Course Title	TRANSFORMS AND STATISTICAL METHODS	Semester	III
Course Code	MVJ20MME31	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 2 : 2 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 hrs

Course objective is to: This course will enable students to

- Comprehend and use of analytical and numerical methods in different engineering fields.
- Apprehend and apply Fourier Series.
- Realize and use of Fourier transforms.
- Realize and use of Z-Transforms.
- Use of statistical methods in curve fitting applications.

Module-1	**RBT Level** L1,L2,L3	08 Hrs.

Laplace Transform: Definition and Laplace transforms of elementary functions. Laplace transforms of Periodic functions and unit-step function and problems.

Inverse Laplace Transform: Definition and problems, Convolution theorem to find the inverse Laplace transforms and problems.

Applications: Solution of linear differential equations using Laplace transforms.

Web Link and Video Lectures:

https://www.youtube.com/watch?v=8oE1shAX96U

https://www.intmath.com/laplace-transformation/7-inverse-laplace-transform.php

https://www.youtube.com/watch?v=HSGgORdJAQg

https://www.youtube.com/watch?v=Pq-tUQzeSRw

Module-2	**RBT Level** L1,L2,L3	08 Hrs.

Fourier series: Recapitulation of Series, Continuous and Discontinuous functions, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 2l and arbitrary period 2π, Half-range Fourier sine and cosine series, Practical Harmonic Analysis and Problems.

Web Link and Video Lectures:

https://www.youtube.com/watch?v=Sq2FhCxcyI8

https://www.youtube.com/watch?v=4N-IwHUCFa0

https://www.youtube.com/watch?v=UGuOVeoo3QE

https://www.youtube.com/watch?v=x04dnqg-iPw

https://nptel.ac.in/courses/111106111/

Module-3	RBT Level L1,L2,L3	08 Hrs.

Fourier transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem and problems.

Applications: Applications of Fourier Transforms.

Web Link and Video Lectures:

https://www.youtube.com/watch?v=spUNpyF58BY

https://www.youtube.com/watch?v=6spPyJH6dkQ

https://www.youtube.com/watch?v=WcNPUXfxCXA

Module-4	RBT Level L1,L2,L3	08 Hrs.

Z-Transforms: Difference Equations, basic definition, Z-Transforms - definition, Standard Z-transforms, Damping rule, Shifting rule, Initial-value and Final-value theorems (without proof) and problems, Inverse Z-transforms.

Applications: Application of Z- transforms to solve difference equations.

Web Link and Video Lectures:

http://www.eas.uccs.edu/~mwickert/ece2610/lecture_notes/ece2610_chap7.pdf

https://electricalbaba.com/final-value-theorem-and-its-application/

https://www.engr.siu.edu/staff/spezia/Web438A/Lecture%20Notes/ET%20438A%20Lecture%202%20pt%202.pdf

http://www.nptelvideos.in/

https://www.classcentral.com/

Module-5	RBT Level L1,L2,L3	08 Hrs.

Curve Fitting: Curve fitting by the method of least squares. Fitting of the curves of the form $y = ax^2 + bx + c$, $y = ae^{bx}$.

Statistical Methods: Introduction, Correlation and coefficient of correlation, Regression, lines of regression and problems.

Web Link and Video Lectures:

https://mathbits.com/MathBits/TISection/Statistics2/correlation.html

https://www.youtube.com/watch?v=xTpHD5WLuoA

https://www.youtube.com/watch?v=fNLeogEjMmM

https://www.youtube.com/watch?v=tl5QNhSe0Yk

Course outcomes:

CO1	Use Laplace transform and inverse transforms techniques in solving differential equations.
CO2	Learn to represent a periodic function in terms of sine and cosine functions.

CO3	Demonstrate Fourier Transform as a tool for solving Integral equations.
CO4	Apply Z Transform to solve Difference Equation. Use Method of Least Square for appropriate Curves.
CO5	Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.

Text Books:	
1.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2.	Prof. G.B.Gururajachar, "Engineering Mathematics –III, Academic Excellent series publications, 2016 – 17.

Reference Books:	
1.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014.
2.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
3	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition.
4	Jain R. K. & Iyengar S.R.K., Advanced Engineering Mathematics, Narosa Publishing House, 2002.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (10 marks)
- Assignment (10 marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	MECHANICS OF MATERIALS	Semester	III
Course Code	MVJ20ME32	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3: 2 : 0	SEE	50
No. of Contact Hours/week	05	Total	100
Credits	04	Exam. Duration	03 Hrs

Course objective is to:

- This course will give details about various engineering materials behaviour when dealing under different load combinations and help us to study the induced stresses, strains and deformation.
- To study the distribution of various stresses in mechanical elements that deform under various loads.

Module-1	RBT Level L1, L2	10 Hrs.

Stresses and Strains: Stress and strain due to axial force, elastic limit, Hooke's law-factor of safety -stepped bars, uniformly varying sections, stresses in composite bar due to axial force and temperature. Strain Energy due to axial force- proof resilience, stresses due to gradual load, sudden load, and impact load.

Lab Sessions:

- The material property like modulus of elasticity can also be found for different engineering materials like copper, bronze, aluminium apart from mild steel (Material testing lab can be used).

Applications: The students will be asked to find stresses and strains induced in various applications like, chair/bench where the students are sitting, strain in the shoe while jogging, in the concrete building etc.

Video link:
https://www.mtu.edu/materials/k12/experiments/tensile/

Module-2	RBT Level L1, L2	10 Hrs.

Changes in Dimensions and Volume: Lateral strain - Poisson's ratio, volumetric strain, changes in dimensions and volume, shear stress, shear strain, relationship between elastic constants. Hoop and Longitudinal stresses in thin cylindrical and spherical shells under internal pressure- changes in dimensions and volume.

Lab Sessions:

- A practical observation of strain gauges will be given, one of the most important sensors of the electrical measurement technique applied to the measurement of mechanical quantities like forces, pressure etc (metrology and measurement lab can be used).

Applications: Change in dimensions in all three directions for different geometrical cross sections like square, rectangle can be found for a minimum two different materials with application of loads

Video link: https://www.youtube.com/watch?v=qHi8FPnWP6E

Module-3	RBT Level L1, L2, L3	10 Hrs.

Principal Stresses and Strains: (Two dimensional only) State of stress at a point - normal and tangential stresses on a given plane, principal stresses and their planes, plane of maximum shear stress, analytical method, Mohr's circle method, application to simple problems, Strain Rosettes.

Lab Sessions:

- Material subjected to 2D state of stress (wood and ply wood) and its analysis can be thought using Ansys software under static condition (Computer Aided Modelling and Analysis lab can be used).

Applications: Mohr's circle can be used to find the principal plane in wood materials.

Video link: https://www.youtube.com/watch?v=wbkvJmUEKHY

Module-4	RBT Level L1, L2, L5	10 Hrs.

Bending Moment and Shear Force: Relationship between load, shear force and bending moment - shear force and bending moment diagrams for cantilever, simply supported and overhanging beams under concentrated loads, uniformly distributed loads, uniformly varying loads, concentrated moments, maximum bending moment and point of contra flexure.

Flexure in Beams: Theory of simple bending and assumptions - derivation of equation, section modulus, normal stresses due to flexure.

Lab Sessions:

- A cantilever and simply supported beam subjected to different types of loads like point load, UDL, UVL couple can be thought using Ansys software under static condition (Computer Aided Modelling and Analysis lab can be used).

Applications: The importance of the beam cross section for a particular loading condition will be thought by taking some case studies like Metro Train pillars.

Video link: https://www.youtube.com/watch?v=-9DYHrqq51E		
Module-5	RBT Level L1, L2,L3	10 Hrs.
Deflection of Determinate Beams: Governing differential equation - Macaulay's method-moment area method, application to simple problems; Bending moment and shear force diagram of a typical shaft, elastic instability, Euler Formula. *Torsion:* Theory of torsion and assumptions-derivation of the equation, polar modulus, stresses in solid and hollow circular shafts, power transmitted by a shaft, close coiled helical spring with axial load. Lab Sessions: • Dynamic analysis of a shaft subjected to torque can be thought using Ansys software (Computer Aided Modelling and Analysis lab can be used). Applications: A propeller shaft of an automobile which transmits power and motion from engine to the wheels. Video link: https://www.youtube.com/watch?v=cZwg6XYpzRw		

Course outcomes:	
CO1	Upon completion of this course, the students can be able to apply mathematical knowledge to calculate the deformation behaviour of simple structures.
CO2	Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behaviour for different types of loads.
CO3	Analyse the deflection in beams.
CO4	Analyse buckling and bending phenomenon in columns, struts, and beams.
CO5	Analysis of shaft for various cross sections.

