply neuro-fuzzy control to case studies.

UNIT – 1 - Introduction to Fuzzy Logic **CLASSES:12**

Fuzzy sets – Fuzzy relations – Fuzzy conditional statements – Fuzzy rules – Fuzzy algorithm – functional diagram.

LEARNING OUTCOME:

1. Understand the fuzzy relations. (L2)
2. Understand the fuzzy algorithm. (L2)

UNIT – 2 – Fuzzy Logic Control Systems **CLASSES:10**

Fuzzy logic controller – Fuzzification interface – Knowledge hase – Decision making logic –Defuzzification interface – Design of Fuzzy logic controller – Case study.

LEARNING OUTCOME:

1.Demonstrate fuzzification interface. (L2)

2. Understand the design of fuzzy logic controller. (L2)

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UNIT – 3 – Introduction and different Architectures of Neural Networks	**CLASSES:10**
Artificial Neuron – MLP – Backpropagation – Hopfield Networks – Kohenen self-organising maps – Adaptive Resonance.	
LEARNING OUTCOME: 1. Understand the concept of Artificial Neuron(L2) 2.Understand Architecture of Neural Networks. (L2)	
UNIT – 4 – Neural Networks to Fuzzy Logic	**CLASSES :08**
Schemes of Neuro-control-Identification & control of dynamical systems – case study.	
LEARNING OUTCOME: 1.Understand the Schemes of Neural Networks (L2). 2. Apply NN Schemes to different Sector (L3).	
UNIT – 5 – Neuro-Fuzzy Control	**CLASSES :08**
Adaptive fuzzy systems – optimization of membership function and rule base of fuzzy logic controller using neural networks – fuzzy neuron – case study.	
LEARNING OUTCOME: 1. Understand the adaptive fuzzy systems (L2). 2. Apply fuzzy logic controller to case study (L3).	
TEXT BOOK : 1. Klir G.J., and T.A., Fuzzy Sets, uncertainty and information, Prentice Hall of India, New Delhi,2020. 2. Nie & Linkers : Fuzzy Neural Control : Principles, Algorithms and Applications, PHI,2021	
REFERENCE BOOK : 1. Simon Hayking, Neural Network,ISA, Research triangle Parke, 2018. 2. Kosco b., Neural Networks and Fuzzy systems : A Dynamical approach to machine Intelligence, Prentice Hall, USA, 2019. 3. Hertz j., Korgh A., and Palmer R.G. Introduction to the Theory of Neural Computation Addison – Wesley Publishing Co., California, 2021.	

V. Ramudu

2280370: SURFACE ENGINEERING & TRIBOLOGY

(Professional Elective-V)

B.Tech. IV Year II Sem

L	T	P	C
3	0	0	3

PRE-REQUISITES:

COURSE OBJECTIVES

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

1. Describe the fundamentals of surface features and different types of friction associated with metals and non metals. (L2)
2. Analyze the different types of wear mechanism and its standard measurement. (L4)
3. Understand the different types of corrosion and its preventive measures. (L1)
4. Describe the different types of surface properties and surface modification techniques. (L2)
5. Analyze the various types of materials used in the friction and wear applications. (L4)

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Describe the fundamentals of surface features and different types of friction associated with metals and non metals. (L2)
2. Analyze the different types of wear mechanism and its standard measurement. (L4)
3. Understand the different types of corrosion and its preventive measures. (L1)
4. Analyze the different types of surface properties and surface modification techniques. (L4)
5. Describe the various types of materials used in the friction and wear applications. (L2)

UNIT – 1 UNITI SURFACES AND FRICTION

Basics of surfaces features – Roughness parameters – surface measurement - Cause of frictionLaws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand the surface features. (L2)
2. Understand the Friction properties of metal and nonmetals. (L2)

UNIT – 2 WEAR

Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Analyse the wear mechanisms. (L4)
2. Understand International standards in friction and wear measurements. (L2)

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UNIT – 3 CORROSION
Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand the impartance of corrosion. (L2) 2. Analyse how to prevent corrosion. (L4)
UNIT – 4 SURFACE TREATMENTS
Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand the surface properties. (L2) 2. Analyse the various surface coating techniques. (L4)
UNIT – 5 ENGINEERING MATERIALS
Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand the importance of engineering materials. (L2) 2. Analyse the importance of nano tribology. (L4)
TEXT BOOK: 1. G.W.Stachowiak andA.W.Batchelor, "Engineering Tribology", Butterworth-Heinemann, 2005. 2. S.K.Basu, S.N.Sengupta and B.B.Ahuja ,"Fundamentals of Tribology", Prentice Hall of India, 2005.
REFERENCE BOOK: 1. Fontana G., "Corrosion Engineering", McGraw Hill, 1985. 2. Halling, J. (Editor), "Principles of Tribology ", MacMillian, 1984

2280369:NON-DESTRUCTIVE TESTING

(Professional Elective V)

B.Tech. IV Year II Sem

L	T	P	C
3	0	-	3

PRE-REQUISITES: None

COURSE OBJECTIVES

To make the students to understand the importance of NDT in quality assurance.

- To imbibe the students the basic principles of various NDT techniques, its applications, Limitations, codes and standards.
- To equip the students with proper competencies to locate a flaw in various materials, products.
- To make the students to be ready to use NDT techniques for in-situ applications too.
- To inculcate the knowledge of selection of the right NDT technique for a given application

COURSE OUTCOMES:

The students will be able

- To compare the differences between the various visual inspection techniques and apply the same to the components to be inspected.
- To recognise the importance of Penetrant testing in NDT with the understanding of the procedures involved in the Penetration methods
- To interpret the images and the results obtained from the Thermographic technique and the Eddy current testing
- To evaluate and interpret the results obtained in the Ultrasonic inspection and Acoustic Emission technique
- To explain the techniques involved in the Radiographic testing and the various advancements in Radiography.

UNIT – 1 INTRODUCTION & VISUAL INSPECTION METHODS CLASSES:9

NDT versus Mechanical testing, Need for NDT, Relative merits and limitations, various physical characteristics of materials and their applications in NDT. Visual Inspection -Unaided, Aided- Borescopes - Videoscopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications.

LEARNING OUTCOME:

After successful completion of the unit, students can able to

1. Understand the importance of NDT inspection methods. (L2)
2. Develop the testing procedures of visual inspection.(L3)

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UNIT – 2LIQUID PENETRANT TESTING& MAGNETIC PARTICLE TESTINGCLASSES: 9
LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipments, Advantages and limitations, Inspection and Interpretation, Applications and case study. MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications, Residual magnetism, Demagnetisation – need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting.
LEARNING OUTCOME: After successful completion of the unit, students can able to 1. Understand the importance of NDT inspection methods. (L2) 2. Develop the testing procedures of NDT inspection method. (L3)

UNIT – 3 THERMOGRAPHY & EDDY CURRENT TESTING CLASSES :9
Thermography – Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations, Interpretation of Results& applications.
LEARNING OUTCOME: After successful completion of the unit, students can able to 1. Understand the importance of NDT inspection methods. (L2) 2. Develop the testing procedures of NDT inspection method. (L3)
UNIT – 4 ULTRASONIC TESTING & ACOUSTIC EMISSION TESTING CLASSES :9
Ultrasonic Testing-Principle, Basic Equipment, Transducers, couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B-Scan & C-Scan, Phased Array Ultrasound& Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results& Applications. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.
LEARNING OUTCOME: After successful completion of the unit, students can able to 1. Understand the importance of Ultrasonic inspection method. (L2) 2. Develop the testing procedures of Ultrasonic inspection method. (L3)

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UNIT – 5 RADIOGRAPHY **CLASSES :9**

Introduction, Principle, X-ray Production, Gamma ray sources, tubing materials, X-ray tubing characteristics, Interaction of X-ray with matter, Imaging, Film techniques, Filmless techniques, Types and uses of filters and screens, Real time radiography, geometric factors, inverse square law, *characteristics of film, graininess, density, speed, contrast, characteristic curves, Penetrameters,* Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography – Film Digitisation, Direct Radiography &Computed Radiography, Computed Tomography, Gamma ray Radiography, Safety in X- ray and Gamma Ray radiography.

LEARNING OUTCOME:

After successful completion of the unit, students can able to
1.Understand the importance of radiography inspection method. (L2)
2. Develop the testing procedure of radiography inspection method. (L3)

TEXT BOOK:

1. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley/2nd edition New Jersey, 2005
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.

REFERENCE BOOK:

1. Ravi Prakash, "Non-Destructive Testing Techniques", New Age International Publishers/1st revised edition,2010.
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200/Volume-17.
3. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol.

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2280363: COMPOSITE MATERIALS & MECHANICS

(Professional Elective – IV)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

COURSE OBJECT:

- Develop understanding of the structure of ceramic materials on multiple length scales.
- Develop knowledge of point defect generation in ceramic materials, and their impact ontransport properties.
- To describe key processing techniques for producing metal, ceramic-, and polymer-matrixcomposites.
- To demonstrate the relationship among synthesis, processing, and properties in composite materials.

COURSE OUTCOMES:

- Knowledge of the crystal structures of a wide range of ceramic materials and glasses.
- Able to explain how common fibers are produced and how the properties of the fibers arerelated to the internal structure.
- Able to select matrices for composite materials in different applications.
- Able to describe key processing methods for fabricating composites.
- Understanding of composite properties and fabrication techniques.
- Analyse the micromechanical properties of fiber reinforced composites.

UNIT – 1 INTRODUCTION TO COMPOSITE MATERIALS CLASSES: 9

Introduction: Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement and matrix. Types of reinforcements and their properties: Fibers: Carbon, Boron, Glass, Aramid, Al2O3, SiC, Nature and manufacture of glass, carbon and aramid fibres, Comparison of fibres. Role of interfaces: Wettability and Bonding, the interface in Composites, Interactions and Types of bonding at the Interface, Tests for measuring Interfacial strength.

LEARNING OUTCOME:

- A knowledge of contemporary issues
- An ability to identify, formulate, and solve engineering problems
- A knowledge of chemistry and physics with depth in both

UNIT – 2 MANUFACTURING OF COMPOSITES 1	CLASSES: 9
Fabrication of Polymeric Matrix Composites, Structure and properties of Polymeric Matrix Composites, Interface in Polymeric Matrix Composites, Applications; Fabrication of Ceramic Matrix Composites, Properties of Ceramic Matrix Composites, Interface in Ceramic Matrix Composites, Toughness of Ceramic Matrix Composites Applications of Ceramic Matrix Composites.	
LEARNING OUTCOME: • An ability to apply knowledge of mathematics, science and engineering • An ability to identify, formulate, and solve engineering problems • A knowledge of chemistry and physics with depth in both • A familiarity with statistics and linear algebra	
UNIT – 3 MANUFACTURING OF COMPOSITES 2	**CLASSES: 9**
Fabrication of Metal Matrix Composites: Solid state fabrication, Liquid state fabrication and In-situ fabrication techniques; Interface in Metal Matrix Composites: Mechanical bonding, Chemical bonding and Interfaces in In-situ Composites; Discontinuously reinforced Metal Matrix Composites, Properties and Applications. Fabrication of Carbon fiber composites, properties, interface and applications.	
LEARNING OUTCOME: • An ability to apply knowledge of mathematics, science and engineering • An ability to identify, formulate, and solve engineering problems • A knowledge of chemistry and physics with depth in both • A familiarity with statistics and linear algebra	
UNIT – 4 LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES	**CLASSES: 9**
Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.	

