COURSE STRUCTURE (R20)
AND
DETAILED SYLLABUS
(II YEAR)

MECHANICAL ENGINEERING

For
B.Tech, Four Year Degree Course
(Applicable for the batches admitted from 2020-21)

LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUK, Kakinada
Accredited by NAAC with "A" Grade and NBA (CSE, ECE, EEE & ME)
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DEPARTMENT OF MECHANICAL ENGINEERING

B. Tech II-Year Course Structure and Syllabus –R20

II Year - I Semester

S.No	Course Code	Course Title	Category	Hours			Credits
				L	T	P	
1	R20BSH-MA2103	Calculus and Partial Differential Equations	BS	3	0	0	3
2	R20MEC-PC2101	Mechanics of solids	PC	3	0	0	3
3	R20MEC-PC2102	Machine Drawing	PC	3	0	0	3
4	R20MEC-ES2101	Engineering Thermodynamics	ES	3	0	0	3
5	R20MEC-PC2103	Kinematics of Machinery	PC	3	0	0	3
6	R20MEC-PC2104	Computer Aided Engineering Drawing	PC	0	0	3	1.5
7	R20MEC-PC2105	Mechanics of Solids Lab	PC	0	0	3	1.5
8	R20MEC-ES2102	Material Science and Engineering Lab	ES	0	0	3	1.5
9	R20BSH-SC2101	Employability Skills (Skill Oriented Course)	SC	1	0	2	2
10	R20BSH-MC2102	Essence of Indian Traditional Knowledge	MC	2	0	0	0
11	R20BSH-MC1203	Community Service Project (Evaluation)	MC	0	0	0	0
Total credits							**21.5**

II Year - II Semester

S.No	Code	Course Title	Category	Hours			Credits
				L	T	P	
1	R20BSH-MA2201	Complex Variables and Statistical Methods	BS	3	0	0	3
2	R20MEC-PC2201	Dynamics of Machinery	PC	3	0	0	3
3	R20MEC-PC2202	Fluid Mechanics& Hydraulic Machinery	PC	3	0	0	3
4	R20MEC-PC2203	Production Technology	PC	3	0	0	3
5	R20BSH-HM2203	Managerial Economics and Industrial Management	HM	3	0	0	3
6	R20MEC-PC2204	Production Technology Lab	PC	0	0	3	1.5
7	R20MEC-PC2205	Fluid Mechanics& Hydraulic Machinery Lab	PC	0	0	3	1.5
8	R20MEC-PC2206	Theory of Machines Lab	PC	0	0	3	1.5
9	R20BSH-SC2201	MATLAB For Computational Methods (Skill Oriented Course)	SC	1	0	2	2
Total credits							**21.5**
Honors Course -1/Minor Course-1							
Summer Internship-1(After Second Year & Evaluated in III-I Semester)							

II Year –I Semester

Subject Code	Subject Name	L	T	P	C
R20BSH-MA2103	Calculus and Partial Differential Equations	3	0	0	3

Course Objectives:

- To familiarize the learners with transform techniques.
- To enlighten the learners in the concept of partial differential equations.

Course Outcomes:

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

1. Utilize mean value theorems to real life problems, Apply Infinite series to real life problems. (L3)
2. Understand the concept of Fourier series and find Fourier Series, for different functions (L2)
3. Understand the concept of Fourier transforms and find, Fourier transforms for different functions (L2)
4. Form a partial differential equation and solve first order linear and non-linear partial differential equations. (L3)
5. Solve higher order homogeneous partial differential equations. Method of separation of variables.(L4)

Unit I :

Mean Value Theorems & Infinite Series (without proofs):

Mean Value Theorems: Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders.

Infinite Series: Infinite series, convergence and divergence of series, geometric series, auxiliary series, comparison tests, ratio test, Cauchy's root test, Raabe's test, alternating series, Leibnitz test, absolute and conditional convergence.

Learning Outcomes:

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

- analyze the behaviour of functions by using mean value theorems. (L3)
- translate the given function as series of Taylor's and Maclaurin's with remainders. (L3)
- apply the suitable test to study the convergence of a given series. (L3)**.**

Unit II:

Fourier Series: Fourier series: Fourier series, determination of Fourier coefficients, Dirichlet's conditions, Fourier series of even and odd functions, Fourier series of even and odd periodic functions in an arbitrary interval, Half-range Fourier sine and cosine expansions.

Applications: Practical Harmonic Analysis.

Learning Outcomes:

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

- evaluate the Fourier series expansion for different periodic functions. (L3)
- understand the nature of the Fourier series that represent even and odd functions.(L3)

Unit III:

Fourier transforms: Fourier integrals, Fourier cosine and sine integrals, Fourier transform, sine and cosine transform, properties. Inverse Fourier transforms, Finite Fourier transforms.

Learning Outcomes:

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

- examine the properties of Fourier transformation. (L2)
- apply Fourier transformation for different functions. (L3)

Unit IV:

First Order Partial Differential Equations (PDE): Formation of first order partial differential equations, solutions of first order linear and standard forms of non-linear PDE.

Learning Outcomes:

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

- solve the first order linear PDE. (L2)
- solve the first order non- linear PDE. (L2)

Unit V:

Higher Order Partial Differential Equations:

Homogeneous and non-homogeneous PDE, Method of separation of variables.

Applications: 1D Wave equation, one dimension heat equation, two dimension heat equation-Laplace equation (Cartesian, Polar).

Learning Outcomes:

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

- solve the higher order PDE. (L2)
- Apply PDE to Mechanical engineering problems. (L3)

Text Books

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

References

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. James Stewart, Calculus, 7th Edition, Brooks/Cole Cengage Learning (Chapter 14).
3. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2011.
4. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018.
5. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 13/e, Pearson Publishers, 2013.
6. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002.
7. Glyn James, Advanced Modern Engineering Mathematics, 4/e, Pearson publishers, 2011.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2101	Mechanics of Solids	3	0	0	3

Course Objectives:

- Introduce the concepts of different stresses, strains and their relationships.
- Discuss the principal stresses and components of stress on different planes and maximum shear force and bending moment of different beams under different loading conditions.
- Demonstrate bending stress and shear stress distribution of various cross sections of beams and to predict the maximum slope and deflection of beams.
- Familiarize the Euler's concept of buckling in columns & struts.

Course Outcomes:

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

1. Apply the basic concepts of simple stresses and strains, principal stresses and strains, thermal stresses for solving the fundamental problems related to solids and structures. (L3)
2. Analyse the shear force and bending moment diagrams for designing of beams for given load conditions. (L3)
3. Apply the flexural and shear stress equations to analysing stress distribution and efficiency of beam cross-sections, and deflections in beams. (L3)
4. Apply the principles of stress analysis to calculate stresses and strains produced in pressure vessels, fluid storge vessels for the given internal pressure. (L3)
5. Analyse the buckling loads for columns with different end conditions and torsional shear strength of a machine members such as shafts, spindles, and axles (L3)

Unit I:

Simple Stresses and Strains: Types of stresses and strains, stress-strain relations, stress-strain diagram for ductile and other materials, axial loaded bars of uniform and varying cross section, compound bars, relation between three elastic moduli, thermal stresses.

Principal stresses and strains: Biaxial state of stress with and without shear - Mohr's Circle and analytical methods.

Application: beams and structures

Learning outcomes:

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

- Determine stresses and deformations due to axial loads in simple members. (L3)
- Analyse stresses compound bars due to temperature raise. (L4)
- Correlate the elastic constants of materials.(L3)
- Construct the Mohr's circle for calculating principal stresses.(L3)
- Analyse principal stresses in biaxial state of loading. (L4)

Unit II:

Analysis of Beams: Types of beams and loads, shear force and bending moment diagram for cantilever, simply supported and overhanging beams for different types of loadings, point of contra flexure, relation between shearing force and bending moment.

Application: analysis of structures and Automobile Chassis.