Text Books:	
1	Popov E P, "*Mechanics of Materials*", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.
2	Heam E J, "*Mechanics of Materials*", Vol. I, Pergamon Press, 1977.
Reference Books:	
1	Ramamrutham S and Narayan R, "*Strength of Materials*", Dhanpat Rai and Sons, New Delhi, 1997.
2	Singh D K, "*Strength of Materials*", ANE Books, 2007.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks) - Assignment (10 marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	2	1	2	1
CO2	3	3	1	2	2	3	2	-	2	2	1	2
CO3	3	2	2	3	3	1	-	-	2	1	2	1
CO4	3	3	2	3	3	2	1	-	2	2	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Course Title	THERMODYNAMICS	Semester	III
Course Code	MVJ20ME33	CIE	50
Total No. of Contact Hours	40 L: T : P :: 2: 2:0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 hrs

Course objective is to:

- Introduce basic concepts of thermodynamics
- Learn first law and second law of thermodynamics.
- Learn entropy and ideal gas behaviour

Module-1	RBT Level L1,L2,L3	8 hrs

Fundamental Concepts & Definitions: Thermodynamics; definition and scope. Microscopic and Macroscopic approaches. Engineering Thermodynamics Definition. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state, change of state, path and process, quasistatic process, Cycle. Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium- Zeroth law of thermodynamics, Temperature; concepts, scales, measurement.

Work & Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; at part of a system boundary, at whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. other types of work. Heat; definition, units and sign convention.

Applications: IC Engines, Thermometers, Dynamometer etc.

Video link:

1. https://www.youtube.com/watch?v=WFMIzS2jQQg&t=48s
2. https://nptel.ac.in/courses/112105123/

Module-2	RBT Level L1, L2, L3	8 hrs

First Law of Thermodynamics: Joule's experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non -cyclic processes, energy, energy as a property, modes of energy, Specific heat at constant volume, enthalpy, specific heat constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications.

Laboratory Sessions Experimental learning:

First law for open system- (Use HMT Lab heat exchanger)

- Flow hot water through tubes, find the inlet temperature of water and outlet temperature of water. With the help of steam table find inlet and outlet enthalpy for the corresponding temperature. Use steady flow energy equation and continuity equation find the mass flow rate of water
- Making Model for Perpetual Motion Machine (PMM1) _ Group activity

Applications: Compressors, Turbines, IC engines etc

Video link:

1. https://www.youtube.com/watch?v=10FlW80XN64
2. https://nptel.ac.in/courses/112104113/

Module-3	RBT Level L1,L2,L3	8 hrs

Second Law of Thermodynamics: Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Reserved heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamic; PMM I & PMM II . Clausius's statement of Second law of Thermodynamic; Equivalence of the two statements; Reversible and irreversible processes; factors that make a process irreversible, reversible heat engine, Carnot cycle, Carnot principles. Thermodynamic temperature scale.

Applications: Refrigerator, Heat Pump, Heat Engines etc

Video link :

1. https://www.youtube.com/watch?v=cobFAMZDS0o
2. https://nptel.ac.in/courses/112108148/

Module-4	RBT Level L1,L2,L3	8 hrs

Entropy: Clausius inequality; statement, proof, application to a reversible cycle. Q/T as independent of the path. Entropy; definition, a property, principle of increase of entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Introduction to available and unavailable energy.

Pure Substances: P-T and P-V diagrams, triple point, and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor, and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use.

Laboratory Sessions/ Experimental learning:

- Take two fluids hot and cold measure temperature of hot fluid and cold fluid by thermometer and find mass. After mixing of both the fluid find the entropy change.
- Calculate the entropy change of universe for the following cases:
    a) Metal block of mass m1, Cp and T1 placed in water whose temperature is T2
    b) The same block at temp T1 is dropped from a height 100 into the water
    c) Two different blocks of different temperatures are joined together
- M1 mass of water at T1 temperature is brought into contact with heated water of temperature T2 when T1 temperaure of water reached T2 temperature find the entropy change. What will be the entropy change if water get T2 temperature in no of stages?
- Draw T-S diagram experimentally by taking T1 temperature of cold water which get heated to T2 temperature of water at 1 atm pressure

Applications: Air conditioning, Boilers etc

Video link :

1. https://www.youtube.com/watch?v=YM-uykVfq_E
2. https://nptel.ac.in/content/storage2/courses/112108148/pdf/Module_4.pdf

Module-5	RBT Level L1,L2,L3	8 hrs

Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties.

Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases.

Applications: Exhaust gas equipment designs, Compressor designs etc.

Video link:

1. https://www.youtube.com/watch?v=2mv4XqF4uZs
2. https://www.youtube.com/watch?v=o9ueYSKj9og

Course outcomes:	
CO1	Define the basic concepts of thermodynamics like systems, equilibrium, process etc. and its applications.
CO2	Realize the laws of thermodynamics and apply to solve engineering, problems.
CO3	Identify the different types of work and heat transfer mechanisms.
CO4	Differentiate reversible and irreversible process using second law and entropy concepts.
CO5	Understand the behaviour of ideal gases and real gases at various conditions.

Text Books:	
1	T R Sitaraman, " *Basic Thermodynamics*", Interline Publishing
2	Nag P.K. "*Basic & Applied Thermodynamics*". Tata McGraw Hill Pub. Co, 2nd edition
Reference Books:	
3	Yunus A. Cenegal and Michael A. Boles "*Thermodynamics -An Engineering Approach*". Tata McGraw-Hill, 7th edition
4	Claus Borgnakke, Richard Edwin Sonntag, "*Fundamentals of Thermodynamics*" 8th Edition, WILEY, ISBN - 9781306947732

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks) - Assignment (10 marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-
CO4	2	2	3	3	-	-	-	-	-	-	-	-
CO5	2	3	2	3	-	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	MATERIALS ENGINEERING	Semester	III
Course Code	MVJ20ME34	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3:0:0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 Hrs

Course objective is to:

- Understand various crystal structures of engineering materials and their mechanical properties.
- Understand different material failure criteria.
- Learn behaviour of different phases in the material.
- Understand different heat treatment processes used for engineering materials.
- Understand behaviour alloys and alloying elements.

Module-1	RBT Level L1,L2,L3	08 Hrs.

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

Laboratory Sessions/ Experimental learning:

- Making Models of all Crystal Structures using Tenis Balls or Thermocol.
- Plot stress strain curves from the raw data obtained from the laboratory equipment.
- Compare stress strain curves of different Engineering Materials

Applications: Crystal Structure and Mechanical Properties of all engineering materials used for developing products for engineering applications.

Video link / Additional online information:

http://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1

Module-2	RBT Level L1,L2,L3	08 Hrs.

Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics:

intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Creep, Fracture with fatigue, Introduction to non-destructive testing (NDT)

Laboratory Sessions/ Experimental learning:

- Demonstrate non-destructive tests, like dye penetrant test for a shaft collected from nearby garage.

Applications: Used in design the structural components **Video link / Additional online information**:

https://www.youtube.com/watch?v=_XgzMR-9cWk

Module-3	RBT Level L1, L2, L3	08 Hrs.

Alloys, substitutional and interstitial solid solutions: Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.

Laboratory Sessions/ Experimental learning*:*

- To generate pattern of change in colour of material when they are undergoing phase change from liquid to solid.

Applications: Developing different alloy metals.

Video link / Additional online information:
https://www.youtube.com/watch?v=waLo6Yqtsug

Module-4	RBT Level L1, L2, L3	08 Hrs.

Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

Laboratory Sessions/ Experimental learning:

- Use any one Heat treatment process for cooling of mild steel.

Applications: Used in engineering applications to develop products.

Video link / Additional online information:
https://www.youtube.com/watch?v=748_MEOpOAg

Module-5	RBT Level L1, L2, L3	08 Hrs.

Alloying of steel: properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys. Laboratory Sessions/ Experimental learning: • To observe the microstructure of the brass, bronze and Al alloys Applications: Used in engineering applications to develop products. Video link / Additional online information: https://www.youtube.com/watch?v=lExZrAcNTyw

Course outcomes:	
CO1	Understand different crystal structures applicable for engineering materials and basic mechanical properties of engineering materials.
CO2	Realize the different theories of failures and use to solve engineering problems.
CO3	Understand various phases of alloys and interpret their mechanical behaviour
CO4	To understand different heat treatment processes used in mechanical industries.
CO5	Understand the behaviour of alloy steels and their phases.