LEARNING OUTCOME:

- An ability to apply knowledge of mathematics, science and engineering
- An ability to identify, formulate, and solve engineering problems
- A knowledge of chemistry and physics with depth in both
- A familiarity with statistics and linear algebra

UNIT – 5 MICROMECHANICS OF COMPOSITES **CLASSES: 9**

Micromechanics of Composites: Density, Mechanical Properties: Prediction of Elastic constants, Micro mechanical approach, Halpin-Tsai equations, Transverse stresses; Thermal properties: Hydrothermal stresses and Mechanics of Load transfer from matrix to fiber.

TOTAL PERIODS: 45Hrs

TEXT BOOK:

1. Composite Materials – Science & Engineering, K.K. Chawla, Springer-Verlag, New York, 1987.
2. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt. 1997.

REFERENCE BOOK:

1.Composites, Engineered Materials Handbook, Vol. 1, ASM International, Ohio, 1988.

2. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993

3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman

2280364: ROBOTICS

(Professional Elective IV)

B.Tech. IV Year II Sem

L T P C
3 0 0 3

Pre-requisites: Basic principles of Kinematics and mechanics

COURSE OBJECTIVES

- To familiarize the students with the concepts and techniques in robotic engineering.
- To understand manipulator kinematics, dynamics and control, chose, and incorporaterobotic technology in engineering systems.
- Make the students acquainted with the theoretical aspects of Robotics .
- Enable the students to acquire practical experience in the field of Robotics through design projectsand case studies.
- Make the students to understand the importance of robots in various fields of engineering.
- Expose the students to various robots and their operational details.

COURSE OUTCOMES: After completion of the course the student is able to

- Understand the basic components of robots. (L1)
- Understand the Differentiate types of robots and robot grippers. (L2)
- Modeling of forward and inverse kinematics of robot manipulators. (L3)
- Knowledge of working principle of wind energy systems. (L2)
- Analyze forces in links and joints of a robot: (L4)
- Programme a robot to perform tasks in industrial applications and Design intelligent robots using sensors.(L3)

UNIT – 1 **CLASSES:08**

Introduction: Automation and Robotics – An over view of Robotics – present and future applications.
Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors,
Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

LEARNING OUTCOME:

1. Knowledge on Architecture, Design end effectors. (L2)

UNIT – 2 **CLASSES:12**

Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems.
Manipulator Kinematics: H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

LEARNING OUTCOME:

1. Understanding the motion analysis and manipulator kinematics. (L1)

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UNIT – 3	CLASSES :10
Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.	
LEARNING OUTCOME: 1. Understanding the transformation of manipulators and Euler formulations, trajectory planning. (L4)	
UNIT – 4	**CLASSES :10**
Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools	
LEARNING OUTCOME: 1. Knowledge on Robot Actuators and feedback components. (L2)	
UNIT – 5	**CLASSES :08**
Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading Processing - spot and continuous arc welding & spray painting - Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.	
LEARNING OUTCOME: 1. Acquire the knowledge on application in Manufacturing. (L2)	
TEXT BOOKS: 1. Industrial Robotics / Groover M P /Mc Graw Hill 2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson.	
REFERENCE BOOKS: 1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley 2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science 3. Robotics – Fu et al / TMH Publications.	

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2280365: MECHATRONICS

(Professional Elective IV)

B.Tech. IV Year II Sem

L	T	P	C
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PRE-REQUISITES: Basic Electronics Engineering

COURSE OBJECTIVES

1. To explain the concept of Mechatronics
2. Understand & Elements of sensors, transducers & displacement of characteristics.
3. To analyse the PN junction diode, BIT, FET, DIA and TRIAC and its significance.
4. To gain the Knowledge about Hydraulic and Pneumatic acting system in industrial application.
5. Understand the concept of PLC system and significance of PLC control
6. Detailed study of system and in its facing data.

COURSE OUTCOMES : After completion of the course the student is able to

1. Develop a simulation model for simple physical systems and explain mechatronics design process.(L4)
2. Knowledge of working principle of various energy systems Outline appropriate sensors and actuators for an engineering application.(L1)
3. Time and Frequency domain analysis of system model (for control application).(L4)
4. Implement Mechatronic System/Process which is Environment Friendly with appropriate Consideration for Public Health and Safety.(L3)
5. Explain linearization of nonlinear systems and elements of data acquisition.(L2)
6. Development of PLC ladder programming and implementation of real life system.(L5)

UNIT – 1 **CLASSES:08**

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion , acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

LEARNING OUTCOME:

1. Identification of key elements of mechatronics system and its representation in terms of block diagram.(L2)
2. Develop a simulation model for simple physical systems and explain mechatronics design process.(L5)

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UNIT – 2	CLASSES:12
Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.	
LEARNING OUTCOME: 1. Describe the principle and analyze the operation of p-n diodes, BJTs. (L2) 2. Interfacing of Sensors, Actuators using appropriate DAQ micro-controller.(L1)	

UNIT – 3	CLASSES :10
Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydrop neumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.	
LEARNING OUTCOME: 1. Outline appropriate sensors and actuators for an engineering application.(L3) 2. Development of PLC ladder programming and implementation of real life system.(L4)	
UNIT – 4	**CLASSES :10**
Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control	
LEARNING OUTCOME : 1. PLC implementation on real time systems.(L4) 2. Explain various applications of design of mechatronic systems.(L2)	
UNIT – 5	**CLASSES :08**
System and interfacing and data acquisition, DAQS, SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.	
LEARNING OUTCOME : 1. Exhibit Effective Project Management Skills to Conceive and Develop a Project Plan. (L4) 2. Apply Knowledge of Math, Science, and Mechatronic Engineering disciplines to Solve Real Life Industrial Problems.(L5)	

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TEXT BOOK :

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Ist Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering? W Bolton/ Pearson Education Press/3rd edition, 2005.

REFERENCE BOOK:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai. 3rd edition
2. Mechatronics N. Shanmugani /Anuradha Agencies Publishers. 1st edition
3. Mechatronics System Design I Devdas shey/RichardIThomson, 2nd edition

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2280366: MECHANICAL VIBRATIONS

B.Tech. IV Year II Sem

PRE-REQUISITES: Engineering Mechanics

L	T	P	C
3	0	-	3

COURSE OBJECTIVES

To impart the knowledge of vibration on various levels.

To understand remedies for vibrations at various levels.

To impart the knowledge on single degree of freedom systems.

To impart the knowledge on two degree of freedom systems

To understand the working and use of vibration measuring instruments.

COURSE OUTCOMES : After completion of the course the student is able to

Understand the causes and effects of vibration in mechanical systems (L_2)

Outline various schematic models for physical systems and formulate governing equations of motion. (L_2)

Analyze rotating and reciprocating systems and compute critical speeds .(L_3)

Analyze and design machine supporting structures, vibration isolators and absorbers. .(L_3)

Understand the role of damping, stiffness and inertia in mechanical systems (L_2)

Demonstrate various vibration measuring instruments. (L_2)

UNIT – 1 **CLASSES:8**

UNIT - I **Introduction**: Introduction to vibrations & basic concepts

Damped Single Degree Freedom System: Damping Models- Viscous Damping, Structural Damping, Coulomb Damping Single Degree Freedom System with Damping- Over Damped, Under Damped, Critically Damped, Logarithmic Decrement.

LEARNING OUTCOME:

1. Discuss basic concepts on vibration. (L_2).
2. Calculate natural frequency and damped frequency for the single-degree-of freedom system.(L_3).

UNIT – 2 **CLASSES:10**

Single Degree Freedom System – Forced Vibrations: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Critical Speed of shaft.

LEARNING OUTCOME:

1. Discuss the equation of motion of a single-degree-of-freedom system using different methods such as Newton's second law, D'Alembert's principle, and the principle of conservation of energy. (L_2)
2. Calculate the equation of motion for the different types of initial conditions. (L_3)

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UNIT – 3	CLASSES :12
Two-degree freedom systems: Principal modes- undamped and damped free and forced vibrations; undamped vibration absorbers; Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems.	
LEARNING OUTCOME: 1. Discuss linear vibratory models of dynamic systems with changing complexities(L_2) 2. calculate the differential equations of motion of vibratory systems (L_3)	
UNIT – 4	**CLASSES :8**
Continuous system: Free vibration of strings – longitudinal oscillations of bars- traverse vibrations of beams- Torsional vibrations of shafts. **Critical speeds of shafts**: Critical speeds without and with damping, secondary critical speed.	
LEARNING OUTCOME : 1. Able to calculate critical speeds with and without damping. (L_3). 2. Understand the concept of free vibration in continous systems. (L_2).	
UNIT – 5	**CLASSES :8**
Vibration measurements: Vibrometers, velocity meters & accelerometers, seismic instruments **Numerical Methods:** Rayleigh's stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods **Acoustics and Noise Control**: Acoustic wave equation, Acoustic energy and sound intensity. Propagation of sound, Concept of Acoustic impedance. Sound power transmission, Transmission Loss. Human Response and ratings, Sound measuring instruments	
LEARNING OUTCOME : 1. To formulate numerical methods for multi degree freedom of systems(L_3). 2. To understand various instruments used to measure vibration.(L_2).	

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Textbooks:

1. Elements of Vibration Analysis / Meirovitch/ Mc Graw Hill / 2nd Edition
2. Principles of Vibration / Benson H. Tongue/Oxford / 2nd Edition

REFERENCE BOOK :

1. Mechanical Vibrations by G.K. Groover./8 th Edition
2. Mechanical Vibrations / SS Rao / Pearson/4th Edition.
3. Mechanical Vibration /Rao V. Dukkipati, J Srinivas/ PHI/ / 2nd Edition

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2280367: TOTAL QUALITY MANAGEMENT

(Professional Elective V)

B.Tech. IV Year II Sem

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To explain the concept of Total Quality Management (TQM).
2. To analyse the customer focus and satisfaction.
3. To outline the organizing for Total Quality Management related to system approach, quality implementation.
4. To understand the cost of quality, accounting system and quality management.
5. To gain knowledge on the universal standards of quality.
6. To outline the management of process quality.

COURSE OUTCOMES : After completion of the course the student is able to

1. Understanding of product Inspection vs Process control. (L2)
2. Knowledge on role of marketing and sales. (L1)
3. Capability to understanding the evolution of bench marking. (L3)
4. Knowledge to make the transition from a traditional to a TQM organization. (L2)
5. Knowledge of quality pertaining to documentation, services and the cost of certification. (L3)
6. Students are expected to have a good command over Total Quality Management.(L2)

UNIT – 1 **CLASSES:08**

Introduction: The concept of TQM, Quality and Business Performance, Attitude and Involvement of Top Management, Communication, Culture and Management Systems. Management of Process Quality: Definition of Quality, Quality Control, a Brief History, Product Inspection Vs Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

LEARNING OUTCOME:

1. Evaluate the quality management and the whole process of quality control. (L4)
2. Understand the history of total quality management to have an excellent business performance. (L2)

UNIT – 2 **CLASSES:12**

Customer Focus and Satisfaction: Process Vs Customer, Internal Customer Conflict, Quality Focus, Customer Satisfaction, Role of Marketing and Sales, Buyer – Supplier Relationships.
Bench Marking: Evolution of Bench Marking, Meaning of Bench Marking, Benefits of Bench Marketing, the Bench Marking Procedure, Pitfalls of Bench Marketing.