Learning outcomes:

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

- Draw shear force and bending moment diagrams in beams subject to bending

loading.(L3)

- Draw bending stresses in beams under different loading. (L3)

Unit III:

Bending Stresses: Flexural equation, bending stress distribution and efficiency of various cross sections of beams.

Shear Stresses: Shear stress distribution for different cross sections of beams.

Deflection of Beams

Differential equations of the deflection curve, Macaulay's method and Moment area method for simply supported ,cantilever.

Application: analysis of shafts and couplings.

Learning outcomes:

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

- Demonstrate the shear stress and bending moment distribution in different cross sections of beams.(L3)
- Compare the slope and deflection in beam under different loading.(L5)
- Distinguish various approaches for calculating slope and deflection. (L4)
- Explain the difference between strain energy, resilience, elastic strain energy and modulus of toughness. (L2)
- Evaluate the maximum shear force and bending moment and their location in beams. (L5)

Unit IV:

Thin Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders – Riveted boiler shells – Thin spherical shells.

Thick Cylinders: –lame's equation – cylinders subjected to inside & outside pressures – compound cylinders. Application: Supporting members and pressure vessels.

Learning outcomes:

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

- Determine buckling load in compressive members. (L2)
- Apply concepts of elastic stability of columns. (L3)
- Assess hoop and longitudinal stresses in thin cylinders. (L3)

Unit V:

Buckling of Columns: Analysis of columns to evaluate buckling loads with different boundary conditions, Euler's formula and its limitations, Rankine's formula, columns under eccentric load, columns under initial curvature.

Torsion of Circular Shafts: Theory of pure torsion, transmission of power in solid and hollow circular shafts, comparison of strengths of solid and hollow shafts, shafts in series and parallel, combined bending and torsion.

Application: Power Transmissions Systems and Damping units.

Learning outcomes:

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

- Analyse circular shafts subjected to twisting couple. (L4)
- Determine stresses in shafts subjected to combined loads.(L5)
- Determine angle of twist in shafts.(L5)

- Determine stresses and deformations in helical and leaf springs.(L5)

Text Books:

1. F.P. Beer, E.R. Johnston, Jr&John.T. DeWolf, Mechanics of Materials, 7/e, Tata McGraw-Hill, 2016.
2. SS Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.

References:

1. Timoshenko, Strength of Materials Part-I& II, 3/e, CBS Publishers, 2004.
2. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2102	Machine Drawing	3	0	0	3

Course Objectives:

- Identify the conventional representation of various components like bolts, nuts, screws etc.,
- Know the fastening arrangements such as welding, riveting the different styles of attachment for shaft.
- Prepare the assembly of various machine or engine components and miscellaneous machine components.

Course Outcomes:

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

1. Explain the conventional representation of materials, machine components, welding symbols, and standard fasteners such as screws, bolts, and nuts as per industrial standards (L2).
2. Construct detailed sketches of riveted joints, keys, cotter joints, knuckle joints, and shaft couplings using appropriate proportions and conventions (L3).
3. Illustrate different types of journal bearings, pivot bearings, and footstep bearings using standard drawing conventions and proportions (L3).
4. Interpret given part drawings and construct assembly drawings for engine components such as connecting rod, eccentric, stuffing box, and piston, ensuring clarity and correctness (L4).
5. Develop detailed assembly drawings of machine parts like screw jack, Plummer block, tailstock, and valves by following engineering drawing standards (L3).

PART-A

I. Drawing of Machine Elements and simple parts

1. Conventional representation of materials, machine components, welding symbols, Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.

2. Rivets and Riveted joints

3. Keys, cotter joints and knuckle joint, Shaft coupling

4. Solid Journal bearings, Bushed Journal bearings, pivot and collar bearings and foot step bearings.

PART-B

II. Assembly Drawings: Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions.

i. Engine parts – connecting rod, eccentric, stuffing box, piston.
ii. machine parts - Screws jack, Plummer block, Tailstock, .
iii. Valves: spring loaded safety valve, Non Return valve and air cock.

Text Books:

1. Machine Drawing – N.Siddeswar, K.Kannaiah & V.V.S.Sastry - TMH
2. Machine Drawing –K.L.Narayana, P.Kannaiah & K. Venkata Reddy / New Age/ Publishers

References:

1. Machine Drawing – P.S.Gill,
2. Machine Drawing – Luzzader
3. Machine Drawing – Rajput

4. Machine Drawing – N.D. Junnarkar, Pearson
5. Machine Drawing – Ajeeth Singh, McGraw Hill
6. Machine Drawing – KC John, PHI
7. Machine Drawing – B Battacharya, Oxford
8. Machine Drawing – Gowtham and Gowtham, Pearson

Subject Code	Subject Name	L	T	P	C
R20MEC-ES2101	Engineering Thermodynamics	3	0	0	3

Course Objectives

- Familiarize concepts of heat, work, energy and governing rules for conversion of one form to another.
- Relate different properties of matter using laws of thermodynamics.
- Analyze the properties of steam undergoing various thermodynamic processes using tables & Charts.
- Introduce the fundamental concepts and applications of thermodynamics cycles
- Impart the knowledge on mixture of perfect gasses and their properties using different laws and charts.

Course Outcomes

1. Apply various laws of thermodynamics to various processes and real systems. (L3)
2. Apply the concept of Entropy, Calculate heat, work and other important thermodynamic properties for various ideal gas processes. (L3)
3. Explain the condition of steam and its properties for working of steam power plants. (L3)
4. Explain the performance of various Thermodynamic gas power cycles. (L3)
5. Use Psychrometric charts and estimate various essential properties related to Psychrometry and processes(L3)

Unit I

Introduction: Basic Concepts: Macroscopic and microscopic viewpoints, definitions of thermodynamic terms, quasi – static process, point and path function, forms of energy, ideal gas and real gas, Zeroth law of thermodynamics, principle of thermometry.

First law of Thermodynamics: Joule's experiment - first law of thermodynamics, corollaries-perpetual motion machines of the first kind, first law applied to non-flow and flow process-limitations of first law of thermodynamics**.**

Applications: Thermometry, Thermal system analysis which involves heat and work transfer processes.

Learning outcomes:

At the end of this Unit, the student will be able to

- Identify thermodynamic systems, properties and their importance in solving engineering problems. (L3)
- Explain energy balance for various closed systems and open systems. (L4)
- Solve simple thermodynamics problems. (L3)

Unit II

Second Law of Thermodynamics: Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - perpetual motion machines of second kind - reversibility and irreversibility, cause of irreversibility - Carnot cycle, heat engine, heat pump and refrigerator, Carnot theorem, Carnot efficiency.

Entropy: Clausius inequality - Concept of Entropy- entropy equation for different processes and systems

Availability and Irreversibility: Definition of exergy and energy, expressions for availability and irreversibility. Availability in steady flow, non-flow processes and irreversibility.

Applications: Refrigerators, heat pump and heat engines efficiency calculations

Learning outcomes:
At the end of this Unit, the student will be able to

- Apply second law of thermodynamics in design of heat engine, refrigerator and heat pump. (L3)
- Explain the efficiency of thermodynamic systems.(L2)
- Enumerate the causes for poor performance of thermodynamic systems. (L3)
- Apply entropy effects to estimate the performance of systems. (L3)
- Explain thermo-economics.(L3)

Unit III

Properties of Steam and use of Steam Tables: Pure Substances, P-V-T surfaces, T-s and h- s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry.
Applications: Steam quality calculation in Steam power plants.
Learning outcomes:
At the end of this Unit, the student will be able to

- Apply properties of steam to design steam systems. (L3)
- Examine steam systems using conservation equations. (L4)
- Evaluate the performance of steam systems. (L4)

Unit IV

Thermodynamic Relations: Maxwell relations, TdS equations, difference in heat capacities, ratio of heat capacities, Energy equation, Joule Thompson coefficient, Clausius-Clapeyron equation.
Air Standard Cycles: Otto, Diesel and dual cycles, P-V and T -S diagrams - description and efficiencies, mean effective pressures. Comparison of Otto, Diesel and dual cycles
Applications: IC engines
Learning outcomes:
At the end of this Unit, the student will be able to

- Explain the importance of T-ds equations. (L3)
- Relate specific heats, internal energy, enthalpy and Joule-Thomson coefficient in standard form. (L3)
- Examine the importance of compression ratio. (L4)
- Explain the cycles on which internal combustion engines work. (L3)

Unit V

Mixtures of perfect Gases – Mole Fraction, Mass friction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Mole fraction , Volume fraction and partial pressure, Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, Atmospheric air - Psychrometric Properties – Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation , Carrier's Equation – Psychrometric chart.
Applications: Psychrometric
Learning outcomes:
At the end of this Unit, the student will be able to

- Explain Psychrometric chart (L3)

- Calculate various psychrometric properties of air. (L3)

Text Book(s):

1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill, 2011.