Text Books:	
1.	W. D. Callister, "*Materials Science and Engineering-An Introduction*", Wiley India, 6th Edition, 2006.
2.	Kenneth G. Budinski and Michael K. Budinski, *Engineering Materials*, Prentice Hall India, 4th Edition, 2002.
Reference Books:	
1.	V. Raghavan, "*Material Science and Engineering*", Prentice Hall India, 5th Edition, 2004

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks) - Assignment (10 marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	-	-	-	-	-	-	-
CO2	3	3	2	1	-	-	-	-	-	-	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-
CO4	2	2	3	2	-	-	-	-	-	-	-	-
CO5	2	3	2	1	-	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	MANUFACTURING PROCESS	Semester	3
Course Code	MVJ20ME35	CIE	50
Total No. of Contact Hours	40 L: T : P :: 3: 0 :0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3hrs

Course objective is to:

- Recognize the various manufacturing principles and techniques. To gain theoretical and practical knowledge in material casting processes and develop an understanding of the dependent and independent variables which control materials casting in a production setting.
- Describe moulding, patterns and moulding furnaces. Determine the appropriate parameters for different manufacturing processes. Justify the most appropriate manufacturing process for a given product.
- To enable the students to acquire a fundamental knowledge on metal forming technology which is necessary for an understanding of industrial processes and to introduce students to the wide range of materials and processes in plastic region, which are currently used in manufacturing industry.
- To provide methods of analysis allowing a mathematical/physical description of polymer processing and powder metallurgy techniques in manufacturing.
- To enable the students to identify the processes characteristics, select the main operator parameters, the tool geometry and materials, and determine forces and power required to select the main and auxiliary equipment for all non-conventional machining.

Module-1	RBT Level L1,L2,L3	08 Hrs.

Prerequisites: Basics of materials Science.

Manufacturing Process: Introduction to basic manufacturing, Classification of manufacturing process, Primary manufacturing process of Iron and Aluminium, Primary and Secondary Manufacturing process classification and Applications. Introduction about metal casting.

Pattern Making: Functions of pattern, Classification of pattern, Different pattern materials, various pattern allowances in design of pattern, Simple problems in design of pattern.

Mould Making: Moulding sand ingredients, Types of Moulds, Mould making, Desirable properties of Sand Mould, functions of cores. Concept of gating system, different types of gating systems, gating system design, risering design.

Laboratory Sessions/ Experimental learning:

- Demonstration of casting and moulding process (sand casting) in foundry laboratory.

Applications:

- Engineering and Developments Limited: Sand Casting Foundry UK, Casting Foundry UK, Sand Castings Manufacturer
  https://youtu.be/1x3uJ-KSyjY
  https://www.youtube.com/watch?v=1x3uJ-KSyjY
- Society of Manufacturing Engineers - https://www.sme.org/
- Shell Mould Casting Process : https://www.youtube.com/watch?v=28_I7Bdz4yY
- Die Casting Process : https://www.youtube.com/watch?v=0XkDK46rwvQ
- Aluminium Casting Process :
  https://www.youtube.com/watch?v=UmVjLSDDHIY&list=PLUvI3up7Htf6kur1fu1yRIrdNBwqJQ4po&index=18

Video link / Additional online information:

- Sand Casting Process: https://www.youtube.com/watch?v=mx1qteRUYwI
- Fundamentals of manufacturing processes, Mechanical Engineering, Dr. D. K. Dwivedi IIT Roorkee, Video Lecture. --- https://nptel.ac.in/courses/112/107/112107219/
- Manufacturing Process Technology -Part I Mechanical Engineering, Dr. Shantanu Bhattacharya, IIT Kanpur, Video Lecture
  https://nptel.ac.in/courses/112/104/112104195/
- Sand Casting Animation by Force Beyond (https://www.forcebeyond.com)
  https://www.youtube.com/watch?v=fCyaJ8Q76U8

Module-2	RBT Level L1,L2,L3	08 Hrs.

Metal Forming Processes: Advantages of Mechanical Working Processes, Difference Between Hot and Cold Working, Advantages and Disadvantages of Cold and Hot Working Processes, Classification of Metal Forming Processes.

Forging: Introduction, Classification of Forging, Die Forging with Power Hammers, Open Die Forging, Impression Die Forging, Closed Die Forging, Forging Defects.

Rolling: Introduction, Nomenclature of Rolled Products, Mechanism of Rolling, and Types of Rolling Mill, Rolls and Roll Pass Design, Ring Rolling, Cold Rolling.

Laboratory Sessions/ Experimental learning:

- Demonstration of forging and rolling operations in Foundry laboratory.

Applications:

- MIT - Massachusetts Institute of Technology - http://web.mit.edu/2.810/www/files/lectures/2015_lectures/lec6-sheet-metal-forming-2015.pdf
- Simufact Engineering – manufacturing simulation specialists – https://www.simufact.com/fields-of-application-forming.html

Video link I Additional online information:

- Principles of Metal Forming Technology, Mechanical Engineering. Dr. Pradeep K. Jha IIT Roorkee, Video Lecture.
- https://nptel.ac.in/courses/112/107/112107250/

Module-3	RBT Level L1,L2,L3	08 Hrs.

Extrusion, Wire Drawing, Tube Drawing and Making: Introduction, Extrusion Processes, Machines for Extrusion, Extrusion Defects, Wire Drawing, Tube Drawing.

Press Work and Die-Punch Assembly: Tools, Bending, Deep Drawing, Coining and Embossing, Coining.

Special casting processes: Shell moulding, investment casting, Gravity die casting, Pressure die casting, Centrifugal casting, Continuous casting, Injection moulding. Defects in casting

Laboratory Sessions/ Experimental learning:

- Demonstration of tube bending, die and punch assembly and grinding operations in Machine Shop.

Applications: Reliable EDM - Tool and Die Making –

https://www.youtube.com/watch?v=z31J8Y4FeIU&list=PLC75FAAB1F1C22EED&index=3

Video link / Additional online information:

Society of Manufacturing Engineers (SME)

- Tool Materials

: https://www.youtube.com/watch?v=OuH9bIwTazE&list=PLB8F8FCFCB2E640DE

- Cutting Tool Design:

https://www.youtube.com/watch?v=GCQT4I99zX4&list=PLB8F8FCFCB2E640DE&index=2

- Fixture Design:

https://www.youtube.com/watch?v=SJ1nvKNwLRU&list=PLB8F8FCFCB2E640DE&index=3

- Progressive Die Design:

https://www.youtube.com/watch?v=S9qzJat3Mzk&list=PLB8F8FCFCB2E640DE&index=4

- Rapid Tooling Design:

https://www.youtube.com/watch?v=3CVEUVl61G8&list=PLB8F8FCFCB2E640DE&index=6

- Trouble Shooting Tool and Die Design:

https://www.youtube.com/watch?v=JFo7eooXE2w&list=PLB8F8FCFCB2E640DE&index=8

Module-4	RBT Level L1,L2,L3	08 Hrs.

Powder Metallurgy: Introduction to powder metallurgy, Preparation of powders (Atomization, Electrolysis, and Granulation Process, Mechanical Alloying), Powder Blending, Powder Compaction, Sintering. Finishing operations, application of powder metallurgy products, advantages and limitations. ***Plastic Products Manufacturing Process***: Injection moulding, Extrusion, and Blow moulding. Galvanizing Process and Electroplating Process.

Brief discussion on following topics: Micro Machining and Nano Machining Process, Super Plasticity, Solidification Mechanism and volume shrinkage.

Laboratory Sessions/ Experimental learning:

- Demonstration of welding process and sheet metal work in the Welding shop

Applications:

- European Powder Metallurgy Association :

https://www.epma.com/powder-metallurgy-process

- Comtec Mfg., Inc – Powder Metallurgy Specialist

https://www.youtube.com/watch?v=azGg68B-GlA

Video link / Additional online information:

1. NPTEL : Powder Metallurgy Material :

https://nptel.ac.in/content/storage2/courses/112101005/downloads/Module_3_Lecture_6_final.pdf

2. ASME *:* Powder Metallurgy and its Applications : www.asminternational.org

https://www.asminternational.org/documents/10192/1849770/Z05438L_Sample.pdf/fee7b45-917b-4911-bc5d-bd8dac26e153

3. EPMA : Powder Metallurgy Component Production Cycle :

https://youtu.be/_eM49JlmFp0

Module-5	RBT Level L1,L2,L3	08 Hrs.

Non-Conventional Machining Processes:

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, Electrical Discharge Machining, principle and processes parameters with sketches. Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining Principle.

Laboratory Sessions/ Experimental learning:

Demonstration of crystal structure of various materials and etching process in Material Testing Laboratory.