LEARNING OUTCOME:

1. Identify the buyer – supplier relationships. (L1)
2. Importance of bench marketing. (L2)

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UNIT -3	CLASSES :10
Organizing for TQM: The Systems Approach, Organizing for Quality Implementation, Making the Transition from a Traditional to a TQM Organization, Quality Circles, Seven Tools of TQM: Stratification, Check Sheet.	
LEARNING OUTCOME: 1. Develop the system approach. (L4) 2. Categorize the quality circles and seven tools of TQM. (L5)	
UNIT – 4	**CLASSES :10**
The Cost of Quality: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.	
LEARNING OUTCOME : 1. Analyze the quality costs and measuring quality costs. (L4) 2. Knowledge of the cost of quality. (L1)	
UNIT – 5	**CLASSES :08**
ISO9000: Universal Standards of Quality: ISO Around the World, The ISO9000 ANSI/ASQC Q-90, Series Standards, Benefits of ISO9000 Certification the Third Party Audit, Documentation ISO9000 and Services, the Cost of Certification Implementing the System.	
LEARNING OUTCOME : 1. Comparsion of universal standards of quality in terms of ISO around the world. (L2) 2. Importance of ISO 9000 certification. (L2)	
TEXT BOOK : 1.Total Quality Management/Joel E.Ross/Taylor AND Franscis Limited 3rd Edition 2.Total Quality Management/P.N.Mukharjee/PHI 3rd Edition	
REFERENCE BOOK : 1.Beyond TQM/Robert L.Flood, 1st Edition 2.Statistical Quality Control / E.L. Grant, 12th Edition 3.Total Quality Management: A Practical Approach/H.Lal, 1st Edition	

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2280368: QUALITY AND RELIABILITY

(Professional Elective-V)

B.Tech. IV Year II Sem

L	T	P	C
3	-	-	3

PRE-REQUISITES: Total Quality Management

COURSE OBJECTIVES:

- The main learning objective of this course is to prepare the students for:
- Applying the 7 QC tools in problem solving for continuous improvement.
- Designing online sampling plan for quality control using control charts and perform process capability studies.
- Applying the strategies of acceptance sampling plan to perform quality audit in the customer site.
- Evaluating the different reliability measurements applying the reliability concepts
- Selecting the suitable method of improving the reliability and integrate reliability concepts in new product design and development.

COURSE OUTCOMES:

- Upon completion of this course, the students will be able to:
- Understand the principles and concepts of the seven quality control tools and their role in identifying and addressing process issues.
- Utilize control charts to monitor processes in real-time, detect deviations, and make data-driven decisions for process adjustments.
- Understand the principles and objectives of acceptance sampling and its application in quality audits.
- Students will be able to calculate and interpret reliability indices such as MTBF (Mean Time Between Failures) and MTTR (Mean Time to Repair).
- Students will learn to balance reliability objectives with cost considerations in product development.

UNIT – 1 NTRODUCTION AND STATISTICAL PROCESS CONTROL CLASSES:09

Introduction: -definitions of quality, Evolution of Quality: Inspection, Quality Control, Quality assurance Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality costs-Prevention; Appraisal and Failure costs. Seven SPC tools -Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts and flow chart.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Understand how quality management has evolved over time, from basic inspection to more advanced quality control and assurance methods. (L2)
- Apply these tools to analyze processes and make improvements that reduce defects and enhance the overall quality of products or services. (L3)

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UNIT – 2 ONLINE QUALITY CONTROL	CLASSES:09
Control chart for attributes –control chart for non-conforming– p chart and np chart – control chart for nonconformities– C and U charts, Control chart for variables – X chart, R chart and σ chart -State of control and process out of control identification in charts, pattern study and process capability studies.	
LEARNING OUTCOME: After successful completion of the unit, students can • Develop the ability to analyze control charts to detect patterns and trends that may indicate process issues. (L3) • Understand how these charts help monitor processes, spot control states, identify deviations, and evaluate process capability. (L2)	

UNIT – 3 OFFLINE QUALITY CONTROL	CLASSES :09
Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producers Risk and consumers Risk. AQL, LTPD, AOQL concepts standard sampling plans for AQL and LTPD- uses of standard sampling plans.	
LEARNING OUTCOME: After successful completion of the unit, students can • Understand different ways to sample products in lots (single, double, multiple sampling). (L2) • Apply these plans to decide whether to accept or reject product lots, ensuring quality in various industries. (L3)	
UNIT – 4 RELIABILITY CONCEPTS	**CLASSES :09**
Reliability engineering - fundamentals – failure data analysis, Mean failure rate, Mortality curves concept of burn –in period, useful life and wear out phase of a system, mean time to failure, meantime between failure, hazard rate – failure density and conditional reliability-Maintainability and availability – simple problems.	
LEARNING OUTCOME: After successful completion of the unit, students can • Apply the concepts of maintainability and availability in practical problem-solving scenarios. (L3) • Solve simple problems related to maintainability and availability to assess and improve the reliability of systems and components. (L2)	
UNIT – 5 RELIABLITY ESTIMATION	**CLASSES :09**
System reliability: Series, Parallel and Mixed configurations, Reliability improvement techniques, use of Pareto analysis – design for reliability – redundancy unit and standby redundancy- fault tree analysis – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.	
LEARNING OUTCOME: After successful completion of the unit, students can • Understand the various configurations of system reliability, including Series, Parallel, and Mixed configurations. (L2) • Apply the principles of reliability engineering in real-world scenarios, particularly in product design and development. (L3)	

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TEXT BOOK:

1. Douglas.C. Montgomery, "Introduction to Statistical quality control", 7th edition, John Wiley2012.
2. Srinath. L.S., "Reliability Engineering", 4th edition Affiliated East west press, 2011

REFERENCES BOOKS:

1. Besterfield D.H., "Quality Control", 8th edition, Prentice Hall, 2009.
2. Connor, P.D.T.O., "Practical Reliability Engineering", 5 theditionWiley India, 2012
3. Grant, Eugene .L "Statistical Quality Control", TMH, 2005

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2260333: DESIGN OF TRANSMISSION SYSTEMS

B.Tech. III Year II Sem

L	T	P	C
3	1	-	4

PRE-REQUISITES: Study of engineering mechanics, design of machine members-I and theory of machines.

COURSE OBJECTIVES:

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

1. Designing flexible elements like belt, ropes and chain drives for engineering applications.
2. Designing spur and helical gear drives for power transmission.
3. Designing bevel and worm drives for power transmission.
4. Designing multi speed gear box for machine tool and automotive applications.
5. Designing clutch and brake systems for engineering applications.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Design flexible elements like belt, ropes and chain drives for engineering applications.
2. Design spur and helical gear drives for power transmission.
3. Design bevel and worm drives for power transmission.
4. Design multi speed gear box for machine tool and automotive applications.
5. Design clutch and brake systems for engineering applications.

Note: (Use of standard Design Data Book is permitted in the END examination)

UNIT – 1 DESIGN OF FLEXIBLE ELEMENTSCLASSES:09

Transmission of power by Belt and Rope Drives, Transmission efficiencies, Belts – Flat and V types – Ropes - pulleys for belt and rope drives. Design of Transmission Chains and Sprocket.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Illustrate design procedures for belt and rope drives. (L2)
- Make use of those design theories in manufacturing components. (L3)

UNIT – 2DESIGN OF GEARS CLASSES:09

Gear materials - Design of straight tooth spur & helical gears based on speed ratios, number of teeth, Fatigue strength, Factor of safety, strength and wear considerations. Force analysis –Tooth stresses - Helical gears – Module - normal and transverse, Equivalent number of teeth – forces.
Straight bevel gear: Gear materials - Tooth terminology, tooth forces and stresses, equivalent number of teeth, estimation of dimensions of straight bevel gears. Worm Gear: Gear materials - Tooth terminology, Thermal capacity, forces and stresses, efficiency, estimation of dimensions of worm gear pair.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Illustrate design procedures for various gears. (L2)
- Make use of those design theories in design soft wares.(L3)

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UNIT – 3 ENGINE PARTS CLASSES :09
Engine Parts: Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends –Pistons, Forces acting on piston – Construction, Design and proportions of piston.
LEARNING OUTCOME: After successful completion of the unit, students can • Illustrate design procedures for bevel and worm gears. (L2 • Make use of those design theories in design soft wares. (L3)
UNIT – 4 GEAR BOXESCLASSES :09
Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box (6,9,12 speed gear box) for machine tool applications- Constant mesh gear box - Speed reducer unit. – Variable speed gear box.
LEARNING OUTCOME: After successful completion of the unit, students can • Illustrate design procedures for assembling gear box. (L2) • Make use of those design theories in assembling gearbox in design soft wares (L3)
UNIT – 5 BEARINGSCLASSES :09
Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs - Selection of Rolling Contact bearings.
LEARNING OUTCOME: After successful completion of the unit, students can • Illustrate design procedures for various bearings. (L2 • Make use of those design theories in design soft wares.(L3)
TEXT BOOK: 1. Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., "Mechanical Engineering Design", 10 th Edition, Tata McGraw-Hill, 2014. 2. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2003
REFERENCE BOOK: 1. Bhandari V, "Design of Machine Elements", 15th Reprint, Tata McGraw-Hill Book Co, 2014 R2. New Technology – Bhattacharya A, The Institution of Engineers, India 1984. 2. Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, 4th edition, Anuradha Publications, 2014. 3. C.S.Sharma, KamleshPurohit, "Design of Machine Elements", 1st edition, Prentice Hall of India,Pvt. Ltd., 2004.

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2260334: THERMAL ENGINEERING-II

B.Tech. III Year II Sem | **L T P C**
PRE-REQUESTS: Thermodynamics | **3 0 - 3**

COURSE OBJECTIVES

- To develop basic knowledge of students on Rankine cycles.
- To provide sufficient knowledge on Boilers and chimneys to the students.
- To enable student knowledge on steam nozzles and steam turbines.
- To improve the knowledge of students on steam formation process.
- To provide sufficient knowledge to the students on gas turbine plant.

COURSE OUTCOMES: After completion of the course the student is able to

- Develop state – space diagrams based on the schematic diagrams of process flow of steam and gas turbine plants(L1)
- Apply the laws of Thermodynamics to analyze thermodynamic cycles(L4)
- Student will be able to design the blades and impeller for impulse and reacrtion turbine.
- Differentiate between vapour power cycles and gas power cycles (L3)
- Infer from property charts and tables and to apply the data for the evaluation of performance parameters of the steam and gas turbine plants(L3)
- Understand the functionality of major components of jets and rocket to do the analysis of these components(L1)

UNIT – 1 **CLASSES:10**

Steam Power Plant: Rankine cycle - Schematic layout, Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance – Regeneration & reheating.
Boilers: Classification – Working principles with sketches including H.P.Boilers – Mountings and Accessories – Working principles- Boiler horse power, Equivalent Evaporation, Efficiency and Heat balance – Draught- Classification – Height of chimney for given draught and discharge- Condition for maximum discharge- Efficiency of chimney.