References:

1. J.B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons, 2012.
2. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley, 2015
3. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009
4. R.K. Rajput, S.Chand& Co., Thermal Engineering, 6/e, Laxmi publications, 2010.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2103	Kinematics of Machinery	3	0	0	3

Course Objective:

- Explain the purpose of kinematics, Kinematic joint and mechanism and to study the relative motion of parts in a machine without taking into consideration the forces involved
- Understand the various mechanisms for straight line motion and their applications including steering mechanism
- Analyze the velocity and acceleration concepts and the methodology using graphical methods and principles and application of four bar chain and understand the application of slider crank mechanism etc. also the concepts involved in cams.
- Understand gears, power transmission through different types of gears and also to determine the velocity ratio of different types of gear trains.
- Impart various power transmission mechanisms and methodologies and working principles.

Course outcomes:

After completion of this unit, students will be able to

1. Design the complex mechanical systems from the fundamental principles of kinematics and dynamics of machines. (L3)
2. Apply the knowledge of various mechanical linkages and steering gear mechanisms in practical engineering scenarios. (L3)
3. Apply the relative velocity method for four-bar chains and other common mechanisms, the theories involved in cams, applications of cams and their working principles. (L3)
4. Design of gears, power transmission through different types of gears and gear trains. (L3)
5. Apply theoretical and practical knowledge to design efficient and effective belt drive systems. (L3)

UNIT –I

MECHANISMS : Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained . Grublers criteria , Grashoff's law , Degrees of freedom, Kutzbach criterion for planar mechanisms, Mechanism and machines – classification of machines – kinematic chain – inversion of mechanism – inversions of quadric cycle chain – single and double slider crank chains.

Application: I.C Engines, Lathe Machine.

Learning Outcomes:

After completion of this unit student will be able to

1. Classify the types of kinematic pairs (L2)
2. Determine degrees of freedom for different mechanisms (L2)
3. Analyze inversions of four bar, slider crank and double slider mechanisms.(L4)

UNIT –II

LOWER PAIR MECHANISM: Exact and approximate copiers and generated types – Peaucellier, Hart and Scott Russul – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and straight line motion, Pantograph. Conditions for correct steering – Davis Steering gear, Ackermans steering gear – velocity ratio; Hooke's Joint: Single and double – Universal

coupling– application–problems.
Applications: Four Wheeler Steering mechanism, locomotive.

Learning Outcomes:
After completion of this unit student will able to
1. Describe applications of different mechanisms with lower pairs (L2)
2. Analyze Davis and Ackerman steering gear mechanisms (L4)

UNIT –III

KINEMATICS: Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of a given mechanism, Plane motion of body: Instantaneous center of rotation, centrode and axode – Three centers in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.
CAMS Definitions of cam and followers – their uses – Types of followers and cams – Terminology –Types of follower motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.
Applications: I.C Engines valves, Reciprocating steam engines
Learning Outcomes:
After completion of this unit student will able to
1. Determine the instantaneous centers for a given mechanism (L5)
2. Analyze the velocities and accelerations by relative velocity method for the given mechanism (L4)
3. Evaluate the cam profile for different follower motions (L5)

UNIT –IV

Gears: Higher pairs, friction wheels and toothed gears–types – law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding – Basic concepts of interference, Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact – Introduction to Helical, Bevel and worm gearing.
Introduction to gear Trains, Train value, Types – Simple and reverted gear train – Epicyclic gear Train. Methods of finding train value or velocity ratio – Epicyclic gear trains.
Application: Transmission systems in automobiles
Learning Outcomes:
After completion of this unit student will able to
1. Analyze the gears for transmission purposes (L4)
2. Explain different types of gear trains (L2)

UNIT –V

Belt and Rope Drives : Introduction, Belt and rope drives, selection of belt drive- Types of belt drives, V-belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt.
Applications: Mills, Air compressors, Lathe machine .
Learning Outcomes:
After completion of this unit student will able to

1. Determine the velocity ratio, slip, creep, power transmission of Belt drives by considering centrifugal and initial tension (L5)

Text Books:

1. Theory of Machines / S.S Rattan/ Mc. Graw Hill Publ.
2. Theory of machines / Khurmi / S.Chand.
3. Theory of machines and Mechanisms – J.J Uicker, G.R.Pennock & J.E. Shigley - Oxford publishers.

References:

1. Theory of Machines Sadhu Singh Pearsons Edn
2. Theory of Machines / Shigley / MGH 3. Machine Drawing – Rajput
3. Kinematics of Machinery through Hyper Works – J.S. Rao – Springer Publ.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2104	Computer Aided Engineering Drawing	**0**	**0**	**3**	**1.5**

Course Objectives:

- Enhance the skills in engineering drawing by using CAD software tools.
- Construct orthographic views of solids using CAD software.
- Draft the sectional views of solids using CAD software.
- Impart knowledge for development of surfaces using CAD software.
- Develop 2D (orthographic) and 3D (isometric) views in CAD software.

Course Outcomes:

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

1. Apply the various commands in AutoCAD for drafting the geometrical entities.(L3)
2. Draw the orthographical projections of solids. (L2)
3. Analyze the intricate details of solid parts through sectional views.(L4)
4. Develop the surfaces of solids for optimization of material requirement. (L3)
5. Model the 2D and 3D objects using CAD software. (L3)

PART-A

Introduction to Computer Aided Drafting:

Introduction to CAD, AutoCAD Interface, Basic commands, Drawing and Editing Commands, Dimensioning, Layers, Layouts.

Projections of Solids: Projections of Regular Solids inclined to both planes.

Sections of Solids: Sections and Sectional views of Regular Solids – Prism, Cone, Cylinder, Pyramid – Auxiliary views.

Development and Interpenetration of Solids: Development of Surfaces of Regular solids – Prisms, Cylinder, Pyramid Cone.

PART B

Computer Aided Solid Modelling: Isometric(3D) and orthographic(2D) projections of objects.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2105	Mechanics of Solids Lab	0	0	3	1.5

Course Objectives:

- To study the stress – strain relations of different materials.
- To study uni-axial tension test on Steel, Aluminium, Copper and Brass
- To determine the Brinnell's and Vicker's hardness numbers of different materials.
- To determine the Impact strength and Modulus of rigidity of different materials.
- To find out the stiffness of spring under different load conditions.

Course Outcomes:

The student is able to

1. Understand the stress-strain relations of Mild Steel, Tor Steel, Copper, Aluminium, and other materials through tension/compression tests.(L2)
2. Determine compressive and shear strength of wood, GI sheet, and hardness numbers of Steel, Brass, Aluminium, and Copper.(L4)
3. Analyse the modulus of rigidity for Solid and Hollow shafts made of steel and aluminium.(L4)
4. Calculate Young's modulus by conducting deflection tests on various beam configurations.(L3)
5. Analyse the impact strength, buckling load of materials and deflection in leaf springs with experimental testing.(L4)

Note: Atleast 8 experiments need to be conducted.