Applications:

1. M/s Holepop Manufactures of EDM Machines :
   https://www.holepop.com/about-our-company
   https://www.holepop.com/common-applications-for-electrical-discharge-machining/
2. M/s Ainnovative International Pvt Ltd
   https://www.waterjet.co.in/waterjet-applications.htm

Video link / Additional online information:

1. Introduction to Non-Traditional Machining by N. Sinha Department of Mechanical Engineering
   IIT Kanpur -- http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf
2. Introduction to Non-Traditional Machining by N. Sinha Department of Mechanical Engineering
   IIT Kanpur : Video Lecture -- https://nptel.ac.in/courses/112105212/
3. Society of Manufacturing Engineers :
   a) EDM Manufacturing Process : https://www.youtube.com/watch?v=L1D5DLWWMp8
   b) LBM Manufacturing Process : https://www.youtube.com/watch?v=PQuAr4bs-Mc
   c) Abrasive Machining Process: https://www.youtube.com/watch?v=N0iXh80_jXU
   d) Water Jet Machining Process : https://www.youtube.com/watch?v=4Begp-_zJ70

Course Outcomes:	
C01	Identify and explain all the steps involved in basic casting processes.
C02	Identify and explain the principle behind metal forming process and detail all the forging and rolling process.
C03	Categorise and explain all the special casting processes and Press and Die punch assembly
C04	Understand the process of Powder Metallurgy and Polymer product manufacturing process along with micro and Nano machining.
C05	Categorise and explain the non-conventional Machining Process and its applications.

Text Books:	
1.	Serope Kalpakjain and Steve R Schmid, "*Manufacturing Engineering and Technology*", 6th Edition SI Units, Pearson – Prentice Hall Publication.
2.	P.C. Pandey and H. S. Shan, "*Modern Machining Process*", Tata McGraw-Hill Publishing company Ltd. 33rd Reprint.
3.	Mikell. P. Groover, "*Fundamentals of Modern Manufacturing: Materials, Processes, and systems*".
Reference Books:	
1.	Degarmo, Black & Kohser, "*Materials and Processes in Manufacturing*"
2.	P N Rao, "*Manufacturing Technology: Foundry, Forming and Welding*", 2nd Edition Tata Mc Graw-Hill Publication.
3.	O.P Khanna, "*Foundry Technology*", Dhanpat rai publications-2003 reprint.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks) - Assignment (10 marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO MAPPING												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	2	2	2	-	-	-	-	-	-	-	-	-
C02	2	2	2	-	-	-	-	-	-	-	-	-
C03	2	2	2	-	-	-	-	-	-	-	-	-
C04	2	2	2	-	-	-	-	-	-	-	-	-
C05	2	2	2	-	-	-	-	-	-	-	-	-
Avg	2	2	2	-	-	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	MACHINE DRAWING	Semester	III
Course Code	MVJ20ME36	CIE	50
Total No. of Contact Hours	40 L: T : P :: 2: 0 :2	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	03	Exam. Duration	03 Hr

Course objective is:

- To acquire the knowledge of CAD software and its features. Make the students to understand of the devices, instruments.
- To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.
- To familiarize the students with Indian Standards on drawing practices.
- To impart knowledge of thread forms, fasteners, keys, joints, couplings and Assembly Drawings.

Module-1	RBT Level L1, L2	08 Hrs.

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry.

Orthographic views: Conversion of pictorial views into orthographic projections of simple machine parts with and without section. (Bureau of Indian Standards conventions are to be followed for the drawings), Hidden line conventions, Precedence of lines.

Laboratory Sessions/ Experimental learning:

- Conversion ISO view to orthogonal view of different machine components to be done using available software tool in the lab.

Applications: All manufacturing Industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=-_qz8_sbhwY
2. https://www.youtube.com/watch?v=zO8coRhrJM0

Module-2	RBT Level L1,L2,L3	08 Hrs.

Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal and External), square, Acme and Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut.

Laboratory Sessions/ Experimental learning:

- 2D drawing of a different type of threads are practiced using available software tool in the lab and same threads are manufactured in M/C shop.

Applications: Assembly and sub assembly of components.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=TPURJnlekeo
2. https://www.youtube.com/watch?v=Z38Aq9ykUCM

Module-3	RBT Level L1,L2,L3	04 Hrs.

Riveted joints: Single and double riveted lap joints, Butt joints with single/double cover straps (Chain and zigzag using snap head riveters).

Laboratory Sessions/ Experimental learning:

- Lap and Butt joint of different plate thickness are drawn using soft wear.

Applications: Bridge construction, Boiler construction, Automobile sheet metal assembly. Video link / Additional online information:

https://www.youtube.com/watch?v=C5ZPaCvoigw

Module-4	RBT Level L3,L4	04 Hrs.

Joints: Cotter joint (socket and spigot), Knuckle joint (pin joint) for two rods.

Laboratory Sessions/ Experimental learning:

- 2D Drawing are drawn using software & 3D individual parts are made and assembled as per given drawing.

Applications: Power transmission assembly, Automobile (Heavy Trucks) industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=J9Aj17MAyLY
2. https://www.youtube.com/watch?v=esfr74WhbYg
3. https://www.youtube.com/watch?v=qjGF08LvZ9M

Module-5	RBT Level L3,L4	16 Hrs.

Assembly Drawings: (Part drawings shall be given)

1. Plummer block (Pedestal Bearing)
2. I.C. Engine connecting rod
3. Screw jack (Bottle type)

4. Tailstock of lathe

5. Machine vice

6. Lathe square tool post

Laboratory Sessions/ Experimental learning:

- 3D individual parts are made and assembled as per given drawing.

Applications: Heavy equipment manufacturing, IC engine manufacturing, Automotive industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=boyN1l3fA6g&list=PLQL-DlNb9_TVqG1Zrw-9F-S0LItg3T5fD
2. https://www.youtube.com/watch?v=yKl_FiUdAu4&list=PLQL-DlNb9_TUHs8CUXYw-Lna-Gp4rTu9g
3. https://www.youtube.com/watch?v=pyzsBiU-raE&list=PLQL-DlNb9_TXofoObUwlRjLzPst-sRbG3

Course outcomes:	
CO1	Students will be able to convert Orthographic views of machine parts with and without sectioning in 2D.
CO2	Able to understand design of thread forms and Sectional views for threads in 2D.
CO3	Students able to Draw the Hexagonal and square headed bolt and nut with washer, screw assemblies in 2D.
CO4	Students will be able to draw the single and double riveted joints, in 2D.
CO5	Students will be able to construct assemblies of mechanical component in 3D environment and able to generate 2D and 3D draft.

Text Books:	
1.	N.D.Bhat & V.M.Panchal, "*Machine Drawing*", Published by Charotar Publishing House, 1999.
2.	N.Siddeshwar, P.Kannaih, V.V.S. Sastri, "*Machine Drawing*" published by Tata Mc.Grawhill, 2006.
Reference Books:	
1.	S. Trymbakaa Murthy, "*A Text Book of Computer Aided Machine Drawing*" CBS Publishers, New Delhi, 2007.
2.	K.R. Gopala Krishna, "*Machine Drawing*" Subhash publication.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	-	-	-	-	3	1	3
CO2	3	3	1	1	2	-	-	-	-	1	1	1
CO3	3	3	1	1	2	-	-	-	-	1	2	1
CO4	3	3	3	1	2	-	-	-	-	1	2	1
CO5	3	3	3	2	2	-	-	-	-	1	3	3

High-3, Medium-2, Low-1

Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.
Module 1 (Q1) or Module 2 (Q2): 12.5 Marks Weightage
Module 3 (Q3) or Module 4 (Q4): 12.5 Marks Weightage
Module 5 (Q5) or Module 5 (Q6): 25 Marks Weightage

Course Title	MECHANICS AND MATERIALS TESTING LAB	Semester	III
Course Code	MVJ20MEL37	**CIE**	50
Total No. of Contact Hours	20 L : T : P :: 00:01:03	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	02	**Exam. Duration**	3 hrs

Course objective is to:

- Prepare and characterize the specimens for microstructure.
- Conduct standard tests to characterize the mechanical properties of engineering materials.
- Understand the significance of materials failure theories.
- To understand the influence of treatment processes on the mechanical properties of engineering materials.

	EXPERIMENTS
	PART-A
1.	Impact Test: Determining the impact strength of a given material using Charpy & IZOD tests.
2.	Tension Tests using Universal Testing Machine: Tension test on the given specimens (at least 2 materials for comparison) and to plot the stress strain graphs.
3.	Compression Tests using Universal Testing Machine: Compression test on the given specimens and to plot the stress strain graphs.
4.	Bending and Double Shear Tests using Universal Testing Machine: Bending test, Double Shear test on the given specimens and to plot the stress strain graphs.
	PART-B
5.	Hardness Test: Estimating the Hardness of different Engineering materials using Brinell"s & Rockwell Hardness Testers
6.	Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of any 3 of the following materials, plain carbon steel, tool steel, grey C.I, SG iron, Brass, Bronze & composites.

7.	Demonstration of any two NDT methods to students.
8.	Demonstration of wear test to students.
9.	Conduct of torsion test on Mild steel specimen.

Course outcomes:	
CO1	Develop experimentation skills in the field of material testing
CO2	Conduct Tension, Compression, Bending & Shear tests on UTM and evaluate material properties.
CO3	Conduct Hardness & Impact tests and determine various hardness numbers and impact energy
CO4	Apply the knowledge of testing methods in related areas.
CO5	Develop the aptitude for reading and understanding the microstructure of the materials

Reference Books:	
1.	Dieter, "*Mechanical Metallurgy*" 3rdEdition, 2013, McGraw Hill Education (India) Private Limited.

Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.

1	One question is to be set from Part-A: 20 Marks
2	One question is to be set from Part-B: 20 Marks
3	Viva – Voce: 10 marks

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	1	1	1	1	3	1	3
CO2	3	3	1	1	2	1	1	1	1	1	1	1
CO3	3	3	1	1	2	1	1	1	1	1	2	1
CO4	3	3	3	1	2	1	1	2	2	1	2	1
CO5	3	3	3	2	2	1	1	1	1	1	3	3

High-3, Medium-2, Low-1

Course Title	FOUNDRY, FORGING AND WELDING LAB	Semester	III
Course Code	MVJ20MEL38	CIE	50
Total No. of Contact Hours	20 L : T : P :: 00:01:03	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	02	Exam. Duration	3 hrs

Course objective is to:

- Provide an insight into the testing of moulding sand and core sand properties.
- To provide an insight into different moulding practices.
- To provide training to students to enhance their practical skills in welding of different joints.
- To practically demonstrate precautions to be taken during the forging, foundry and welding practices.

EXPERIMENTS

PART-A

Testing of Moulding sand and Core sand (MINOR EXPERIMENT)

Preparation of sand specimen's and conduction of the following tests:

1. Compression, Shear, Transverse and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Core hardness & Mould hardness tests.
4. Sieve Analysis to find Grain Fineness number of Base Sand
5. Clay content determinations in Base Sand.
6. Moisture content test in Base Sand

Foundry Practice (MAJOR EXPERIMENT)

Use of foundry tools and equipment. Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes). Preparation of one casting (Aluminium or cast iron-Demonstration only)

EXPERIMENTS

PART-B

Forging Operations (MAJOR EXPERIMENT)

1. Calculation of length of the raw material required to do the model.
2. Preparing minimum three forged models involving upsetting, drawing and bending operations.

Welding Practice (MINOR EXPERIMENT) Use of Arc welding tools and welding equipment, Preparation of welded joints using Arc Welding equipment, L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats	
Course outcomes:	
CO1	Demonstrate the knowledge and necessary skills to perform sand testing and preparation of moulds and Foundry practices.
CO2	Demonstrate skills in forging different shapes and geometries.
CO3	Demonstrate skills in preparation of various welding joints on M.S flats using Arc welding

Reference Books:	
1.	Rao P N, "*Manufacturing Technology: Foundry, Forming and Welding*" Volume 14th Edition, 2013, McGraw Hill Education (India) Private Limited.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1	One Major Question to be chosen from either PART A or PART B for 20 Marks
2	One Minor Question to be chosen from PART A for 10 Marks and PART B for 10 Marks
3	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	1	1	1	1	3	1	3
CO2	3	3	1	1	2	1	1	1	1	1	1	1
CO3	3	3	1	1	2	1	1	1	1	1	2	1
CO4	3	3	3	1	2	1	1	2	2	1	2	1
CO5	3	3	3	2	2	1	1	1	1	1	3	3

High-3, Medium-2, Low-1

Electronic Universal Testing Machine in Mechanics and Materials Testing Lab

LPG Fired Gas Furnace in Foundry, Forging and Welding Lab

Course Title	Additional Mathematics-I (Common to all branches)	Semester	III
Course Code	MVJ20MATDIP31*	CIE	50
Total No. of Contact Hours	40 L : T : P :: 2* : 1* : 0	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	-	Exam. Duration	3 Hrs.

Course objective is to: This course viz., aims to prepare the students:

To familiarize the important and basic concepts of Differential calculus and Differential Equation, ordinary/partial differential equations and Vector calculus and analyse the engineering problems.

Module-1	RBT Level L1,L2	8 Hrs.

Differential calculus: Recapitulations of successive differentiations -n^{th} derivative -Leibnitz theorem and Problems, Mean value theorem -Rolle's theorem, Lagrange's Mean value theorem , Cauchy's theorem and Taylor's theorem for function of one variables.

Video Link:

https://users.math.msu.edu/users/gnagy/teaching/ode.pdf

Module-2	RBT Level L1,L2	8 Hrs.

Integral Calculus:

Review of elementary Integral calculus, Reduction formula

$\int_0^{\frac{\pi}{2}} sin^m x\, dx$, $\int_0^{\frac{\pi}{2}} cos^m x\, dx$, $\int_0^{\frac{\pi}{2}} sin^m cos^n x\, dx$ and problems.

Evaluation of double and triple integrals and Simples Problems.

Video Link:

https://www.youtube.com/watch?v=rCWOdfQ3cwQ

https://nptel.ac.in/courses/111/105/111105122/

Module-3	RBT Level L1,L2	8 Hrs.

Vector Calculus: Derivative of vector valued functions, Velocity, Acceleration and related problems, Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. Vector identities - div (ϕA), curl (ϕA), curl (grad ϕ), div (curl A).

Video Link: https://www.whitman.edu/mathematics/calculus_online/chapter16.html https://www.math.ust.hk/~machas/vector-calculus-for-engineers.pdf		
Module-4	**RBT Level L1,L2,L3**	8 Hrs.
Probability: Introduction-Conditional Probability, Multiplication theorem, Independent events, Baye's theorem and Problems. Video Link: https://www.khanacademy.org/math/statistics-probability/probability-library https://nptel.ac.in/courses/111/105/111105041/		
Module-5	**RBT Level L1,L2,L3**	8 Hrs.
Differential equation: Homogenous differential equation, Linear differential equation, Bernoulli's differential equation and Exact differential equation. Video Link: https://www.mathsisfun.com/calculus/differential-equations.html		

Course outcomes:	
CO1	Apply the knowledge of Differential calculus in the modeling of various physical and engineering phenomena
CO2	Apply the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes.
CO3	Study on Vector calculus to understand the various solution to Application to Engineering problems.
CO4	Understand the basic Concepts of Probability
CO5	Solve first order linear differential equation analytically using standard methods.

Text Books:	
1.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.

Reference Books:	
1.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition, 2014.
2.	G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (10 marks)
- Assignment (10 marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours..

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	1
CO2	2	3	0	3	0	0	0	0	0	0	1	1
CO3	2	2	0	2	0	0	0	0	0	0	1	0
CO4	3	2	0	3	0	0	0	0	0	0	0	1
CO5	3	3	0	2	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

Course Title	UNIVERSAL HUMAN VALUES - I	Semester	III
Course Code	MVJ20UHV310	CIE	50
Total No. of Contact Hours	20 L : T : P :: 1 : 0 :0	SEE	50
No. of Contact Hours/week	1	Total	100
Credits	1	Exam. Duration	3 Hours

Course objective is to:

- Perceive the need for developing a holistic perspective of life
- Sensitise the scope of life – individual, family (inter-personal relationship), society and nature/existence, Strengthening self-reflection
- Develop more confidence and commitment to understand, learn and act accordingly

Module-1	L1, L2, L3	04 Hours

Welcome and Introductions: Getting to know each other (Self-exploration)

Aspirations and Concerns: Individual academic, career, Expectations of family, peers, society, nation, Fixing one's goals (Basic human aspirations Need for a holistic perspective Role of UHV)

Self-Management: Self-confidence, peer pressure, time management, anger, stress, Personality development, self-improvement (Harmony in the human Being)

Health: Health issues, healthy diet, healthy lifestyle, Hostel life (Harmony of the Self and Body Mental and physical health)

Relationships: Home sickness, gratitude, towards parents, teachers and, others Ragging and interaction, Competition and cooperation, Peer pressure (Harmony in relationship Feelings of trust, respect, gratitude, glory, love)

Society: Participation in society (Harmony in the society)

Natural Environment: Participation in nature (Harmony in nature/existence)

Video link:

1. https://youtube.com/playlist?list=PLYwzG2fd7hzc4HerTNkc3pS_IvcCfKznV
2. https://youtube.com/playlist?list=PLYwzG2fd7hzcZz1DkrAegkKF4TseekPFv

Presentation: https://fdp-si.aicte-india.org/AicteSipUHV_download.php

Module-2	L1, L2, L3	04 Hours
Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Self-exploration as the Process for Value Education, Happiness and Prosperity – Current Scenario. **Video link:** 1. https://www.youtube.com/watch?v=85XCw8SU084 2. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3pZ3yA7g_OAQz 3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Module-3	**L1, L2, L3**	**04 Hours**
Introduction to Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body, The Body as an Instrument of the Self, Harmony of the Self with the Body. **Video link:** 1. https://www.youtube.com/watch?v=GpuZo495F24 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Module-4	**L1, L2, L3**	**04 Hours**
Introduction to Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society. **Video link:** 1. https://www.youtube.com/watch?v=F2KVW4WNnS8 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Module-5	**L1, L2, L3**	**04 Hours**
Introduction to Implications of the Holistic Understanding: Natural Acceptance of Human Values, Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Holistic Technologies, Production Systems and Management Models-Typical Case Studies. **Video link:** 1. https://www.youtube.com/watch?v=BikdYub6RY0 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Course outcomes:		
CO2	Develop a holistic perspective about life	