LEARNING OUTCOME:

1. Describe basic components of Rankine cycle (L2)
2. Restate boilers and its components(L2)

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UNIT – 2	CLASSES:10
Steam Nozzles: Stagnation Properties- Function of nozzle – Applications and Types- Flow through nozzles- Thermodynamic analysis – Assumptions -Velocity of nozzle at exit-Ideal and actual expansion in nozzle- Velocity coefficient- Condition for maximum discharge- Critical pressure ratio- Criteria to decide nozzle shape- Super saturated flow, its effects, Degree of super saturation and Degree of under cooling - Wilson line	
LEARNING OUTCOME: 1. Understand the concept of nozzle and diffuser (L1). 2. Summarizes the properties of steam and apply it to nozzle flow analysis (L3).	
UNIT – 3	**CLASSES :12**
Steam Turbines: Classification – Impulse turbine; Mechanical details – Velocity diagram – Effect of friction – Power developed, Axial thrust, Blade or diagram efficiency – Condition for maximum efficiency. De-Laval Turbine - its features- Methods to reduce rotor speed-Velocity compounding and Pressure compounding- Velocity and Pressure variation along the flow – Combined velocity diagram for a velocity compounded impulse turbine. **Reaction Turbines**: Mechanical details – Principle of operation, Thermodynamic analysis of a stage, Degree of reaction –Velocity diagram – Parson's reaction turbine – Condition for maximum efficiency. .	
LEARNING OUTCOME: 1. Principle, Classification and compounding of steam turbine (L3) 2. Analyze the concepts of velocity diagram and design of impulse steam turbine by both analytical and graphical approach. (L4).	

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2260335: HEAT TRANSFER

B.Tech. III Year II Sem

PRE-REQUESTS: Mathematics & Thermodynamics

L	T	P	C
3	0	-	3

COURSE OBJECTIVES :

- To make the student understand the heat transfer through conduction.
- To make the student calculate the heat transfer rate in convection.
- To make the student determine the overall heat transfer coefficient in heat exchangers.
- To enable the student to understand the phenomena of two stage heat transfer.
- To make the student to evaluate the heat transfer by radiation.

COURSE OUTCOMES :

At the end of the Course, Student will be able to:

- Estimate the heat transfer rate through conduction in various bodies.(L5)
- Determine the convective heat transfer coefficient in various bodies.(L4)
- Analyze the heat transfer rate through free convection invarious bodies.(L4)
- Calculate the heat transfer coefficient during boiling and condensation and also the performance of heat exchanger.(L4)
- Evaluate the shape factor and heat transfer rate throughradiation.(L5)
- Design of heat exchangers using LMTD and NTE methods.(L5)

UNIT–1 **HOURS :12**

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

LEARNING OUTCOME :

1. Understand the basic laws of heat transfer. (L2)
2. Analyze problems involving steady state heat conduction in simple geometries.(L4)

UNIT – 2	HOURS :10
One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature **One Dimensional Transient Conduction Heat Transfer:** Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi infinite body.	
LEARNING OUTCOME : 1. Understand the fundamentals of convective heat transfer process.(L2) 2. Evaluate heat transfer coefficients for forced convection inside ducts and exterior surfaces.(L5)	
UNIT – 3	**HOURS :10**
Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers . **Forced convection: External Flows:** Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders. **Internal Flows:** Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.	
LEARNING OUTCOME : 1. Obtain numerical solutions for thermal boundary layer.(L5) 2. Evaluate heat transfer coefficients for natural convection.(L5)	
UNIT – 4	**HOURS :8**
Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes. **Heat Exchangers:** Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.	
LEARNING OUTCOME : 1. Evaluation of heat transfer through pipes and plates.(L5) 2. Analyze heat exchanger performance by using the method of heat exchanger effectiveness. (L4)	

UNIT – 5 RADIATION HEAT TRANSFER	HOURS :10

Heat Transfer with Phase Change:

Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling

Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

Radiation Heat Transfer : Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks

LEARNING OUTCOME :

1. Calculate radiation heat transfer between black body surfaces.(L3)
2. Calculate radiation heat exchange between gray body surfaces.(L3)

TOTAL PERIODS:50

TEXT BOOK :

1. Fundamentals of Engg. Heat and Mass Transfer, R.C.Sachdeva, NewAge International Publications/5th edition.
2. Heat Transfer, P.K.Nag, TMH Publications/3rd edition.

REFERENCE BOOK :

1. Heat Transfer, J. P. Holman, TMH Publications/ Special Indianedition.
2. Principles of Heat Transfer, Frank Kreith, R. M. Manglik& M. S. Bohn, Cengage learning publisher/ Specialedition.
3. Heat and Mass Transfer, D.S.Kumar,'S.K.Kataria& Sons Publications/3rd edition.

Note: Heat and Mass transfer Data Book by C P Kothandaraman and Subrahmanyan is used to design and analyze various thermal processes and thermal equipment

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2260302: ROBOTICS

(Open Elective II)

B.Tech. III Year II Sem

L	T	P	C
3	0	0	3

Pre-requisites: Basic principles of Kinematics and mechanics

COURSE OBJECTIVES

1. To familiarize the students with the concepts and techniques in robotic engineering.
2. To understand manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.
3. Make the students acquainted with the theoretical aspects of Robotics .
4. Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
5. Make the students to understand the importance of robots in various fields of engineering.
6. Expose the students to various robots and their operational details.

COURSE OUTCOMES: After completion of the course the student is able to

1. Understand the basic components of robots. (L1)
2. Understand the Differentiate types of robots and robot grippers. (L2)
3. Modeling of forward and inverse kinematics of robot manipulators. (L3)
4. Knowledge of working principle of wind energy systems. (L2)
5. Analyze forces in links and joints of a robot. (L4)
6. Programme a robot to perform tasks in industrial applications and Design intelligent robots using sensors. (L3)

UNIT – 1 **CLASSES:08**

Introduction: Automation and Robotics – An over view of Robotics – present and future applications.
Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors,
Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

LEARNING OUTCOME:

1. Knowledge on Architecture, Design end effectors. (L2)

UNIT – 2 **CLASSES:12**

Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems.
Manipulator Kinematics: H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

LEARNING OUTCOME:

1. Understanding the motion analysis and manipulator kinematics. (L1)

UNIT – 3	CLASSES :10
Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.	
LEARNING OUTCOME: 1. Understanding the transformation of manipulators and Euler formulations, trajectory planning. (L4)	
UNIT – 4	**CLASSES :10**
Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools	
LEARNING OUTCOME: 1. Knowledge on Robot Actuators and feedback components. (L2)	
UNIT – 5	**CLASSES :08**
Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading Processing - spot and continuous arc welding & spray painting - Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.	
LEARNING OUTCOME: 1. Acquire the knowledge on application in Manufacturing. (L2)	
TEXT BOOKS: 1. Industrial Robotics / Groover M P /Mc Graw Hill 2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson.	
REFERENCE BOOKS: 1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley 2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science 3. Robotics – Fu et al / TMH Publications.	

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2260355: UNCONVENTIONAL MACHINING PROCESS
(Professional Elective-II)

B.Tech. III Year II Sem

L	T	P	C
3	-	-	3

PRE-REQUISITES: Engineering Physics, Mathematics, Engineering chemistry, Mechanics of solids& Metallurgy and material science

COURSE OBJECTIVES
- Understand the need and importance of non-traditional machining methods and process selection.
- Gain the knowledge to remove material by thermal evaporation, mechanical energy process.
- To teach the effects of tool geometry on machining force components and surface finish.
- To teach the machining surface finish and material removal rate.

COURSE OUTCOMES:
1. Understand the basic techniques of Unconventional Machining processes modeling.
2. Summarize the principle and processes of abrasive jet machining.
3. Understand the principles, processes and applications of thermal metal removal processes.
4. Identify the principles, processes and applications of EBM.
5. Understand the principles, processes and applications of Plasma Machining.
6. Knowledge of electric equipment required for effective running of EDM with the complexity of power losses and economy.

Tables/Codes: Steam Tables and Mollier Chart

UNIT – 1 **CLASSES:12**

Introduction – Need for non-traditional machining methods-Classification of modern machining processes – considerations in process selection. Materials. Applications. Ultrasonic machining – Elements of the process, mechanics of metal removal process, parameters, economic considerations, applications and limitations, recent development. Abrasive Jet Machining, Water Jet Machining and Abrasive Water Jet Machining: Basic principles, equipment, process variable, and mechanics of metal removal, MRR, application and limitations.

LEARNING OUTCOME:
1.To understand the abrasive jet machining water and water jet machining process (L2)
2. Classify the modern machining process (L2)

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UNIT – 2	CLASSES:10
Electro – Chemical Processes: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring processes, metal removal rate in ECM, Tool design, Surface Finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate. Chemical machining.	
LEARNING OUTCOME: 1. Examine electro chemical process (L4) 2. To solve the problems in metal removal rate for ECM process (L2)	

UNIT – 3	CLASSES :12
Thermal Metal Removal Processes: Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.	
LEARNING OUTCOME: 1. To gain knowledge on thermal metal removal process like electric discharge machining, wire electric discharge machining and laser beam machining (L3) 2. Describe the process of EBM and Ion beam machining. (L1)	
UNIT – 4	**CLASSES :08**
Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological is finishing, Magneto rheological abrasive flow finishing.	
LEARNING OUTCOME: 1. Compare the process of abrasive flow machining and magnetic abrasive finishing (L4). 2. Ability to analyze Magnetorheological finishing and Magnetorheological abrasive flow finishing. (L4).	

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UNIT – 5	CLASSES :08
Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.	
LEARNING OUTCOME: 1. Study the various hybrid non-traditional machining processes its advantages and limitations (L2) 2. Compare different non-traditional machining process. (L4)	
TEXT BOOK: 1. Advanced Machining Processes / VK Jain / Allied publishers / 1st Edition 2. 2. Modern Machining Processes - P. C. Pandey, H. S. Shan/ Mc Graw Hill / 1st Edition	
REFERENCE BOOK: 1. Fundamentals of machining process/ Hassan Abdel-Gawad El-Hofy / 2nd Edition 2. Advanced Methods of Machining/ J.A. McGeough/ Springer International /1st Edition 3. Non-Traditional Manufacturing Processes/ Benedict G.F./ CRC Press/1st Edition	

2260356: METAL FORMING TECHNOLOGY
(Professional Elective-II)

B.Tech. III Year II SEM

L	T	P	C
3	0	0	3

PRE-REQUISITES: PRODUCTION TECHNOLOGY

COURSE OBJECTIVES

- To expose the students to fundamentals of forming process and to provide the insight into classification and advances.
- Toimpart the fundamentals of forging and rolling and the principles of their advanced processes along with their application.
- To provide the understanding of principles, classification and defects in drawing and extrusion process.
- To impart the basic knowledge on sheet metal forming processes.
- Toprovideatechnicalunderstandingofrecent advances inmetalformingprocesseslikesuper plastic forming, hydro forming, CAD and CAM in forming.

COURSE OUTCOMES:

After the completion of this course, students will be able to:

- To understand the fundamental mechanics of metal forming processes
- To learn the principle, classification, equipments used and applications of Rolling and Forging Processes
- To learn the principle, classification, equipment's used and applications of Extrusion and Drawing Processes
- To understand the principle, procedure of various sheet metal forming processes
- To study about the recent advances in technology for metal forming.