List of Experiments: Mechanics of Solids Lab

1. Study the stress – strain relations of (a) Mild Steel and (b) Tor Steel by conducting tension/compression test on U.T.M.
2. Study the stress – strain relation of (a) Copper (b) Aluminium (c) other materials by conducting tension /compression test.
3. Find the compressive and shear strength of wood and shear strength of GI sheet by conducting relevant tests.
4. Find the Brinnell's and Vicker's hardness numbers of (a) Steel (b) Brass (c) Aluminium (d) Copper.
5. Determine the Modulus of rigidity (a) Solid shaft (b) Hollow shaft made of steel and aluminium.
6. Find the spring index and modulus of rigidity of the material of a spring by conducting compression and tensile tests.
7. Determine the Young's modulus of the material by conducting deflection test on a simply supported, propped cantilever and continuous beams.
8. Find impact strength of a given material by conducting a) Charpy test and b) Izod test
9. Determine buckling load in a compressive member made with steel and aluminium.
10. Determine the deflection in leaf spring with a single leaf and multiple leafs.

Subject Code	Subject Name	L	T	P	C
R20MEC-ES2102	Material Science and Engineering Lab	0	0	3	1.5

Course Objectives:

- To understand microstructure of pure metals.(L1)
- To Identify various microstructures of steels and cast irons. (L2)
- To find out hardness of treated and untreated steels. (L4)
- To Understand the hardenability of steels.(L1)
- To Recognize the microstructure of heat treated steels.. (L1)
- To Deduce the microstructure of non-ferrous alloys. (L2)

Course Outcomes:

The student will be able to

1. Identify various microstructures of steels and cast irons. (L3)
2. Evaluate hardness of treated and untreated steels. (L5)
3. Analyze the hardenability of steels.(L4)
4. Examine the microstructure of heat treated steels.. (L4)
5. Identify the microstructure of non-ferrous alloys. (L2)

List of Experiments:

1. Study of microstructure of pure metals – Iron, copper and aluminum.
2. Study of microstructure of low carbon steel, mild steel and high carbon steel.
3. Study of microstructure of cast irons.
4. Study of microstructure of non-ferrous alloys – aluminum and copper alloys.
5. Study hardenability of steels by Jominy End Quench Test.
6. Study of microstructure of heat treated steels.
7. Find hardness of various untreated and treated steels.

Subject Code	Subject Name	L	T	P	C
R20BSH-SC2101	Employability Skills (Skill Oriented Course) Common to MEC & CSSE	1	0	2	2

Course Objectives

- Aims to help learners develop their English language skills, particularly those planning to appear for Competitive Exams that test their English Language abilities.
- Gains the power of expression through rich Vocabulary.
- Imparts critical reading strategies for comprehension of complex texts
- Provides training and opportunities to develop fluency in English through participation in formal group discussions and Self Introductions.
- Demonstrates good writing skills for effective Paragraph Writing, Essay Writing and formal correspondence through Emails.
- Encourages use of a wide range of grammatical structures, Phrases, Clauses and Idioms in speech and writing.

Course Outcomes

1. Enable students to identify Parts of Speech and use them flawlessly, write Emails in formal correspondence effectively, participate confidently by introducing oneself in any formal discussion.
2. Attain Language Proficiency & Accuracy through Contextualized Vocabulary, Verb forms, Tense and subject verb agreement, produce coherent expressions for professional writing, introduce themselves unhesitatingly with Task-Based Activities.
3. Develop the fluency and accuracy to write Technical Reports and Emails for professional communication by using appropriate vocabulary and participate confidently in any formal discussion.
4. Assimilate lifelong reading habit to comprehend a passage for its gist. Avoid the errors in both Speech & Writing and write Letters and Emails for official communication.
5. Realise the technical communicative competence and attainment of grammatically correct structures for formal communication.

Unit 1

Vocabulary: How to talk about actions. **Grammar: U**sing and Identifying Parts of Speech accurately **. Writing:** Paragraph Writing and formal correspondence through Emails**. Speaking:** Background to Group discussions & Self-introductions.

Learning Outcomes

At the end of the module, the learner will be able to

- Acquire vocabulary and use it contextually(L2)
- identify parts of speech and use them flawlessly in both Speech and Writing (L3)
- write paragraphs and Emails in formal correspondence effectively (L3)
- participate confidently in any formal discussion and introduce themselves unhesitatingly (L3)

Unit 2

Vocabulary: How to talk about various speech habits. **Grammar**: Learning Verb forms, Tenses and Subject-verb agreement and using them accurately in both Speaking and Writing contexts. **Writing:** Essay Writing and formal correspondence through Emails. **Speaking:** Four major

areas -Subject Knowledge, Oral Communication Skills, Leadership Skills and Team Management-of GD; Real time GDs for Evaluation.

Learning Outcomes

- At the end of the module, the learner will be able to
- Acquire vocabulary and use it contextually (L2)
- use Verb forms, Tense and subject verb agreement for effective speaking and writing (L3)
- produce coherent expressions for professional writing (L4)

participate confidently in any formal discussion and introduce themselves unhesitatingly (L3)

Unit 3

Vocabulary: How to insult your enemies**. Grammar:** Sentence Analysis & Synthesis - Voice, Degrees of Comparison, Reported Speech and Types & Forms of sentences. **Writing:** Report writing and Emails for formal correspondence**. Speaking:** Roles in structured GDs; real time GDs for practicing the above roles.

Learning Outcomes

- At the end of the module, the learner will be able to
- Acquire vocabulary and use it contextually(L2)
- identify the complexity in the structure of a sentence (L2)
- write technical reports and emails for professional communication (L3)
- participate confidently in any formal discussion and introduce themselves unhesitatingly (L3)

Unit 4

Vocabulary: How to flatter your friends**. Grammar**: Common errors and Correction of Sentences **Reading:** Reading Comprehension passages through Skimming and Scanning and understanding the gist or the specific purpose of them.. **Writing:** Letter writing and Emails. **Speaking:** Advantages of GDs for hiring process ; real time GDs for evaluating.

Learning Outcomes

At the end of the module, the learner will be able to

- Acquire vocabulary and use it contextually(L2)
- comprehend a passage and know its gist(L3)
- avoid the errors in both Speech and Writing (L2)
- write letters and emails for official communication(L3)
- participate confidently in any formal discussion and introduce themselves unhesitatingly (L3)

Unit 5

Vocabulary & Grammar: High-frequency words for all competitive exams, Clause ,Phrase & Idioms**. Reading:** Reading for Comprehending **Writing:** Business Letters and Emails **Speaking:** Group Discussions for Evaluation

Learning Outcomes

At the end of the module, the learner will be able to

- Acquire vocabulary and use it contextually(L2)
- use grammatically correct structures for formal communication (L3)
- write Business Letters effectively (L3)
- participate confidently in any formal discussion and introduce themselves unhesitatingly (L3)

Reference Books

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018.
3. Skilful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
4. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012. (Student Book, Teacher Resource Book, CD & DVD)
5. Word Power Made Easy by Norman Lewis

Subject Code	Subject Name	L	T	P	C
R20BSH-MC2102	Essence of Indian Traditional Knowledge Common to MEC, ECE & EEE	2	0	0	0

Course Objectives:

- Facilitate students with the concepts and roots of traditional knowledge system.(L2)
- Importing thought process reasoning and inference sustainability of Indian traditional knowledge system (L2)
- Comprehend the legal frame work, traditional knowledge, biological diversity act 2002 . (L3)
- Focus on traditional food and modern food. (L2)
- Facilitate traditional knowledge in various sectors. (L3)

Course Outcomes:

After completion of the course students will be able to:

1. Knowledge about the concept of traditional knowledge(L2)
2. Apply significance of traditional knowledge protection(L3)
3. Analyze various enactments related to the protecting facets of traditional knowledge. (L2)
4. Evaluate the significance Traditional Knowledge and modern food. (L2)
5. Compare the traditional knowledge in various sectors(L2)

Unit-I:

Introduction to Traditional Knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, Indigenous Knowledge(IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge vis-à-vis formal knowledge.

Learning Outcomes:

At the end of the unit the student will able to:

- Recognize the social change in traditional knowledge(L2)
- Contrast and compare characteristics importance kinds of traditional knowledge.(L2)
- Analyze physical and social contexts of traditional knowledge. (L3)

Applications: Compare and contrast the traditional knowledge with formal knowledge.