CO3	Explore his/her role (value) in all aspects of living – as an individual, as a member of a family, as a part of the society as an unit in nature
CO4	Become more responsible in life, and in handling problems with sustainable solutions
CO5	Have better critical ability
	Become sensitive to their commitment

Reference Books:	
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	-	-	-	2	2	3	2	1	2	1
CO2	-	1	-	-	-	2	2	3	2	1	2	1
CO3	-	1	-	-	-	2	2	3	2	1	2	1
CO4	-	1	-	-	-	2	2	3	2	1	2	1
CO5	-	1	-	-	-	2	2	3	2	1	2	1

High-3, Medium-2, Low-1

Scheme for IV Semester B.E.(Mechanical Engineering)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical /Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	BSC	MVJ20MME41	Complex Variables and Numerical Methods	Mathematics	2	2	0	3	50	50	100	3
2	PCC	MVJ20ME42	Applied Thermodynamics	ME	3	2	0	3	50	50	100	4
3	PCC	MVJ20ME43	Manufacturing Technology	ME	3	0	0	3	50	50	100	3
4	PCC	MVJ20ME44	Kinematics of Machines	ME	2	2	0	3	50	50	100	3
5	PCC	MVJ20ME45	Fluid Mechanics	ME	2	2	0	3	50	50	100	3
6	PCC	MVJ20ME46	Instrumentation and metrology	ME	3	0	0	3	50	50	100	3
7	PCC	MVJ20MEL47	Machine shop-Lab	ME	0	1	3	3	50	50	100	2
8	PCC	MVJ20MEL48	Instrumentation and measurement-Lab	ME	0	1	3	3	50	50	100	2
9	HSMC	MVJ20KAN49	Kannada	Humanities	1*	0	0	3*	50*	50*	100	1
		MVJ20CPH49	CPH		1	0	0	3	50	50		
10	BSC	MVJ20MATDIP41*	Additional Mathematics-2	Mathematics	2*	1*	0	3	50	50	100	-
				Total	16	10	6	30	500	500	1000	24

Note: 1. BSC: Basic Science, PCC: Professional Core Course , HSMC: Humanity and Social Science, MVJ20MATDIP41*- Mandatory Non Credit Course for Lateral Entry (Diploma) Students.

2. Programming using C++ for 30 hours duration in 4th semester Vacation to be taught as Bridge Course for Audit Course on Application development using Python in V Semester and Machine Learning in VI Semester.

3.. Students can take up Certification Course of 60 (30+30) hours duration on CATIA for 2 credits in the IV Semester to be offered in association with the EDS Technologies.

Course Title	COMPLEX VARIABLES AND NUMERICAL METHODS	Semester	IV
Course Code	MVJ20MME41	CIE	50
Total No. of Contact Hours	40 L : T : P :: 2:2:0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 hrs

Course objective is to: This course will enable students to

•Understand the concepts of Complex variables and transformation for solving Engineering Problems.

•Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems.

•Apply the concept to find extremal of functionals.

•Solve initial value problems using appropriate numerical methods.

•Students learn to obtain solution s of ordinary and partial differential equations numerically.

Module-1	RBT Level L2,L3,L4	08Hrs.

Complex variables - 1:

Functions of complex variables, Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions (Using Milne-Thomson method).

Transformations:

Bilinear Transformation, Conformal transformation, Discussion of the transformations $w = z^2$, $w = e^z$ and $w = z + \frac{a}{z}, (z \neq 0)$.

Video link / Additional online information :

https://www.youtube.com/watch?v=oiK4gTgncww

https://www.youtube.com/watch?v=WJOf4PfoHow

https://math.mit.edu/~jorloff/18.04/notes/topic4.pdf

https://math.mit.edu/~jorloff/18.04/notes/topic10.pdf

Module-2	RBT Level L2,L3,L4	08Hrs.

Complex variables-2:

Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles, Residues-definitions, Cauchy residue theorem - Problems.

Web Link and Video Lectures:

https://www.youtube.com/watch?v=oiK4gTgncww

https://www.youtube.com/watch?v=WJOf4PfoHow

https://math.mit.edu/~jorloff/18.04/notes/topic4.pdf

https://math.mit.edu/~jorloff/18.04/notes/topic10.pdf

Module-3	RBT Level L2 & L3	08Hrs.

Numerical methods-1:

Numerical solution of Ordinary Differential Equations of first order and first degree, Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth Predictor and Corrector method.

Web Link and Video Lectures:

1. https://www.khanacademy.org/
2. http://www.nptelvideos.in/
3. https://www.classcentral.com/

Module-4	RBT Level L2 & L3	08Hrs.

Numerical methods-2:

Numerical solution of Ordinary Differential Equations of second order: Runge-Kutta method of fourth order, Milne's Predictor and Corrector method.

Calculus of variations:

Variation of function and Functional, variational problems, Euler's equation, Geodesics.

Applications: Hanging Chain problem.

Web Link and Video Lectures:

1. https://www.khanacademy.org/
2. http://www.nptelvideos.in/
3. https://www.classcentral.com/

Module-5	RBT Level L2 & L3	08Hrs.

Numerical methods-3:

Numerical solution of Partial Differential Equations: Introduction, Finite difference approximations to derivatives, Numerical Solution of Laplace Equation, Numerical solution of one-dimensional heat equation by Bender - Schmidt's method and by Crank-Nicholson Method, Numerical solution of one-dimensional wave equation.

Web Link and Video Lectures:

1. https://www.khanacademy.org/
2. http://www.nptelvideos.in/
3. https://www.classcentral.com/

Course outcomes:

CO1	State and prove Cauchy - Riemann equation with its consequences and demonstrate Con-formal Transformation.
CO2	Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formula and Cauchy's Residue theorem.
CO3	Identify appropriate numerical methods to solve ODE.
CO4	Determine the extremals of functionals and solve the simple problems of the calculus of variations.
CO5	Choose appropriate numerical methods to solve Partial Differential Equations.

Text Books:

1.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2.	Prof. G.B.Gururajachar, "Engineering Mathematics –IV, Academic Excellent series publications, 2017 – 18.

Reference Books:

1.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition, 2014.
2.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
3.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition
4.	H K Dass: "Advanced Engineering Mathematics"- S Chand & Company Ltd. 12th edition.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (10 marks) - Assignment (10 marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	1
CO2	3	3	0	3	0	0	0	0	0	0	1	0
CO3	3	2	0	2	0	0	0	0	0	0	0	0
CO4	3	3	0	3	0	0	0	0	0	0	0	1
CO5	3	3	0	3	0	0	0	0	0	0	1	0

High-3, Medium-2, Low-1

Course Title	APPLIED THERMODYNAMICS	Semester	IV
Course Code	MVJ20ME42	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 : 2 : 0	SEE	50
No. of Contact Hours/week	05	Total	100
Credits	04	Exam. Duration	3 Hours

Course objective is to:

- Students should be able to understand different PV & TS diagram for Air standard cycles, (Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, & MEP for the same).
- Can learn the concepts of combustion and the requirements involved for complete combustion.
- Can learn concepts of IC engines, Calculations of BP, IP, Mechanical efficiency, Heat balance sheet etc.
- Applications of Thermodynamics principles to Gas and vapour power cycles.
- Performance analysis of R.A.C and optimization of compression.

Module-1	RBT Level L1,L2,L3	10 Hours

Air Standard and Gas power cycles: Carnot cycle, Air standard Otto, Diesel and Dual cycles, efficiency and mean effective pressure derivation. Ideal Brayton cycle, effect of reheat, regeneration and Intercooling- (Numerical problems on Otto, Diesel, Dual and ideal Brayton cycle only.).

Laboratory Sessions/ Experimental learning:

Applications: Heat engines of all types form a very important and commercially used application based on thermodynamic principles.

Video link / Additional online information :

1. https://youtu.be/LDXLOCTeJQE,
2. https://youtu.be/b5SPb6NHna4,
4. https://youtu.be/PB7n8Y74890
5. https://youtu.be/Op1b1j0ViJg

Module-2	RBT Level L1,L2,L3,	10 Hours

Combustion Thermodynamics: Theoretical (Stoichiometric) air for combustion of fuels, excess air, mass balance, actual combustion. Exhaust gas analysis. A/F ratio, energy balance for a chemical reaction. (Numerical problems on combustion of fuels only)

Laboratory Sessions/ Experimental learning:

- Using cut section model amount of charge entering into cylinder can be analyzed.