UNIT – 1 **CLASSES:10**

FUNDAMENTALS OF METAL FORMING

State of stress – Components of stress, symmetry of stress tensor, principal stresses – Stress deviator – von-mises, Tresca yield criteria – Octahedral shear stress and shear strain theory – Flow stress determination – Temperature in metal forming – Hot, cold and warm working – strain rate effects – metallurgical structures – residual stresses – Spring back.

LEARNING OUTCOME:

- Understand the fundamentals of forming.(L2)
- Able to calculate the stresses in forming process.(L5)

UNIT – 2	CLASSES:09
FORGING AND ROLLING Principle – classification – equipment – tooling – processes parameters and calculation of forces during forging and rolling processes – Ring compression test - Post forming heat treatment – defects (causes and remedies) – applications – Roll forming.	
LEARNING OUTCOME: • Identify the type of forging and rolling process based on the material given (L1). • Interpret the forming defect and its cause (L6).	

UNIT – 3	CLASSES :09
EXTRUSION AND DRAWING PROCESSES Classification of extrusion processes – tool, equipment and principle of these processes – influence of friction – extrusion force calculation – defects (causes and remedies) – Rod/Wire drawing – tool, equipment and principle of processes – defects – Tube drawing and sinking processes – Mannesmann process of seamless pipe manufacturing – Tube bending.	
LEARNING OUTCOME: • Understand the extrusion and drawing process(L2). • Differentiate the types ofdrawing process and their application (L4).	
UNIT – 4	**CLASSES :10**
SHEET METAL FORMING PROCESSES Classification – conventional and HERF processes – presses – types and selection of presses – formability studies – FLD, Limiting Draw ratio - processes: Deep drawing, spinning, stretch forming, plate bending, Rubber pad forming, bulging and press brake forming – Explosion forming, electro hydraulic forming, Magnetic pulse forming.	
LEARNING OUTCOME: • Understandbasics in spinning and deep drawing(L2) • Concludetheprocessparameterinvarioussheet metal forming methods(L3)	

UNIT – 5 **CLASSES :09**

RECENT ADVANCES

Super plastic forming – Electro forming – fine blanking – Hydro forming – Peen forming – Laser Forming – Micro forming - P/M forging – Isothermal forging – high speed hot forging – near net shape forming high velocity extrusion – CAD and CAM in forming.

LEARNING OUTCOME:

- Identifythedifferenttypesofadvanced formingprocesses.(L4)
- Explain thevarioustypesofoperationscarriedout informing.(L2)

TEXT BOOK:

1. Dieter G.E., "Mechanical Metallurgy", McGraw Hill, Co., S.I. Edition, 2001

2. Nagpal G.R. "Metal forming processes", Khanna publishers, New Delhi, 2004

REFERENCE BOOK:

1. SeropeKalpakjian, Steven R Schmid, "Manufacturing Process for Engineering Materials", 4th Edition, Pearson Education, 2003.
2. Rao, P.N. "Manufacturing Technology", TMH Ltd., 2003
3. Edward M.Mielink, "Metal working Science Engineering", McGraw Hill, Inc, 2000.
4. Metal Handbook Vol.14, "Forming and Forging", Metal Park, Ohio, USA, 1990

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2260357: PRODUCTION PLANNING AND CONTROLL

(Professional Elective-II)

B.Tech. III Year ISem

L	T	P	C
3	0	0	3

Pre-requisites: Extracting the Type of Materials Required, Machine Utilization, Numbers of Workers Required Etc.

COURSEOBJECTIVES

- To understand the problems and opportunities faced by the operations manager in manufacturing and service organizations.
- To develop an ability to apply PPC concepts in a various areas like marketing, accounting, finance, engineering, personnel management, logistics, etc.
- To integrate operations concepts with other functional areas of business
- To understand the PPC function in both manufacturing and service organizations.
- To examine several classic Operations Management planning topics including production planning and inventory control.
- To learn several important contemporary topics relevant to business managers of all functional disciplines, including quality management, lean concepts, and sustainability

COURSEOUTCOMES: After completion of the course the student is able to

1. Recognize the objectives, functions, applications of PPC and forecasting techniques.
2. Explain different Inventory control techniques.
3. Solve routing and scheduling problems
4. Summarize various aggregate production planning techniques.
5. Describe way of integrating different departments to execute PPC functions

UNIT–I **CLASSES:12**

Introduction: Definition – Objectives of Production Planning and Control – Functions of production planning and control– Types of production systems– Organization of production planning and control department.

Forecasting – Definition- uses of forecast- factors affecting the forecast- types of forecasting- their uses – generalprincipleofforecasting.Forecastingtechniques-quantitativeandqualitativetechniques.Measuresofforecastingerrors.

LEARNINGOUTCOME:

1. Know about production, planning and control(L1)
2. Various factors affecting PPC(L2)

UNIT-2	CLASSES:8
Inventory management – Functions of inventories – relevant inventory costs – ABC analysis – VED analysis–Basic EOQ model- Inventory control systems –continuous review systems and periodic review systems, MRP I, MRP II, ERP, JIT Systems – Basic Treatment only. Aggregate planning – Definition – aggregate-planning strategies –aggregate planning methods–transportation model.	
LEARNINGOUTCOME: 1.Varioustypesofproductionsystems(L1)_	
2.Variouscharatesticsofthe production system(L2)	

UNIT–III	CLASSES:10
Line Balancing: Terminology, Methods of Line Balancing, RPW method , Largest Candidate method and Heuristic method. Routing–Definition–Routingprocedure–Factorsaffectingroutingprocedure,RouteSheet.	
LEARNINGOUTCOME: 1. Know about the process planning 2.Various characteristics of process planning	
UNIT–IV	**CLASSES:10**
Scheduling–Definition–SchedulingPolicies–typesofschedulingmethods –differences with loading flow shop scheduling–job shop scheduling, line of balance (LOB)– objectives– steps involved.	
LEARNING OUTCOME: 1. Know about Routing(L3) 2. **Understand the role of the scheduler, and how its behavior** influences the performance of the system. (L1).	

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UNIT-V	CLASSES:08
Dispatching: Definition–activitiesofdispatcher–dispatchingprocedures–variousformsusedindispatching. Follow up: definition – types of follow up – expediting – definition – expediting procedures-Applications of computers in planning and control.	
LEARNING OUTCOME: **1.**Variouscharacteristicsofdispatching.(L2) 2. Becoming a public safety **dispatcher** means choosing **dispatching** not only as a career, but as a moral commitment to maintain public trust.(L1)	
TEXTBOOKS: 1. Operations management–Heizer-Pearson. 2. Production and Operations Management/ AjayKGarg /McGrawHill.	
REFERENCEBOOKS: 1. Production Planning and Control- Text & cases/ SK Mukhopadhyaya /PHI.ProductionPlanningandControl- Jain &Jain– Khannapublications.	

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2260358: FLEXIBLE MANUFACTURING SYSTEMS (FMA)
(Professional Elective-II)

B.Tech. III Year II SEM

L	T	P	C
3	0	-	3

PRE-REQUISITES: None

COURSE OBJECTIVES

1. Understanding of modern trends in design and manufacturing using CAD/CAM.
2. Apply performance analysis techniques.
3. Understand preventive maintenance procedures in manufacturing.
4. Design models for manufacturing systems
5. Apply the concept of system design procedures to different levels of production.

COURSE OUTCOMES:

1. Describe the basic concepts of FMS (L2)
2. Explain the FMS computer control (L2)
3. Illustrate the computer control of the work center and assembly lines (L3)
4. Interpret the simulation software (L3)
5. Knowledge on group technology (L3)
6. Applications of FMS in various fields (L3)

UNIT – 1 **CLASSES:09**

Introduction to FMS– development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility –single product, single batch, n – batch scheduling problem – knowledge based scheduling system.

LEARNING OUTCOME:

After successful completion of the unit, students can able to understand

- Describe the developments of manufacturing systems(L2)
- Explain the importance of FMS (L2)

UNIT – 2 **CLASSES:09**

Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends.

LEARNING OUTCOME:

After successful completion of the unit, students can able to understand

- Analyze the FMS computer control (L4)
- Describe the software specifications of FMS (L2)

UNIT – 3	**CLASSES :09**
Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database.	
LEARNING OUTCOME: After successful completion of the unit, students can able to understand • Explain the simulation model for FMS (L2) • Describe FMS database systems (L2)	
UNIT – 4	**CLASSES :09**
Introduction – matrix formulation – mathematical programming formulation –graph formulation – knowledge based system for group technology – economic justification of FMS- application of possibility distributions in FMS systems justification.	
LEARNING OUTCOME: After successful completion of the unit, students can able to understand • Describe the mathematical programming formulation(L2) • knowledge on group technology (L3)	
UNIT – 5	**CLASSES :09**
FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.	
LEARNING OUTCOME: After successful completion of the unit, students can able to understand • Applications of FMS in various fields(L3) • Assess the future of FMS(L5)	

TEXT BOOK:

1. Jha, N.K. "Handbook of Flexible Manufacturing Systems", Academic Press Inc., 1991.
2. Radhakrishnan P. And Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New AgeInternational Ltd., 1994.

REFERENCE BOOK:

1. Raouf, A. And Ben-Daya, M., Editors, "Flexible Manufacturing Systems: Recent Development",
   Elsevier Science, 1995.
2. Groover M.P., "Automation, Production Systems And Computer Integrated Manufacturing", Prentice Hall Of India Pvt., New Delhi, 1996.

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2260385: HEAT TRANSFER LAB

B.Tech. III Year II Sem | **L T P C**
PRE-REQUESTS: Mathematics & Thermodynamics | **- - 2 1**

COURSE OBJECTIVES :

- To demonstrate the concepts discussed in the Heat Transfer course
- To experimentally determine thermal conductivity and heat transfer coefficient through various materials..
- To experimentally measure effectiveness of heat exchangers.
- To experimentally measure Stefan Boltzmann constant...

COURSE OUTCOMES:

- Applications of concepts of Conduction Convection &Radiation Principles.
- Calculation of thermal conductivity Heat Transfer Coefficient of various experiments.
- Calculation of Heat Transfer Coefficient of various experiments.
- Analyzing the Performance parameters of Heat Exchanger.
- Evaluation of Emissivity of Real Surfaces.
- Assessment of Stefen Boltz's mann Constant.

LIST OF EXPERIMENTS :

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin
6. Determination of heat transfer coefficient in forced convection
7. Determination of heat transfer coefficient in natural convection.
8. Determination of effectiveness of parallel and counter flow heat exchangers.
9. Determination of emissivity of a given surface.'
10. Determination of Stefan Boltzmann constant.
11. Determination of heat transfer rate in drop and film wise condensation.
12. Determination of critical heat flux.
13. Demonstration of heat pipe.
14. Determination of Heat transfer coefficient and instantaneous heat transfer for transient heat conduction.

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2250331: DYNAMICS OF MACHINERY

B.Tech. III Year I Sem | **L T P C**
PRE-REQUISITES: Kinematics of Machinery | **3 1 0 4**

COURSE OBJECTIVES

- To impart the knowledge of basic concepts on gyroscopic couple and its effect on aero plane, ship, two and four wheel drive.
- To illustrate the mathematical models used in static and dynamics of machinery.
- To Impart the knowledge of Various Governors, Brakes and operation of Dynamometers.
- To facilitate the students to know the concepts of balancing of rotating masses and reciprocating masses.
- To introduce mathematical models and solution methods to study Vibration of the mechanical systems.