Unit-II:

Protection of Traditional Knowledge: Need for protecting traditional knowledge, Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Learning Outcomes:

At the end of the unit the student will able to:

- Identify the need of protecting traditional knowledge.(L2)
- Apply significance of TK protection.(L3)
- Analyze the value of TK in global economy. (L3)

Applications: Identify and implementation of traditional knowledge in present scenario.

Unit-III:

Legal framework and Traditional knowledge: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act, 2001 (PVPFR Act), The Biological Diversity Act 2002 and Rules 2004,

Systems of traditional knowledge protection- Legal concepts for the protection of traditional knowledge-Certain non IPR mechanisms of traditional knowledge protection.

Learning Outcomes:

At the end of the unit the student will able to:

- Contrast and compare the Scheduled Tribes and other traditional forest dwellers. (L2)
- Analyze plant variant protections and evaluate farmers right act. (L4)
- Analyze legal concepts for the protection of Traditional Knowledge.(L4)

Applications: Case study to recognize legal concepts, protection of culture and Indian traditional knowledge.

Unit-IV:

Traditional knowledge in Food: Evolution of Indian cuisine, Importance of traditional food – Styles of traditional food- Modern Food-Harmful effects of modern food, Factors influencing food choice- Economic and Physical Determinants-Uniqueness of Culture in Food.

Learning Outcomes:

At the end of the unit the student will able to:

- Recognizing the significance of Traditional food (L2)
- Awareness about the harmful effects of modern food.(L3)

Applications: Distinguish between nutrition levels of traditional and modern food items

Unit-V:

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture.

Learning Outcomes:

At the end of the unit the student will able to:

- Compare traditional knowledge in different sectors. (L2)
- Apply traditional knowledge in engineering. (L3)

Applications: Comparative study of traditional knowledge with current practices in different sectors.

Text Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino.

Reference Books:

1. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta and Vipin Kumar Singh, Pratibha Prakashan 2012.
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002

II YEAR -II Semester

Subject Code	Subject Name	L	T	P	C
R20BSH-MA2201	Complex Variables and Statistical Methods	3	0	0	3

Course Objectives:

- To familiarize the learners with concepts of complex variables.
- To impart knowledge in basic concepts and few techniques in probability and statistics in relation to the engineering applications.

Course Outcomes:

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

1. Examine the analyticity of complex functions. (L3)
2. Evaluate complex integration using Cauchy's theorems and Cauchy's residue theorem. (L3)
3. Compute probabilities, theoretical frequencies using discrete and continuous probability distributions for real data. (L3)
4. Apply the concept of hypothesis test to large samples. (L3)
5. Apply statistical inferential methods to small samples. (L3)

UNIT I:

Complex Variables and Analytic Functions: Functions of a complex variable, continuity, differentiation, analytic functions, Cauchy-Riemann equations, Milne-Thompson method, harmonic functions, harmonic conjugate.

Applications: Flow problems.

Learning Outcomes:

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

- examine continuity and differentiability for complex functions. (L2)
- determine the analyticity using Cauchy-Riemann equations to complex functions. (L3)
- find the analytic function using Milne-Thompson method. (L3)

UNIT II:

Complex Integration (All theorems without proofs) **:** Contour integrals, Cauchy theorem, Cauchy integral formula, Taylor's series, Laurent's series, zeros of analytic functions, singularities, residues, Cauchy residue theorem.

Applications: Evaluation of real integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and $\int_{-\infty}^{\infty} f(x)dx$

Learning Outcomes:

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

- evaluate the Taylor and Laurent expansions of simple functions.(L2)
- determine the nature of the singularities of an analytic function. (L2)
- find the residues of an analytic function. (L2)
- apply Cauchy residue theorem to evaluate improper real integrals. (L3)

UNIT III:

Probability Theory: Probability(Read only):introduction, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem,.

Probability Distribution: Random variable concept, distribution function, density function, Binomial distribution, Poisson distribution, Normal(Gaussian) distribution.

Learning Outcomes:
At the end of this unit, the student will be able to

- evaluate the probabilities of events on various random experiments. (L3)
- apply Baye's theorem to real time problems related to conditional probabilities.(L3)
- differentiate the properties in discrete and continuous probability distribution. (L2)
- apply Binomial and Poisson distributions for real data to compute probabilities, theoretical frequencies. (L3)
- interpret the properties of normal distribution and its applications. (L2)

Unit IV:

Estimation and Testing of Hypothesis, large sample tests:
Estimation and Testing of Hypothesis: Introduction to Sampling, parameters, statistics, sampling distribution, point and interval estimation, formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors.
Large sample tests: Test for single proportion, difference of proportions, test for single mean and difference of means, confidence interval for parameters in one sample and two sample problems.
Learning Outcomes:
At the end of this unit, the student will be able to

- explain the concept of estimation, interval estimation and confidence intervals. (L2)
- apply the concept of hypothesis testing for large samples. (L3)

Unit V:

Small Sample Tests: Student t-distribution (single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for single variance, $\chi 2$ - test for goodness of fit, ANOVA(1-way).
Learning Outcomes:
At the end of this unit, the student will be able to

- apply the concept of testing hypothesis for small samples to draw the inferences. (L3)
- estimate the goodness of fit.(L3)

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44/e, 2017.
2. Veerarajan T., Probability, Statistics and Random Processes, 3rd edition, Tata McGraw-Hill, New Delhi, 2008.

References:

1. Erwin kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7/e, Mc-Graw Hill, 2004.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008.
4. Murray R. Spiegel,Seymour Lipschutz, John J. Schiller , Dennis Spellman,Schaum's Outline of Complex Variables, 2ed (Schaum's Outlines) 2nd Edition.
5. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye, Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson.
6. Miller and Freunds, Probability and Statistics for Engineers, 7/e, Pearson, 2008.

7. S. C. Guptha and V. K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand and Sons Publications, 2012.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2201	Dynamics of Machinery	3	0	0	3

Course Objective:

- Understand the concept of gyroscope and precession on stability of cars, ships and planes etc.
- Understand the laws of friction, brakes and dynamometers.
- Impart the method of calculating dynamic force analysis on slider crank mechanism as well as learn the design and analysis of flywheel, Various concepts on design and types of governors along with other topics such as sensitiveness and hunting.
- Know the methods of balancing of rotating masses and balancing of reciprocating masses as well.
- Analyze the basics of vibration as well as to find out the methods to calculate the natural frequencies of different systems.

Course outcomes:

After completion of this unit, students will be able to

1. Identify various Active, Passive components, Measuring Instruments and test their functionality. (L2)
2. Analyze the V-I characteristics of PN junction and Zener Diodes (L4)
3. Design Half wave and Full wave rectifiers with and without filters (L2)
4. Analyze the input and output V-I characteristics of Transistors and JFETs (L4)
5. Analyze the V-I characteristics of UJT and SCR. (L4)

UNIT –I

Precession: Gyroscopes, effect of precession motion on the stability of moving vehicles such as motor car, motorcycle, aero planes and ships.

Application: Stability of Aero plane, Marine Ship , Four wheeler and Two wheelers.

Learning Outcomes:

After completion of this unit student will able to

1. Explain the stability of vehicles on road, sea and air (L2)
2. Analyze the gyroscopic effects on aeroplanes, ships and automobiles (L4)

UNIT –II

Friction: Inclined plane, friction of screw and nuts, pivot and collar, uniform pressure, uniform wear, friction circle and friction axis: lubricated surfaces, boundary friction, film lubrication.

Clutches: Friction clutches- single disc or plate clutch, multiple disc clutch, cone clutch, centrifugal clutch.

Application: Transmission Systems In Automobile, lifting systems

Learning Outcomes:

After completion of this unit student will able to

1. Understand the working principle of transmission system (L1)
2. Analyze the effect of friction on pivot and collar bearings (L4)

UNIT –III

Turning Moment Diagrams: Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – flywheels and their design.