Applications: Proper mixing of air fuel mixture is learnt for complete combustion process.

Module-3	RBT Level L2,L3, L4	10 Hours

Internal Combustion Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, heat balance, Morse test, Willian's line method, (Numerical problems on Heat balance sheet and Morse test only).

Refrigeration: Vapour compression refrigeration system, description, Refrigerating effect, capacity, Power required, Units of refrigeration, COP, Refrigerants and their desirable properties, Vapour absorption refrigeration system.

Laboratory Sessions/ Experimental learning:

Performance parameters, Morse test and heat balance analysis can be found by conducting the experiments in Energy conversion laboratory.

Applications: Work can be extended related to pollution control methods.

Video link / Additional online information:

1. https://youtu.be/2iYqZ8tIP1I,
2. https://youtu.be/BofCLgFqlSg
3. https://youtu.be/ICgjx-WX6UM
4. https://youtu.be/cobFAMZDS0o
5. https://youtu.be/oclgDmwEfZY

Module-4	RBT Level L2,L3, L4	10 Hours

Vapour Power Cycle: Rankine Cycle ideal and actual. Mean temperature of heat addition. Reheat Cycle, Ideal Regenerative Cycle, and Regenerative Cycle with feed water heaters. Binary Vapour Cycle. Problems.

Video link / Additional online information:

1. https://youtu.be/4-BI22Wx4Pc,

2. https://youtu.be/vt1_7f5l3hI, 3. https://youtu.be/NtoTpeWAAWc 4. https://youtu.be/N86Wi6npX5Y		
Module-5	RBT Level L2,L3, L4	10 Hours
Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression. **Laboratory Sessions/ Experimental learning:** • Performance analysis of air compressor will be analyzed by conducting the experiment related to air compressor available in Fluid mechanics and machines laboratory. **Video link / Additional online information:** 1. https://youtu.be/zX8PnPCGRLE 2. https://youtu.be/9fVLoe9Y_L8		

Course outcomes:	
CO1	Explain various thermodynamic processes and air standard power cycles with p-v and T-s diagrams; derive expressions of efficiency and mean effective pressure of power cycles; understand the measurement of various parameters to assess the performance of internal combustion engines
CO2	Describe the actual process of combustion involved in I.C. Engines and processes involved in reduction of pollution.
CO3	Describe the performance parameters of I.C. Engines and comparison of the parameters to improve the efficiency of the same.
CO4	Understand and compare the Carnot and Rankine vapour power cycles with T-s diagrams; derive expressions for efficiency and solve related numerical problems.
CO5	Describe the working principle of reciprocating air compressor; derive the expressions for its performance and solve related numerical problems

Text Books:	
1	**Onkar Singh, "Engineering Thermodynamics",** New Age International Publishers, First edition, 2006..

2	Yunus, A. Cengel and Michael A.Boles, "Thermodynamics, An Engineering approach", Tata McGraw Hill pub. Co., 2011.
Reference Books:	
1	V. Kadambi, T.R. Seetharam, K.B. Subramanya Kumar, "Applications of Thermodynamics", Wiley publication, First Edition, 2019.
2	A. Domkundwar, C.P. Kothandaraman, S. Domkundwar, "A Course in Thermal Engineering" Danpat Rai and Co (P) Limited, 2013.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	MANUFACTURING TECHNOLOGY	Semester	IV
Course Code	MVJ20ME43	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3:0:0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 Hours

Course objective is to:

- This course will highlight topics related to sheet metal forming and high energy forming process equipment's, with applications in various disciplines in engineering and science.
- The course will deal with welding technology, also thermal and metallurgical consideration of welded material.
- The course will deal with milling shaping and drilling of materials using single and multipoint cutting tool.
- Deals with the Gear cutting methodology and finishing operation.

Module-1	RBT Level L1,L2	08 Hours

Introduction to Sheet metal forming: Mechanical, Hydraulic and pneumatic press machines, applications and limitations of Presses, Shearing, blanking, piercing, punching, nibbling, lancing, notching and non – shearing, bending, stretching, spinning, embossing, coining, drawing, operation & applications of stretch forming & deep drawing, defects in sheet metal formed components, simple numericals to estimate the force requirement in punching.

High Energy Rate Forming: operation & applications of explosive forming, Electro hydraulic forming & Electromagnetic forming.

Laboratory Sessions/ Experimental learning:

- Joining Different metals using different welding process and studying about identification about difference defect by available methods.

Applications: Automobile industry, Aerospace Industry, all type of sheet metal industry.

Video link / Additional online information:

https://www.youtube.com/watch?v=JgNaSll8Obo

Module-2	RBT Level L1,L2,L3	08 Hours

Introduction to Welding: Oxy-acetylene welding, types of flames, welding torches, welding techniques. Resistance welding-spot, seam, projection and butt welding. Laser beam welding, Electron beam welding. Friction welding, Friction stir welding and Ultra sonic welding.

Thermal and metallurgical consideration: Temperature distribution, heating and cooling curves, HAZ and parent metal, micro and macro structures, solidification of weld and properties.

Welding defects and Inspection: Visual, Magnetic Particle, Fluoroscent particle, ultrasonic, Radiography, Eddy current, holography methods of inspection.

Laboratory Sessions/ Experimental learning:

- Studying about single point cutting tool and its geometry.

Applications: Heavy fabrication industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=g7MkIBdl06c&list=PLwdnzlV3ogoUQnGO8eFFygVBTjF0xyYMq
2. https://www.youtube.com/watch?v=mmKy5PbndQI&list=PLyqSpQzTE6M-KwjFQByBvRx464XpCgOEC

Module-3	RBT Level L1,L2,L3	08 Hours

Theory of Metal Cutting: Single point cutting tool nomenclature, Merchants circle diagram and simple problems. Tool wear, tool life, Taylor's tool life equation, effects of cutting parameters on tool life, cutting tool materials, Properties of cutting fluids.

Shaping, Slotting and Planing Machines Tools: Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter. Difference between shaping and planning operations.

Laboratory Sessions/ Experimental learning:

- Merchant circle diagram can be drawing extracting Cutting force and Thrust force using Tool dynamo meter.

Applications: All manufacturing industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=-R-fySRLa9Q
2. https://www.youtube.com/watch?v=i06a7OnIkDk

Module-4	RBT Level L1,L2, L4	08 Hours

Drilling Machines: Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time.

Milling Machines: constructional features (Column and knee and vertical. Milling Machine), milling cutters nomenclature, milling operations, calculation of machining time.

Indexing: Simple, compound, differential and angular indexing calculations. Simple numerical on indexing.

Grinding: Abrasives and bonding, mounting, truing and dressing of grinding wheels. Introduction to lapping, honing and broaching.

Laboratory Sessions/ Experimental learning:

- Indexing in gear cutting operation can be performed using the milling machine with varying number of gear teeth in gear.

Applications: All manufacturing industry

Video link / Additional online information:

1. https://www.youtube.com/watch?v=Rf90Jbbcr3M
2. https://www.youtube.com/watch?v=IR2KhMTl5RM

Module-5	RBT Level L1,L2	08 Hours

Gear Cutting Technology

Gear Milling: Gear milling machine, worm gear milling, bevel gear milling, milling cutters.

Gear Hobbing: Principle of Hobbing process, advantages and limitations of Hobbing process. Hobbing techniques, Hobbing cycles, Hobbing of Worm Wheels.

Gear Shaping: Principle of Gear shaping process, advantages and limitations, Helical Gear shaping: Relationship between cutter teeth and helical guide.

Gear Finishing Process: Gear Shaving, Gear Lapping and Gear Grinding, Gear burnishing, Gear Honning.

Laboratory Sessions/ Experimental learning:

- Gear cutting can be practiced using shaper machine

Applications: Power transmission industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=B8w-0Oi0Yf4

Course outcomes:	
CO1	Students will able to understand Sheet metal forming
CO2	Students able to understand the welding process.
CO3	Able to understand removal of metal using a cutting tool.
CO4	Students will study about milling drilling and grinding machines.
CO5	Analyse and understand Gear cutting technology.

Text Books:	
1	S K Hajara Choudhury "Work shop technology" Volume I and II, Media promoters & publishers
2	Production Technology: HMT Tata McGraw Hill Publishing Co. Ltd.,New Delhi, 1999.
Reference Books:	
1	William K Dalton, Gregg Bruce R, "Modern Materials and Manufacturing Processes", Pearson Education, 2007
2	Rao P N, "Manufacturing Technology", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1998.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	KINEMATICS OF MACHINES	Semester	IV
Course Code	MVJ20ME44	CIE	50
Total No. of Contact Hours	40 L : T : P :: 2 : 2 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 Hours

Course objective is to:

- Explain the types of relative motion to differentiate between Machine, Mechanism, and Structure
- Draw velocity and acceleration diagrams of linkages.
- Determine gear parameters and determine train value & fixing torque in gear trains.
- Design Cam profile for the desired follower motion.