COURSE OUTCOMES : After completion of the course the student is able to

- Analyze complete motion analysis of machines in running condition and able to know friction and its effect on mechanical efficiency.(L2)
- Outline various mechanisms of machines which were used in real life and explain how to get equilibrium condition of machine members while the machine is in running condition.(L2)
- Apply the knowledge regarding use of turning moment diagram and energy fluctuations with in systems.(L3)
- Explain how to balance forces and moments produced by rotating or reciprocating masses of machine members.(L2)
- Analyze the vibrations, which is the major disturbance in machines while in the running condition and also precautions to reduce vibration. (L4)
- Illustrate various Governors, Brakes and operation of Dynamometers. (L2)

UNIT – 1 **CLASSES:10**

Gyroscopes:Introduction,Precision,angular motion, Gyroscopic couple,effect of gyroscopic couple on an aeroplane, effect of gyroscopic couple on a naval ship during steering, gyroscopic couple on a naval ship during pitching, Gyroscopic couple on a naval ship during rolling, stability of a four wheel drive moving in a curved path, stability of a two wheel vehicle taking a turn.

LEARNING OUTCOME:

1. Discuss basic concepts on gyroscopic couple and its effect on aero plane, ship, two and four wheel drive.(L1).
2. Applying concepts in calculating precision and determining the effect of gyroscope.(L3).

UNIT – 2	CLASSES:12
Static Force Analysis: Introduction, Static Equilibrium, Equilibrium of Two force and three force members, Member with Two force **Dynamic Force Analysis**: Introduction, D'Alemberts principle, Dynamic analysis of Four bar and Single slider mechanisms, Piston effort, Turning moment on crankshaft, Inertia of connecting rod, Inertia forces in reciprocating Engines.	
LEARNING OUTCOME: 1. Apply D'Alemberts principle for dynamic analysis in calculating forces on engine. (L3) 2. Apply two force and three force equilibrium in calculating forces in static condition. (L3)	
UNIT – 3	**CLASSES :10**
Governors: Introduction, types of governors, Watt governor, Porter governor, Proell governor, Hartnell governor, Sensitiveness of governor, Hunting, Isochronism, Stability, effort of governor, Power of governor, **Brakes and Dynamometers:** Types of brakes: Simple block brake,band and block brake,internal expanding shoe brake-effect of braking of a vehicle. Dynamometers-absorption and transmission types. General description and methods of operation.	
LEARNING OUTCOME: 1. Calculate the effectiveness of various governors and understand its applications(L3) 2. Understand the concept of dynamometers and its working (L2)	
UNIT – 4	**CLASSES :10**
Balancing of Rotating Masses: Introduction-Balancing of single rotating mass in same and different plane,balancing of several masses rotating in same and different plane. **Balancing of Reciprocating Masses:** Primary,Secondary,and higher balancing of reciprocating masses, graphical methods.Unbalanced forces and couples,examination of"V"multi cylinder inline and radial engines for primary and Secondary balancing, locomotive balancing Hammer blow, Swaying couple, variation of tractive efforts.	
LEARNING OUTCOME : 1. Calculating balancing of rotary and reciprocating masses. (L3). 2. Understand the concept of balancing various engines. (L2).	

UNIT – 5	CLASSES :10

Vibrations: Free Vibration of mass attached to vertical spring–Transverse loads–vibrations of beams with concentrated and distributed loads.Dunkerly's method. Whirling of shafts–critical speed–torsional vibrations–one,two and three rotor systems.

LEARNING OUTCOME :

1. To analyze torsional vibrations occur during running condition (L3).
2. To understand various disturbances in machines during vibrations and precautions to reduce it.(L2).

Textbooks:

1. Theory of Machines/S.SRatan/Mc.GrawHillPubl./ 5th Edition.
2. Theory of machines/Khurmi/S.Chand./ 14th Edition.

REFERENCE BOOK :

1. Theory of Machines by Thomas Bevan/CBS/ 3rd Edition.
2. Theory of Machines/R.K Bansal/ 4th Edition.
3. Theory of Machines Sadhu Singh Pearson's/ 3rd Edition.
4. Mechanism and Machine Theory/JSRao and RVDukkipati/NewAge/2nd Edition.

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2250332: DESIGN OF MACHINE ELEMENTS

B.Tech. III Year I Sem

L	T	P	C
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PRE-REQUISITES: Study of engineering mechanics and theory of machines.

COURSE OBJECTIVES

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

1. Designing machine members subjected to static and variable loads.
2. Designing shafts and couplings for various applications.
3. Analyzing bolted and welded joints for various kinds of loads.
4. Designing helical and leaf springs for various applications.
5. Analyzing Riveted and cotter joints for various kinds of loads.

COURSE OUTCOMES:

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

1. Designing machine members subjected to static and variable loads.
2. Gain knowledge about failure of machine elements
3. Designing shafts and couplings for various applications.
4. Analyzing bolted and welded joints for various kinds of loads.
5. Designing helical, leaf springs and flywheels for various applications.
6. Designing of Riveted and cotter joints for various kinds of loads.

Note: (Use of standard Design Data Book is permitted in the University examination)

UNIT – 1 FUNDAMENTAL CONCEPTS IN DESIGN CLASSES:10

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers- Direct, Bending and torsional loading - Factor of safety – Combined loads – Principal stresses – Eccentric loading –theories of failure – Design based on strength and stiffness – stress concentration – Fluctuating stresses – Endurance limit- Gerber's curve– Goodman's line– Soderberg's line. –Design for finite and infinite life under variable loading.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

- Understand importance of design concept. (L2)
- Understand the design process and various theories given by experts. (L2)

UNIT – 2TEMPORARY AND PERMANENT JOINTS- ICLASSES:09

RivetedJoints: Riveted joints- methods of failure of riveted joints-strengthequations-efficiency of riveted joints-eccentrically loaded riveted joints.

Welded joints-Design of fillet welds-axial loads-circular fillet welds under bending, torsion. Welded jointsunder eccentric loading.

Power screws: – types of screw - Design of screw fasteners – screw subjected to initial tightening- screw subjected to external load, tensile load, shear load, combined load - Design of joints under eccentric loading – lockingdevices.

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LEARNING OUTCOME:

After successful completion of the unit, students can

- **Illustrate design procedures for various joints. (L2)**
- **Make use of those design procedures in modeling components.(L3)**

UNIT – 3 TEMPORARY AND PERMANENT JOINTS-II **CLASSES :09**

Keys, Cotters and Knuckle Joints: Design of keys-stresses in keys-cottered joints-spigot and socket, sleeve and cotter, Gib and cotter joints-Knuckle joints.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Illustrate design procedures for various joints. (L2)
- Make use of those design theories in modelling components in design software.(L3)

UNIT – 4 ENERGY STORING ELEMENTS CLASSES :08

Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs – Flywheel - coefficient of fluctuation of speed – Fluctuation of Energy – Maximum Fluctuationenergy - coefficientof Fluctuationenergy – energy stored in a flywheel -Flywheels considering stresses in rims and arms.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Illustrate design procedures for shafts and couplings. (L2)
- Make use of those design theories in assembling shafts and couplings in design soft wares. (L3)

UNIT – 5 SHAFTS AND COUPLINGS CLASSES :09

Shafts and Axles - Design of solid and hollow shafts based on strength, rigidity and critical speed – – Rigid coupling- Muff, Clamp and Flange couplingsand flexible couplings -Bushed Pin.

LEARNING OUTCOME:

After successful completion of the unit, students can

- Illustrate design procedures for shafts and couplings. (L2)
- Make use of those design theories in assembling shafts and couplings in design soft wares. (L3)

TEXT BOOK:

1. Shigley. J., Mischke. C., Budynas, R., and Nisbett. K., "Mechanical Engineering Design", 10 th Edition, Tata McGraw-Hill, 2014.
2. Bhandari V, "Design of Machine Elements", 15th Reprint, Tata McGraw-Hill Book Co, 2014 R2. New Technology – Bhattacharya A, The Institution of Engineers, India 1984.

REFERENCE BOOK:

1. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine component Design",6th Edition, Wiley, 2017.
2. Md. Jalaludeen , Machine Design, Volume II, Design of Transmission Systems, 4th edition, Anuradha Publications, 2014.
3. C.S.Sharma, KamleshPurohit, "Design of Machine Elements", 1st editionPrentice Hall of India,Pvt. Ltd., 2004.

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2250301: ELEMENTS OF MECHANICAL ENGINEERING
(Open Elective-I)

B.Tech. IIIYear I Sem

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. Basic machine elements.
2. Sources of Energy and Power Generation.
3. Various manufacturing processes.
4. Power transmission elements, material handling equipment.
5. The content of this course shall provide the student the basic concepts of various mechanical systems and exposes th student to a wide range of equipment and their utility in a practical situation.
6. It shall provide the fundamental principles of materials, fuels, Steam, I.C. Engines, and transmission systems that usuall exist in any process plant.

COURSE OUTCOMES : After completion of the course the student is able to

1. Understand basics Concepts and usage of various engineering Materials. (L_1)
2. Apply cam terminologies for design of cam profiles. (L_3)
3. Explain the fundamental definitions used in thermodynamics. (L_2)
4. To Gain Knowledge about IC Engines, general principles and requirement for refrigeration, manufacturing. (L_1)
5. Apply the knowledge of various manufacturing processes; identify various processes like welding, Brazing and soldering. (L_4)
6. Use the knowledge gained by the study of Metal Removal process, using Lathe Drilling Milling Robotics and Automation. (L_5)

Tables/Codes: Steam Tables and Mollier Chart

UNIT – 1 **CLASSES:12**

Introduction to engineering materials-Metals, ceramics, composites-Heat treatment of metals.
Riveted joints- methods of failure of riveted joints-strength equations-efficiency of riveted joints - eccentrically loaded riveted joints.
Machine Elements: Cams: Types of cams and followers

LEARNING OUTCOME:

1. Knowledge of physical properties of materials. (L_1)
2. Apply cam terminologies for design of cam profiles. (L_3)

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UNIT – 2	CLASSES:10
Power Transmission Elements: Gears terminology of spur, helical and bevel gears, gear trains. Belt drives (types). Chain drives. **Material Handling equipment:** Introduction to Belt conveyors, cranes, industrial trucks, bull dozers **Thermodynamics:** Statements of zeroth law, 1st, 2nd and 3rd Laws of thermodynamics with their applications.	
LEARNING OUTCOME: 1. Apply first law of thermodynamics for closed systems and construct conservation of mass and energy equations (L3) 2. Understand the standard geometry, application, failures of Spur and Helical Gear and Design and Developed effectively Gears for different loading conditions. (L_4)	

UNIT – 3	CLASSES :12
Energy: Power Generation: External and internal combustion engines (layouts, element/component description, advantages, disadvantages, applications). **Refrigeration:** Mechanical Refrigeration and types – units of refrigeration – Air Refrigeration system, details and principle of operation –calculation of COP. **Modes and mechanisms of heat transfer** – Basic laws of heat transfer –General discussion about applications of heat transfer.	
LEARNING OUTCOME: 1. To acquire knowledge of thermal efficiency and coefficient of performance for heat engine, refrigerators. (L2) 2. Students will demonstrate an understanding of the basic concepts of conduction, radiation, and convection heat transfer. (L3)	
UNIT – 4	**CLASSES :08**
Manufacturing Processes: Sheet Metal Work: Introduction – Equipments – Tools and accessories – Various processes (applications, advantages / disadvantages). **Welding:** Types – Equipments –Techniques employed –welding positions-defects-applications, advantages / disadvantages – Gas cutting – Brazing and soldering.	
LEARNING OUTCOME : 1. Understand different tools used in sheet metal work process based on industrial applications. (L3). 2. Apply knowledge to select appropriate welding process based on the type of industrial application. (L3)	

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UNIT – 5	CLASSES :08

Casting: Types, equipments, applications.
Machine Tools: Introduction to lathe, drilling machine, milling machine, grinding machine-Operations performed.