Governors: Watt, porter and proell governors, spring loaded governors – Hartnell and Hartung with auxiliary springs. sensitiveness, isochronisms and hunting.

Application: Punching press, shearing machine, Paper cutting machine, stitching machine.

Learning Outcomes:

After completion of this unit student will able to

1. Explain the fluctuation of energy and speed in IC Engines (L2)
2. Analyze slider crank mechanism for turning moment on crankshaft (L4)
3. Analyze the function of governors according to the load conditions (L4)

UNIT –IV

Balancing: Balancing of rotating masses single and multiple –single and different planes, use analytical and graphical methods. Primary, secondary, and higher balancing of reciprocating masses. analytical and graphical methods, unbalanced forces and couples – examination of "V" multi cylinder in line and radial engines for primary and secondary balancing, locomotive balancing, hammer blow, swaying couple, variation of tractive effort.

Application: In-line Engines, V-Engines, Locomotives.

Learning Outcomes:

After completion of this unit student will able to

1. Explain static and dynamic balancing using force and couple diagrams (L2)
2. Determine unbalanced forces and couples in rotary and reciprocating engines (L2)

UNIT –V

Vibrations: Free Vibration of spring mass system, transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly's methods, Rayleigh's method, whirling of shafts, critical speeds, vibration isolation and transmissibility.

Application: Leaf Spring, Coil Springs.

Learning Outcomes:

After completion of this unit student will able to

1. Analyze the natural frequencies of vibrating system (L4)
2. Explain undamped and damped free vibrations(L2)

Text Books:

1. Theory of Machines / S.S Rattan/ Mc. Graw Hill Publ.
2. Theory of machines / Khurmi / S.Chand.

References:

1. Mechanism and machine theory by Ashok G. Ambedkar, PHI Publications.
2. Theory of Machines / Shigley / MGH – Rajput

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2202	Fluid Mechanics& Hydraulic Machinery	3	0	0	3

Course Objectives

- To understand the basic principles of fluid mechanics
- To study the types of flows, energy equation and momentum equation
- To explain the importance of impulse momentum equation
- To familiarize with the types of turbines and analyse their characteristics
- To understand the working of pumps & their performance

Course Outcomes

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

1. Apply the principles of fluid statics to analysing the fluid properties and utilize the measurement devices for determining pressure in practical scenarios. (L3)
2. Apply the principles of fluid kinematics and dynamics to analysing flow characteristics using continuity, energy, Bernoulli's, and momentum equations, and evaluate flow through pipes considering Darcy-Weisbach and minor losses, while incorporating boundary layer concepts and dimensional analysis. (L3)
3. Apply the impulse-momentum principle to assess the hydrodynamic forces on stationary and moving vanes to determine work done and efficiency for different vane configurations in turbomachinery. (L3)
4. Analyse the performance and operational characteristics of hydraulic turbines by interpreting unit and specific quantities, performance curves, and solving related problems. (L4)
5. Analyse the performance of centrifugal and reciprocating pumps by evaluating head losses, efficiencies, specific speed, and operational configurations such as pumps in series and parallel, and interpreting discharge, slip, and indicator diagrams. (L4)

Unit I

Basics of Fluid Statics: Units & Dimensions, Physical properties of fluids- Density, Specific gravity, Specific weight, Viscosity; Compressibility, Vapour pressure, Capillarity and surface tension and their influence on fluid motion, Atmospheric, Gauge and Vacuum pressures, Measurement of pressure, Piezometer, U-tube manometer and Differential manometers

Applications: Pressure measurement devices, water dams and gates, liquid storage tanks

Learning outcomes:

After completion of this unit, students will be able to

- Interpret the properties of fluid and their application (L2)
- Understand the basic properties of fluid at rest (L2)

Unit II

Fluid Kinematics & Dynamics: Flow characteristics, Concepts of system and Control volume, Continuity equation, Application of control volume to continuity, Energy equation, Euler equation, Bernoulli’s equation and Momentum equation

Flow through Pipes: Darcy Weisbach equation, Minor losses in Pipes, Boundary layer concepts & Introduction to Dimensional Analysis

Applications:

1 In meteorology to understand the formation of clouds
2 Calculating forces and moments on aircraft & determining the mass flow rate of petroleum through pipelines

3 To find out the types of losses in fluid flow
4 To identify the stalling in aircrafts
5 Calculation of Reynolds number of fluid flow

Learning outcomes:

After completion of this unit, students will be able to

- Identify various types of flows (L1)
- Apply Bernoulli's principle for determining flow in measuring devices (L3)

Unit III

Basics of Turbo machinery: Impulse momentum equation , Hydrodynamic force of jet striking stationary and moving vanes, flat and curved vanes, centrally and tangentially, series of vanes, radial vanes, velocity triangles, work done and efficiency.

Applications: Hydraulic Turbines, Blowers and aircrafts

Learning outcomes:

After completion of this unit, students will be able to

- Classify turbines based on principle of operation (L2)
- Estimate hydrodynamic forces exerted by jet on blades (L2)
- Solve for forces exerted by the fluid through impulse momentum equation (L3)

Unit IV

Hydraulic Turbines: Classification of hydraulic turbines- Impulse and Reaction turbines, Pelton, Francis and Kaplan turbines, working principles, Unit and specific quantities, performance curves-problems

Applications: Hydraulic power plants

Learning outcomes:

After completion of this unit, students will be able to

- Explain construction and operation of different Turbines (L2)
- Classify turbines based on principle of operation (L2)
- Select suitable turbine for operating conditions (L3)

Unit V

Centrifugal Pumps: Classification, Working Principles, Manometric head losses and efficiencies, Specific speed, Pumps in series and parallel,

Reciprocating Pumps: Working, Discharge, Slip-indicator diagram, Air vessels.

Applications: For pressure boosting and feeding water to boilers in power plant

Learning outcomes:

After completion of this unit, students will be able to

- Explain construction and operation of different pumps (L2)
- Classify pumps based on principle of operation (L2)
- Solve the efficiencies of pumps (L3)
- Identify pump suitable for an application (L3)

Text Books:

1 P N Modi and S M Seth, Hydraulics & Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017
2 Bansal R.K., “Fluid Mechanics and Hydraulic Machines”, 5th edition, Laxmi Publications (P)Ltd., New Delhi, 1995.

References:

1 R.K.Rajput, “A Textbook of Fluid Mechanics and Hydraulic Machines”, 3rd edition, S. Chand, 2006.

2 Frank. M. White, “Fluid Mechanics”, 7th edition, McGraw Hill, 2011.
3 Yunus Cengel, John Cimbala, Fluid Mechanics, McGraw Hill Education, 2017

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2203	Production Technology	3	0	0	3

Course Objectives:

- Introduce fundamental manufacturing processes and criteria for selecting suitable techniques
- Explain casting and forming principles, process steps, and defect identification methods.
- Explore forging and sheet metal forming techniques, focusing on industrial applications and defect remedies
- Familiarize students with metal joining processes such as welding, soldering, and brazing, along with defect prevention strategies
- Impart knowledge on the processing techniques of plastics and powder metallurgy with a focus on sustainability and applications.

Course Outcomes:

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

1. Understand the importance and selection of various manufacturing processes. (L2)
2. Explain the principles of casting and forming processes, along with common defects and their causes. (L2)
3. Apply the principles of forging and sheet metal forming to real-world industrial applications. (L3)
4. Apply metal joining techniques to fabricate components and identify defects with suitable corrections. (L3).
5. Describe the processing methods and sustainability aspects of plastics and powder metallurgy. (L2)

UNIT I

Introduction: Importance and selection of manufacturing processes.

Casting Processes: Introduction to casting process, process steps; pattern: types, materials and allowance; Cores: Types of cores, core prints, principles and design of gating system; Solidification of casting: Concept, solidification of pure metal and alloy; Special casting processes: Shell casting, investment casting, die casting, centrifugal casting, casting defects and remedies.