LEARNING OUTCOME :

1. Analyze the use of casting processes in manufacturing. (L_4)
2. Knowledge gained by the study of Metal Removal process, using Lathe Drilling and Milling. (L_5)

TEXT BOOK :

1. Kumar, T., Leenus Jesu Martin and Murali, G., Basic Mechanical Engineering, Suma Publications, Chennai /Ist Edition 2007.
2. K.R, Gopalakrishna Sudhir, Gopalakrishna S.C, Sharma, Elements of Mechanical Engineering /9th Edition 2005.

REFERENCE BOOK :

1. Prabhu, T. J., Jai Ganesh, V. and Jebaraj, S., Basic Mechanical Engineering, SciTech Publications, Chennai/ 7th Edition 2000.
2. Hajra Choudhary, S.K. and Hajra Choudhary, A. K., Elements of Workshop Technology Vols. I & II, Indian Book Distributing Company Calcutta/ 12th Edition 2007.
3. Nag, P.K., Power Plant Engineering, Tata McGraw-Hill, New Delhi, 2008. 4. Rattan, S.S., Theory of Machines, Tata McGraw-Hill, New Delhi/4th Edition 2010.

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2250351: RENEWABLE ENERGY SOURCES
(Professional Elective-I)

B.Tech. III Year I Sem

L	T	P	C
3	0	0	3

Pre-requisites: -

COURSE OBJECTIVES

1. To explain the concepts of Non-renewable and renewable energy systems.
2. To outline utilization of renewable energy sources for both domestic and industrial applications.
3. To analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.
4. Understand the various forms of conventional energy and renewable energy resources.
5. Learn the present energy scenario and the need for energy conservation.
6. Outline division aspects and utilization of renewable energy sources for both domestics and industria application.

COURSE OUTCOMES: After completion of the course the student is able to

1. Understanding of renewable energy sources. (L1)
2. Understand the principles that underlie the ability of various natural phenomena to deliver solar energy. (L2)
3. Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications. (L3)
4. Knowledge of working principle of wind energy systems. (L2)
5. The students are expected to identify the new methodologies / technologies for effective utilization of renewable energy sources. (L4)
6. Capability to carry out basic design of renewable energy systems. (L5)

UNIT – 1 **CLASSES:08**

Introduction: Global and National Energy Scenario: Over view of conventional & renewable energy sources, need & development of renewable energy sources, types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Renewable and Non-renewable Energy sources, Energy for sustainable development, Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy- concept of Hybrid systems.

LEARNING OUTCOME:

1. Understanding of renewable energy sources. (L1)
2. Knowledge of working principle of various energy systems. (L2)

UNIT – 2	CLASSES:12
Solar Energy: Solar energy system, Solar Radiation, Availability, Measurement and Estimation, Solar Thermal Conversion Devices and Storage, Applications Solar Photovoltaic Conversion solar photovoltaic, solar thermal, applications of solar energy systems.	
LEARNING OUTCOME: 1. Outline the technologies that are used to harness the power of solar energy. (L1) 2. Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment. (L2)	

UNIT – 3	CLASSES :10
Wind Energy: Wind Energy Conversion, Potential, Wind energy potential measurement, Site selection, Types of wind turbines, Wind farms, wind Generation and Control. Nature of the wind, power in the wind, factors influencing wind, wind speed monitoring, classification of wind-characteristics, applications of wind turbines, Betz limit, site selection, wind energy conversion devices. Wind mill component design. Safety and environmental aspects, wind energy potential and installation in India.	
LEARNING OUTCOME: 1. Ability to analyze the viability of wind energy projects. (L4) 2. Capability to integrate various options and assess the business and policy environment regarding wind energy projects.(L6)	
UNIT – 4	**CLASSES :10**
Biogas: Properties of biogas (Calorific value and composition), biogas plant technology and status, Bio energy system, design and constructional features. Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion, direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, types of biogas Plants, applications, alcohol production from biomass, bio diesel production, Urban waste to energy conversion, Biomass energy programme in India.	
LEARNING OUTCOME: 1. Understand the concept of Biomass energy resources and their classification, types of biogas Plants-applications. (L2) 2. To increase the renewable energy production from **biogas** with small-scale. (L3)	

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UNIT – 5 **CLASSES :08**

Other Renewable Energy Sources:

1. Ocean Energy: Ocean wave energy conversion, principle of Ocean Thermal Energy Conversion (OTEC), ocean thermal power plants, tidal energy conversion, Tidal and wave energy its scope and development, Scheme of development of tidal energy.

2. Small hydro Power Plant: Importance of small hydro power plants and their Elements, types of turbines for small hydro, estimation of primary and secondary power.

3. Geothermal Energy: Geothermal power plants, various types, hot springs and steam ejection.

LEARNING OUTCOME:

1. Acquire the knowledge wave power, tidal power and geothermal principles and applications. (L2)
2. Discuss the environmental effects of hydropower installations. (L2)

TEXT BOOKS:

1. Non-Conventional Energy Sources / G.D Rai/ Khanna Publishers
2. Renewable Energy Sources / Twidell, J.W. and Weir, A./ EFN Spon Ltd., 1986.

REFERENCE BOOKS:

1. Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi, 2012
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.

2250352: ELECTRICAL AND HYBRID VEHICLES

(Professional Elective-I)

B.Tech. III Year I Sem

L	T	P	C
3	0	0	3

PRE-REQUISITES: Basic knowledge of electrical engineering.

COURSE OBJECTIVES

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

- Understand the design requirements of electrical vehicles.
- Understand the energy sources like fuel cells
- Analyze the power converters and controls.
- Understand the main elements of hybrid electrical vehicles.
- Understand Case study on specification of electric and hybrid vehicles.

COURSE OUTCOMES:

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

- Understand the operation and architecture of electric and hybrid vehicles
- Identify various energy source options like battery and fuel cell
- Select a suitable electric motor for applications in hybrid and electric vehicles.
- Explain the role of power electronics in hybrid and electric vehicles
- Analyze the energy and design requirements for hybrid and electric vehicles.

UNIT-1 Design considerations for electric vehicles

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand the Design requirements for electric vehicles. (L2)
2. Understand the importance of hybrid vehicles. (L2)

UNIT-2 Energy Sources
Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand various energy source options like battery and fuel cell. (L2) 2. Understand the Battery Management System. (L2)

UNIT III POWER CONVERTERS AND CONTROLLERS
Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand the power converters and controls. (L2) 2. Understand Solid state Switching elements and characteristics. (L2)
UNIT IV HYBRID AND ELECTRIC VEHICLES
Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand design requirements for hybrid and electric vehicles. (L2) 2. Understand Economy of hybrid Vehicles. (L2)

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UNIT V	Energy Management Strategies

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand energy management strategies. (L2)
2. Understand various charging techniques. (L2)

TEXT BOOK:

1. Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005

REFERENCE BOOK:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley & Sons,2003
2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005
3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005

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2250353: OPERATION RESEARCH
(Professional Elective-I)

B.Tech. III Year I Sem

L	T	P	C
3	0	-	3

PRE-REQUISITES: None

COURSE OBJECTIVES:
This course will advance the students development of the following broad capabilities:
- To impart knowledge in concepts and tools of Operations Research
- To understand mathematical models used in Operations Research
- To apply these techniques constructively to make effective business decisions
- To apply various optimization techniques for decision making.
- To understand the mathematical importance of development of model in a particular optimization model for the issue and solving it.

COURSE OUTCOMES: At the end of the course, the student will be able to
- Understanding the problem, identifying variables & constants, Formulation of optimization model and applying appropriate optimization technique (L2, L3)
- Solve Linear Programming Problems (L3)
- Solve Transportation and Assignment Problems (L3)
- Understand the usage of game theory and its applications. (L3)
- Understand the concept of sequencing and replacement policies(L3)
- 6. Understand the dynamic programming applications to solve LPP. (L3)

UNIT – 1 **CLASSES:12**

Development – Definition– Characteristics and Phases – Types of models – Operations Research models – applications.

ALLOCATION: Linear Programming Problem - Formulation – Graphical solution – Simplex method – Artificial variables techniques: Big-M method,Two–phase method.

LEARNING OUTCOME:
1. Understanding the basic concepts of operations research. (L2)
2. Formulation of LPP and solving its methods. (L3)

UNIT – 2	CLASSES: 10
TRANSPORTATION PROBLEM: Formulation – Optimal solution, unbalanced transportation problem – Degeneracy. **Assignment problem:** Formulation – Optimal solution - Variants of Assignment Problem; Travelling Salesman problem.	
LEARNING OUTCOME: 1. Formulation of Transportation problem and finding the degeneracy (L3) 2. Solving the variations of Assignment problems (L3)	

UNIT – 3	CLASSES :08
SEQUENCING: Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through 'm' machines **REPLACEMENT:** Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely- Group Replacement.	
LEARNING OUTCOME: 1. Solving the different types of sequencing problems (L3) 2. Understanding the replacement policies and items replacement. (L2, L3)	
UNIT – 4	**CLASSES :08**
THEORY OF GAMES: Introduction –Terminology– Solution of games with saddle points and without saddle points- 2 x 2 games –m x 2 & 2 x n games - graphical method – m x n games - dominance principle. **INVENTORY:** Introduction – Single item, Deterministic models – Types - Purchase inventory models with one price break and multiple price breaks –Stochastic models – demand discrete variable or continuous variable – Single Period model with no setup cost.	
LEARNING OUTCOME : 1. Applying game theory to different applications (L3) 2. Understanding the importance of inventory and finding the different cost (L2,L3)	

UNIT – 5	CLASSES :08

WAITING LINES: Introduction – Terminology-Single Channel – Poisson arrivals and Exponential Service times – with infinite population and finite population models– Multichannel – Poisson arrivals and exponential service times with infinite population.

DYNAMIC PROGRAMMING: Introduction – Terminology- Bellman's Principle of Optimality – Applications of dynamic programming- shortest path problem – linear programming problem.