Applications:

1 Heavy Equipment: Construction, farming and mining
2 Defence: Vehicles, artillery, munitions, storage and supporting equipment
3 Hardware: Plumbing industry pipes, joints, valves and fitting

Learning Outcomes:

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

- Selection of suitable manufacturing processes for a given product. (L3)
- Understand the steps involved in metal casting, pattern making. (L2)
- Apply the knowledge of designing gating systems, risers. (L3)
- Identify the various casting defects. (L3)

UNIT II

Metal Forming: Introduction, nature of plastic deformation, hot and cold working of metals, mechanics of metal forming; Rolling: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements; Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.

Applications: Metal Forming can be used in to manufacture of piping and tubes, body panels, construction materials, electrical motors, doors, production of tubes and hollow pipes, frames, doors and windows

Learning Outcomes:

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

- Compare cold working and hot working processes. (L2)
- Explain the working of rolling mills. (L2)
- Evaluate the forces and power in rolling and extrusion processes. (L5)

UNIT III

Forging: Principles of forging, tools and dies. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects. Sheet metal forming: Mechanics of sheet metal working, blanking, piercing, bending, stamping.

Applications:

- Aircraft Engines ,Airframe and auxiliary equipment
- Bearings, ball and roller
- Pumps and compressors, Steam Engines and turbines
- Pipeline fittings

Learning Outcomes:

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

- Explain the working of various extrusion processes. (L2)
- Identify the principles of forging, tools and dies. (L3)
- Simplify the various operations of Sheet metal forming. (L6)

UNIT IV:

Metal Joining Processes: Classification of welding processes, types of welds and welded joints and V-I characteristics, arc welding, weld bead geometry, submerged arc welding, gas tungsten arc welding, gas metal arc welding. applications, advantages and disadvantages of the above processes, other fabrication processes. Heat affected zones in welding; soldering and brazing: Types and their applications, Welding defects: causes and remedies.

Applications:

1. Welding of tubes and pipes, chains, LPG cylinders and other items.
2. Fabrication of Steel furniture, gates, doors and door frames, and body
3. Manufacturing white goods such as refrigerators, washing machines

Learning Outcomes:

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

- Classify the working of various welding processes. (L2)

- Compare V-I characteristics of different welding processes. (L4)
- Explain the applications, advantages of various welding processes. (L2)
- Identify the defects in welding. (L3)

UNIT V:

Plastics: Types, properties and their applications, processing of plastics, extrusion of plastics, transfer molding and compression molding, injection molding, thermoforming, rotational molding and blow molding

Powder Metallurgy: Principle manufacture of powders, steps involved.

Applications:

1 Manufacturing white goods such as refrigerators, washing machines

Learning Outcomes:

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

- Explain the methods of manufacturing plastics parts. (L2)
- Show the applications of powder metallurgy. (L2)

Text Books:

1 Rao P.N., Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.

2 Kalpakjian S and Schmid S.R., Manufacturing Engineering and Technology, 7/e, Pearson, 2018.

Reference Books:

1. Millek P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 4/e, John Wiley and Sons Inc, 2010.

1 Sharma P.C., A Textbook of Production Technology, 8/e, S Chand Publishing, 2014.

2 Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1st Edition, Springer, 2010.

Subject Code	Subject Name	L	T	P	C
R20BSH-HM2203	Managerial Economics and Industrial Management	3	0	0	3

Course Objectives:

- Inculcate the basic knowledge with the concepts of Economics & Demand and current business environment.(L2).
- Identify micro environment in which markets operate, how price determination is done under different kinds of competitions and know the different forms of Business organization. .(L2)
- Provide fundamental knowledge on Management, Administration, Organization methodologies (L2)
- Equip with knowledge of Inventory and Quality control (L3)
- Analyses the PERT/CPM techniques for better Project Management (L4)

Course Outcomes:

1. Equipped with the knowledge of fundamentals of economics, estimating the Demand for a product, Capable of analyzing Elasticity & Forecasting methods(L2)
2. Apply production concepts, assess the costs and Determine Break Even Point (BEP) of an enterprise for managerial decision making(L4)
3. Apply concepts & principles of management & designs of organization in practical world. (L3)
4. Apply principles of Work-study, Quality Control techniques and Inventory control in industry(L3)
5. Develop PERT/CPM Charts for projects of enterprise and estimate time & cost of project. (L4)

Unit – I:

Introduction to Managerial Economics: Definition, Nature and scope of Managerial Economics, Demand Analysis- Concept, Determinants , Law of Demand and its exceptions. Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Methods of Demand Forecasting

Learning Outcomes:

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

- Awareness about basics of managerial economics(L1)
- Knowledge of the concepts of demand, elasticity of demand and methods of demand forecasting(L1)

Application:

1. Analyze the demand of a product by applying methods of the elasticity of demand.

Unit – II:

Cost Analysis: Cost Analysis: Cost concepts, cost behavior and cost types-Fixed Cost,Variable Cost Opportunity Cost, Out of Pocket Costs vs. Imputed Costs, Explicit cost Vs Implicit cost, Breakeven Analysis (BEA) - Determination of Breakeven Point (simple problems), Managerial Significance and limitations of BEA.

Learning Outcomes:

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

- Apply Break – Even Analysis and its importance in managerial decision making(L4)

Application:
Compute contribution, revenue, Cost comparison, Margin of safety for making accurate decisions related to profitability of particular Enterprise.

Unit III:

Industrial Management: Concepts of Industrial Management-Nature-Functions- Evolution of Management Thought –Principles of Traditional and scientific management Motivational theories- Maslow and Douglas Mc Gregor theories- Decision making Process.

Learning Outcomes:
At the end of this unit students will be able to:

- Acquire the techniques, skills and modern engineering tools necessary for engineering practice.(L3)
- Apply concepts& principles of management & structures of organization in a practical world(L3)
- Evaluate management aspects and its implementation in aim of achieving organizational goals(L5)

Applications: Divide the class into two teams' old employees and new joiners and motivate the work environment with respect to excellent management and the supportive.

Unit IV:

Operations Management: Classification of production systems-Plant layout and Process layout-Work Study-Ergonomics-Therbligs - Inventory Management: Objectives-Functions, Inventory Controlling Techniques and Inventory controlling costs-EOQ(Simple problems)-ABC Analysis, VED Analysis.

Learning Outcomes:
At the end of this unit students will be able to:

- Compare Job and Mass Production related to manufacturing process(L2)
- Utilization of quality control techniques inProduction process .(L3)
- Estimate qualitative and quantitative techniques of inventory management.(L2)

Applications:
Study the Inventory control employed in Big Bazaar and frames the basic inventory models which represent the inventory management.

UNIT V:

Project Management: Project planning and control- Development of network-Difference between Program Evaluation Review Technique and Critical Path Method- Identifying critical path - project crashing (simple problems)-Statistical Quality Control: X-bar chart, R chart, C chart and P chart, (simple Problems)-Deming's principles.

Learning Outcomes:
At the end of this unit students will be able to:

- Analyze methods of reducing the time and cost of the project.(L2)
- Visualize Project handling and control the techniques for optimum utilization of resources(L2)
- Develop PERT/CPM networks for projects of an enterprise and estimate time & cost of project(L4)

Application:
Estimation of the cost and time of the High way Corridor of the Visakhapatnam Metro Tram Project.

Text Books:

1. Industrial Engineering and management by O.P Khanna, Khanna Publishers.
2. 2.Managerial Economics and Financial Analysis by A.R.Aryasri, TMH, 2012.
3. 3.Industrial Engineering and Production Management, MartandTelsang, S.Chand&
4. Company Ltd. New Delhi.
5. 4.Management Science by Aryasri; Publisher: Tata McGraw Hill, 2009
6. Management by James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R. Gilbert
7. 6th Ed; Publisher: Pearson Education/Prentice Hall.