LEARNING OUTCOME :

1. Applying the waiting lines methods to different applications. (L3)
2. Applying the bellman's principles to different applications. (L3)

TEXT BOOK :

1. Operation Research by J.K.Sharma/4th Edition/ MacMilan.
2. Operations Researchby ACS Kumar/1st Edition/ Yesdee

REFERENCE BOOK :

1. Introduction to OR/Taha/10th Edition/PHI
2. Operations Research/NVS Raju/3rd Revised Edition /SMS Education
3. Operations Research/M.V. Durga Prasad, K.Vijaya Kumar Reddy, J. Suresh Kumar/1st Edition /Cengage

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2250352: SOLAR ENERGY TECHNOLOGY

(Professional Elective-I)

B.Tech. III Year I Sem

L	T	P	C
3	0	0	3

PRE-REQUISITES: Study of engineering mechanics and theory of machines.

COURSE OBJECTIVES

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

1. Understand the technical and physical principles of solar cells and solar collectors.(L2)
2. measure and evaluate different solar energy technologies.(L6)
3. Calculate the required size of solar cell systems and solar collectors.(L4)
4. Critical comparisons of different solar energy systems.(L4)
5. Analyse technological, environmental and socio-economic issues of solar energy.(L4)

COURSE OUTCOMES:

1. State the different types of Solar Cells, Modules and Solar Radiation. (L1)
2. Describe the working System components and their functions.(L2)
3. Describe the working of Solar Thermal Power Plants.(L2)
4. Describe the working of Prepare economic analysis. (L2)
5. Understand the large-scale deployment of active solar energy

Unit – I Solar Radiation, Solar Cells and Modules:

Properties of sunlight. Absorption by the atmosphere. Calculation of solar irradiance at surfaces. The function of solar cells from semiconductor physics. Different solar cell technologies and fabrication methods. Concepts for increasing efficiency based on loss analysis. Wavelength sensitivity. Series connection of solar cells to modules. Module function and characteristics. Shading of cells and modules.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

1. Understand the importance of solar cell fabrication methods. (L2)
2. Understand the solar cell modules. (L2)

Unit – II Solar Cell Systems
System components and their functions. Calculating output and dimensioning of solar cell systems. Analysis and computer simulation of a solar cell system. Concentrated sunlight and solar power (CSP). Properties of optical concentration systems. Solar cells in concentrated sunlight. Overview of the different components in a CSP system and their functions. Examples of CSP-systems globally.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Analyse and simulate the solar cell system. (L4) 2. Understand the different components in a CSP system. (L2)

Unit – III Solar thermal
Thermodynamic description of solar collectors. Optical properties of solar collectors and technologies for fabrication. Solar thermal systems for different applications. Storage of solar generated heat.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Analyse the thermodynamics of solar collectors. (L4) 2. Understand the different applications of solar thermal systems. (L2)
Unit – IV Hybrid systems
Combinations of solar thermal and solar cell systems. Overview of different applications. District heating with solar thermal components.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Analyse the thermodynamics of solar collectors. (L4) 2. Understand the different applications of solar thermal systems. (L2)

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Unit – V Active solar energy in systems:
How large-scale deployment of active solar energy is possible in globally. Buying and selling heat and electric energy. Grid aspects of large-scale deployment of solar cells as well as environmental and social economic aspects.
LEARNING OUTCOME: After successful completion of the unit, students will be able to 1. Understand the large scale deployment of solar energy. (L2) 2. Understand the environmental aspects of solar cells. (L2)
TEXT BOOK: 1. 1 A Text book of Power System Engineering, A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, Dhanpat Rai Publication. 2. Renewable Energy Technologies, Solanki, Chetan S. , PHI Learning, New Delhi, 2011
REFERENCE BOOK: 1. Renewable Energy Sources for Sustainable Development, N.S. Rathore and N. L. Panwar, New India Publishing Agency, New Delhi. 2. Electrical Power System, Mehta, V.K. S. Chand and Company Bew Delhi, 2011.

2250384: COMPUTER AIDED MACHINE DRAWING

B. Tech. III Year I Sem

L	T	P	C
0	0	2	1

PRE-REQUISITES: Study of engineering mechanics and theory of machines.

COURSE OBJECTIVES

1. To recognize with the standard conventions for different materials and machine parts in working drawing.
2. To giant acknowledge of Part drawing including sectional views for various machine elements.
3. To prepare assembly drawings given the details of part drawing.
4. To prepare CAD 2D &3D part models using AUTOCAD and Solid works.
5. To Understand basic sketching commands and Navigational command sin AUTOCAD .

COURSE OUTCOMES: After completion of the course the student is able to

1. Read and interpret machine drawing.
2. Learn conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears.
3. Explore the knowledge on part drawing..
4. 2 D drawing and 3D basic solid models using CAD.
5. Conversion and vice versa manually and by using computer aided drafting.

PART-A

Drawing of machine elements and simple parts:

1. Conventional representation of materials, common machine elements parts such as screws, nuts, bolts, keys , gears.
2. Types of sections-selection of section planes and drawing of sections and auxiliary sectional views, parts not usually sectioned.
3. Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features.
4. The boxes, their size ,location and details-common abbreviations and their liberal usage.
5. Types of drawings-working drawings for machine parts, popular forms of screw threads, bolts, nuts, stud bolts, keys, cottered joints and knuckle joint, riveted joints for plates shaft coupling and Socket pipe joint, journal and foot step bearings.

LEARNING OUTCOME:

After successful completion of the unit, students will be able to

- Conventional representation of materials, common machine elements and part such as screws, nuts, bolts, keys, gears (L1)
- 2. Types of sections-selection of section planes and drawing of sections and auxiliary

TEXT BOOKS:

1. MACHINE drawing by K LNARAYANA, WileyEstern/5TH edition.
2. Machine drawing by N D Bhatt/ charotar / 50th Edition.
3. Machine drawing with AUTOCAD/Gowtham pohit ,gouthamghosh /pearson

Reference books:

1. Machine drawing by BHATTACHARYYA /Oxford /4th edition.
2. Machine drawing by Ajeet singh/Mc Graw Hill/2nd edition.
3. Machine Drawing by P.S. Gill /S.K. KATERIA &sons /2nd edition
4. A primer on computer aided machine drawing-2007;PUBLISHED BY vtu, belgaum.

Note: Question paper consist of PART -A, PART -B& PART-C

1. PART-A consists of Part Drawing.
2. PART- B consists of Assembly Drawing.

PART-C consists of CAD Drawing

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PART –B ASSEMBLY DRWAING
Drawing of assembled views for the part drawing of the following conventional& the Drawing proportions. 1. steam engine parts-stuffing box, eccentrics 2. Other machine parts- screw jacks, petrol engine connecting rod. 3. valves-steam stop valve, feed check valve
LEARNING OUTCOME: 1.Types of sections-selection of planes and drawing of sections and auxiliary views(L2) 2. Preparation of engineering and work drawings with dimensions and bill of materials during design and development. developing assembly drawings using part drawing of machine components(L2) NOTE: First angle projection to be adopted. The students should able to provide working drawing of actual parts

PART -C
1Introduction to drafting software like Auto cad, basic commands ,keyboards shortcuts, coordinate and unit setting, drawing ,editing ,measuring ,dimensioning, plotting commands, layering concepts, matching, detailing, detail drawing. 2. Drawing of shaft coupling and Oldham's coupling. 3. Assembly drawing (2d) w with bill of materials, stuffing box, eccentrics. 4. Assembly drawing (2d) with bill of materials Tail stock, machine vise. 5. Assembly drawing (2D) with bill of materials, screw jack, Plummer block, steam stop value.
LEARNING OUTCOMES: 1. Learn specific software like AUTO CAD basic commands(L1) 2.Apply computer aided drafting tools to 2D drawing i.e. tail stock, eccentric etc(L2) 3.Knowledge on AUTO CAD of shaft couplings.(L1)

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2250382: KINEMATICS AND DYNAMICS OF MACHINERY LAB

B.Tech. III Year I Sem | **L T P C**
PRE-REQUISITES: Kinematics of Machinery | **0 0 2 1**

COURSE OBJECTIVES

1. To impart the knowledge of basic concepts on kinematics and dynamics of mechanical elements.
2. To illustrate the effect of gyroscope for different motions.
3. To Impart the knowledge of various Governors.
4. To facilitate the students to know the concepts of balancing of rotating masses and reciprocating masses.
5. To iintroduce mathematical models and solution methods to study torsional vibration .

COURSE OUTCOMES : After completion of the course the student is able to

1. Understand types of motion. (L_2)
2. Analyze forces and torque of components in linkages.(L_3)
3. Understand forward and inverse kinematics of open loop mechanisms.(L_2)
4. Illustrate how to balance forces and moments produced by rotating or reciprocating masses of machine members.(L_2)
5. Understand concept of whirling of shafts to determine critical speed for n conditions (L_2).
6. Illustrate various Governors, cam and followers. (L_2)

LIST OF EXPERIMENTS (A minimum of 10 experiments to be conducted)

1. To determine the state of balance of machines for primary and secondary forces
2. To determine the frequency of torsional vibration of a given rod
3. Determine the effect of varying mass on the centre of sleeve in porter and proell governor
4. Find the motion of the follower if the given profile of the cam
5. The balance masses statically and dynamically for single rotating mass systems
6. Determine the critical speed of a given shaft for different n-conditions
7. For a simple pendulum determine time period and its natural frequency
8. For a compound pendulum determine time period and its natural frequency
9. Determine the effect of gyroscope for different motions
10. Determine time period, amplitude and frequency of undamped free longitudinal vibration of single degree spring mass systems.
11. Determine the pressure distribution of lubricating oil at various load and speed of a Journal bearing.
12. Determine time period, amplitude and frequency of damped free longitudinal vibration of single degree spring mass systems

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2250383: METROLOGY AND MACHINE TOOLS LAB

B.Tech. III Year I Sem | **L T P C**
PRE-REQUISITES: Production Technology | **0 0 2 1**

COURSE OBJECTIVES

1. To import practical exposure to the metrology equipment & Machine tools
2. To conduct experiments and understand the working of the same.
3. To learn the measurement of bores by internal micrometers and dial bore indicators.
4. To learn the measurement of the Angle and taper s by Bevel protractor, Sine bars, etc.
5. To learn the Step turning and taper turning and thread cutting Drilling and Tapping on lathe machine
6. To the operations of Shaping and milling

COURSE OUTCOMES : After completion of the course the student is able to

1. Student will be able to use different measuring instruments towards quality control. (L2)
2. Measure the angle and taper using Bevel protractor and Sine bar. (L4)
3. Measure screw thread parameters. (L4)
4. Perform step turning, taper turning, thread cutting, drilling and tapping operations on lathe. (L3)
5. Perform operations on shaper and milling machine. (L3)
6. Perform various operation on slotting, shaper and planning machines.(L3)

LIST OF EXPERIMENTS (A minimum of 10 experiments to be conducted)

1. Step turning and taper turning on lathe machine
2. Thread cutting and knurling on lathe machine
3. Machining of groves using slotter and shaper machines
4. Machining of holes using Drilling and boring machines.
5. Gear cutting on the Milling machine
6. Grinding of Tool angles using Cylindrical / Surface Grinding
7. Measurement of lengths, heights, diameters by vernier calipers, micrometers.
8. Measurement of bores by internal micrometers and dial bore indicators.
9. Use of gear teeth vernier calipers for checking the chordal addendum and chordal height of the spur gear.
10. Angle and taper measurements by bevel protractor and sine bars.
11. Thread measurement by 2-wire and 3-wire methods.
12. Surface roughness measurement by Tally Surf.

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