Reference Books :

1. Raghunatha Reddy &Narasimhachary, Managerial Economics & Financial Analysis, Scitech, 2009.
2. Varshney&Maheshwari, Managerial Economics, Sultan Chand& Sons, 2014.
3. S.A. Siddiqui and A.S. Siddiqui, Managerial Economics and Financial Analysis, New Age International Publishers, Hyderabad, 2013
4. Dwivedi, Managerial Economics, Vikas 2012.
5. Industrial Management by Bhattacharya DK, Vikas publishers
6. Industrial Engineering by Banga& Sharma.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2204	Production Technology Lab	0	0	3	1.5

Course Objectives:

- Acquire practical knowledge on Metal Casting, Welding, Press Working and Processing of Plastics.
- To study different testing methods for silica sand, moulding sand and design of pattern
- To study SMAW, GMAW, GTAW, Oxy-acetylene welding and resistance spot welding processes

Course Outcomes:

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

1. Understood how To make different patterns, Mould preparation, Melting and Casting (L2)
2. Understand usage, operations and applications of welding like ARC, GAS and TIG (L2)
3. Analyze Brazing and Soldering operations and their applications (L4)
4. Describe how to do Blanking & Piercing operations with simple, compound and progressive dies on Mechanical press (L2)
5. Explain about bulk forming processes and sheet metal operations like Deep drawing and sheet bending operations on Hydraulic Press. (L2)

1. Metal Casting

a) Pattern making
   i. Single piece pattern
   ii. Split piece pattern

a) Gating Design and pouring time and solidification time calculations.
b) Sand Properties Testing – Exercise for Strength and Permeability.
c) Molding, Melting and Casting for ferrous/ non ferrous materials.

2. WELDING

a) Arc Welding
b) TIG Welding.
c) MIG Welding.
d) Friction stir welding
e) Any other Special Welding Processes.

3. MECHANICAL PRESS WORKING

a) Press Tool: Blanking and Piercing operation with Simple, Compound and Combination dies.
b) Closed die forging, Deep Drawing and Extrusion operations.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2205	Fluid Mechanics& Hydraulic Machinery Lab	0	0	3	1.5

Course Objectives:

- To develop skills in flow measurement and real fluid flow problems
- To impart knowledge in measuring pressure, discharge and velocity of fluid flow
- To understand Major and Minor Losses in pipes
- To gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head

Course Outcomes

Upon the successful completion of course, students will be able to

1. Apply laws of conservation in verification of principles of fluid flow (L3)
2. Calibrate flow measuring devices such as Venturimeter, orifice meter (L4)
3. Examine the water supply pipe networks, by evaluating the losses incurred in pipes (L4)
4. Identify suitable pumps and turbines for different working conditions (L4)
5. Analyze the performance characteristics of Hydraulic Machines (L4).

List of Experiments

1 Calibration of Venturimeter
2 Calibration of Orifice meter
3 Loss of head due to friction in pipes - Major Losses
4 Loss of head due to pipe fittings - Minor Losses
5 Impact of a jet on Vanes
6 Performance characteristics of single centrifugal pump.
7 Performance characteristics of multi stage centrifugal pump.
8 Performance characteristics of reciprocating pump.
9 Performance characteristics of Pelton wheel turbine.
10 Performance characteristics of Francis turbine.

Subject Code	Subject Name	L	T	P	C
R20MEC-PC2206	Theory of Machines Lab	0	0	3	1.5

Course Objectives:

- To find whirling speed of shaft
- To find the position of sleeve under controlling force.
- To analyze the motion of a gyroscope.
- To determine frequency of damped and undamped for free and forced vibration..
- To determine static and dynamic balancing using rigid blocks.

Course Outcomes:

On completion of this lab student will be able to

1. Analyze the behavior of rotating systems, including critical speeds, gyroscopic motion, and the influence of unbalanced forces, using theoretical and experimental approaches. (L4).
2. Analyze the dynamic behavior of governors and gyroscopes, plotting performance characteristics for stability and control in mechanical systems.(L4)
3. Determine the natural frequencies of free and forced vibrations in a spring-mass systems under damped and undamped conditions.(L5).
4. Apply concepts of static and dynamic balancing techniques for rotating masses to achieve proper balancing (L3).
5. Evaluate the kinematic and dynamic parameters of mechanical systems such as cam-follower, slider-crank mechanisms, and frictional parameters of power transmission systems using graphical, analytical, and experimental methods. (L5).

List of Experiments:

1. To determine the whirling speed of the shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyze the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of a spring mass system
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel
8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism
10. To find coefficient of friction between belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage , velocity ratio and efficiency
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears.

Subject Code	Subject Name	L	T	P	C
R20BSH-SC2201	MATLAB For Computational Methods (Skill Oriented Course) Common to MEC & CIT	1	0	2	2

Course Objectives:

- To familiarize the MATLAB Programming for numerical techniques.
- To impart knowledge in basic concepts and few programming techniques using MATLAB in relation to the engineering applications.
- Carry out computational projects within numerical methods using MATLAB.

Course Outcomes:

At the end of the course students will be able to

1. Construct and apply small programs in MATLAB to mathematical problems. (L3)
2. Develop a program to find a real root of an equation using various numerical methods.(L3)
3. Develop programs to find the interpolation values using Lagrange's and Newton's interpolation formulae for a given set of points.(L3)
4. Develop programs to find solutions of ordinary differential equations using various numerical methods. (L3)
5. Develop programs to solve system of linear equations. (L3)

Module 1. MATLAB Basics: Basics for MATLAB, Input and Output operations, arithmetic operations, recovering from problems, errors in input, aborting calculations, algebraic or symbolic computation, substituting in symbolic expressions, symbolic expressions, variable Precision and exact arithmetic, vectors and matrices, suppressing output, functions, built-in functions, user-defined functions, managing variables. Programs on MATLAB basics.

List of Programs:

1. Mathematical computing using Built-in functions.
2. Symbolic Mathematics using Built-in functions

Module 2. MATLAB Programming: Writing scripts and functions, loops, arrays, conditional statements. Programs using functions, loops, arrays and conditional statements. Two-Dimensional Plots.

List of Programs:

1. Script files and functions on Mathematical problems.
2. Programming using loops and conditional statements.
3. MATLAB Code for Two-Dimensional Plots.

Module 3. MATLAB Programming for Numerical Methods: Root finding, interpolation, numerical differentiation, numerical integration, numerical solutions of ordinary differential equations and MATLAB Solvers for differential equations and Numerical Methods.

List of Programs:

1. MATLAB Code for Bisection Method, Regula Falsi Method, Newton-Raphson Method and Iterative methods.
2. MATLAB Code for Newton forward, backward interpolation formula and Lagrange's interpolation formula
3. MATLAB Code for the first order and second order derivatives of the given data.
4. MATLAB Code for trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

5. MATLAB Code for Euler methods modified Euler's methods and Runge-Kutta method of fourth order.
6. MATLAB Code for Gauss-Seidel iteration method.
7. MATLAB Code for solving engineering problems
8. MATLAB Solvers for differential equations and numerical methods.

Suggested Books:

1. B.S. Grewal, Numerical Methods in Engineering & Science, Khanna Publishers, 2014.
2. Steven Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists-McGraw-Hill Higher Education (2006).
3. Sastry, S.S, Introductory Methods of Numerical Analysis, 5th edition, Prentice Hall, 2017.
4. MiszaKalechman, Practical MATLAB Basics For Engineers, CRCPress (2008).
5. John H. Mathews, Kurtis D. Fink, Numerical methods using MATLAB, Prentice Hall (1998).
6. RudraPratap, Getting Started with MATLAB A Quick Introduction for Scientists and Engineers,Oxford University Press (2010).
7. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press(2006).
8. S.R. Otto and J.P. Denier, An Introduction to Programming and Numerical Methods in MATLAB Springer-Verlag London Limited(2005).
9. YogeshJaluria, Computer Methods For Engineering With MatlabApplications,Taylor &Francis(2011).
10. William Bober, Introduction to Numerical and Analytical Methods with MATLAB for Engineers and Scientists, CRC Press(2014).
11. Rao V. Dukkipati, MATLAB: An Introduction with Applications, New Age International (P) Limited, Publishers(2010)