Module-1	RBT Level L1,L2	08 Hours

Introduction: Definition of link, pair, kinematic chain, mechanism, machine, inversion, structure – Types of motion, Grashof's criterion, Inversions of 4 bar chain, single slider crank chain and double slider crank chain – Degrees of freedom – Gruebler's criterion for mobility of mechanisms. **Mechanisms:** Drag link and toggle mechanisms – Straight line mechanisms, Condition for exact straight line motion, Peaucellier and Hart mechanisms – Intermittent motion mechanisms, Ratchet and pawl and Geneva wheel – Pantograph, Condition for perfect steering, Steering gear mechanisms, Ackermann– Hooke's joint, Oldham's Coupling.

Laboratory Sessions/ Experimental learning:

- Preparing simple mechanism models such as single slider crank chain and double slider crank chain, Ratchet and pawl and Geneva wheel.

Applications: These mechanisms are used in trains, automobile vehicles and robotics.

Video link / Additional online information:

1. https://nptel.ac.in/courses/112105268/

Module-2	RBT Level L3,L4	08 Hours

Velocity and Acceleration: Determination of velocity and acceleration of a point/link in simple

mechanisms by relative velocity method (graphical) – Coriolis component of acceleration.

Instantaneous centre – Centrodes – Kennedy's theorem – To determine linear velocity and angular velocity of links of simple mechanisms by instantaneous centre method. Klein's Construction for velocity and acceleration of slider crank mechanism.

Laboratory Sessions/ Experimental learning:

- Analysis of velocity and acceleration of single slider crank chain and four bar chain by complex algebra method.

Applications: These methods are adopted in ships to know the directions of movement.

Video link / Additional online information:

1. https://swayam.gov.in/nd1-noc20-me21/

Module-3	RBT Level L2,L3,L4	08 Hours

Spur Gear: Classification of toothed wheels – Gear terminology –Law of gearing –Velocity of sliding – Length of path of contact, Arc of contact – Contact ratio – Interference in involute gears, Methods of avoiding interference –Minimum number of teeth to avoid interference on pinion meshing with gear and on pinion meshing with rack. Characteristics of involutes action, Comparison of involute and cycloidal teeth profiles. Numerical problems.

Laboratory Sessions/ Experimental learning:

- Building of spur gears prototype.

Applications: It can be used in different machines and automobile vehicles to vary the running speed.

Video link / Additional online information:

https://nptel.ac.in/courses/1121/104/112104121/

Module-4	RBT Level L1,L2, L4	08 Hours

Gear Trains–Velocity ratio & Train value, Types of gear trains– Simple, Compound, Reverted & Epicyclic gear trains. Algebraic/Tabular method of finding Train value of Epicyclic gear trains. Numerical problems.

Laboratory Sessions/ Experimental learning:

- Building of gears trains prototype.

Applications: It can be used in different machines and automobile vehicles to run at different speeds.

Video link / Additional online information :

https://nptel.ac.in/courses/1121/104/112104121/

Module-5	RBT Level L3,L4,L5	08 Hours

Cams: Types of cams, Types of followers and types of follower motion –Displacement, velocity and acceleration curves for SHM, Uniform velocity, UARM and Cycloidal motion – To draw cam profile for disc cam with reciprocating follower (knife edge, roller and flat faced)– To find maximum velocity and acceleration in each case.

Laboratory Sessions/ Experimental learning:

- Developing the CAM models using Solid Edge.

Applications: CAMS are placed in engine cylinder of vehicles for inlet and outlet valves flow.

Video link / Additional online information:

https: //nptel.ac.in/courses/1121/104/112104121/

Course outcomes:

CO1	Define the basic mechanisms for developing a machine.
CO2	Construct velocity and acceleration diagram for mechanism
CO3	Design and synthesize mechanisms for specific type of relative motion
CO4	Estimate kinematic parameters for industrial mechanism of gears.
CO5	Construct the Cams for various followers.

Text Books:

1	S S RATHAN: **"Text Book of Theory of Machines"**, 4th Edition, McGraw-Hill Education,(INDIA) private limited.
2	SADHU SINGH : **"Theory of Machines"**, 2nd Edition, Pearson Education Publications, 2007

Reference Books:	
1	R S KHURMI, J K GUPTA: "A Text Book of Theory of Machines", S CHAND publication.
2	GHOSH A. AND MALLICK A.K : "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd, New Delhi, 1988.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	FLUID MECHANICS	Semester	IV
Course Code	MVJ20ME45	CIE	50
Total No. of Contact Hours	40 L : T : P :: 2 : 2 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 Hours

Course objective is to:

- To have a working knowledge of the basic properties of fluids and understand the continuum approximation.
- To calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.
- To understand the flow characteristic and dynamics of flow field for various Engineering applications.
- To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand, why designing for minimum loss of energy in fluid flows is so important.
- To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
- Understand the concept of dynamic similarity and how to apply it to experimental modelling.

Module-1	RBT Level L1,L2	08 Hours

Prerequisites: Basics of fluid properties, manometer, buoyancy.

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges.

Laboratory Sessions/Experimental learning:

- Calculating density of different oils.

Applications: Measurement of pressure drop in different joints, valves and also in calibration of

gauges.

Video link / Additional online information:

1. https://lake.videoken.com/nptel/search/fluid%20mechanics/video/NH6fDKPNjMk?tocitem=2

Module-2	RBT Level L1,L2	08 Hours

Prerequisites: Basics of fluid flow, Laplace equation.

Fluid Statics: Total pressure and centre of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Buoyancy, centre of buoyancy, meta centre and meta centric height, application in shipping, stability of floating bodies.

Fluid Kinematics: Fluid Kinematics: Types of Flow-steady , unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

Laboratory Sessions/ Experimental learning:

- Estimate total pressure and buoyancy of objects submerged in fluid.

Applications: Measure of fluid flow pattern in pipelines.

Video link / Additional online information:

https://lake.videoken.com/nptel/search/Lec-%20Fluid%20Statics/video/DpsRNq5mlVQ?tocitem=3

Module-3	RBT Level L1,L3	08 Hours

Prerequisites: Basics of fluid flow, Differential Equations.

Fluid Dynamics: Momentum equation, Impacts of jets- force on fixed and moving vane, flat and curved. Numerical. Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem. Introduction to Navier-Stokes equation, application of Bernoulli's theorem such as venturimeter, orifice meter, rectangular and triangular notch, pitot tube.

Laboratory Sessions/ Experimental learning:

- Study and use of venturimeter, orificemeter and pitot tube.

Applications: Flow rate of blood in arteries.

Video link / Additional online information:

https://lake.videoken.com/nptel/search/fluid%20mechanics/video/6k6Iyf_Xu-8?tocitem=10

Module-4	RBT Level L1,L2, L3	08 Hours

Prerequisites: Basics of Reynolds number, laminar flow, fluid friction.

Laminar and turbulent flow: Reynolds Number, Entrance flow and Developed flow, Navier-Stokes Equation (no derivation), Laminar flow between parallel plates, Poiseuille equation – velocity profile, Couette flow, Fully developed laminar flow in circular pipes, Hagen - Poiseuille equation, related numerical. Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, Darcy Weisbach formula, major and minor losses in pipes, Commercial pipe, Colebrook equation, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe, Related Numerical and simple pipe design problems.

Laboratory Sessions/ Experimental learning:

- Determining Reynolds number for various fluid flows, analyse the losses in different pipes due to friction.

Applications: To monitor/control smooth flow of viscous liquid through a tube or pipe.

Video link / Additional online information :

https://lake.videoken.com/nptel/search/Laminar%20flow/video/yNbDyOJa76Y?tocitem=7

Module-5	RBT Level L1,L2,L3	08 Hours

Prerequisites: Basics of Boundary layer, airfoil, Dimensions and units.

Flow over bodies: Development of boundary layer, Prandtl's boundary layer equations, Blasius solution, laminar layer over a flat plate, boundary layer separation and its control. Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift, streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil, Numerical problems.

Dimensional analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Similitude and Model studies. Numerical problems.

Laboratory Sessions/ Experimental learning:

- Preparing different aerofoils and estimate the drag and lift co-efficient. Study of Boundary layer and its control.

Applications: Measure and control angle of attack of airfoil, calculation of shear drag, which breaks boundary layer.

Video link / Additional online information :

https://lake.videoken.com/nptel/search/Boundary%20layer/

Course outcomes:	
CO1	Identify and calculate the key fluid properties used in the analysis of fluid behaviour.
CO2	Understand and apply the principles of pressure, buoyancy and floatation.
CO3	Apply the knowledge of fluid statics and kinematics while addressing problems of mechanical engineering.
CO4	Apply the knowledge of fluid dynamics to analyze the flow instruments like venture meter, orifice meter and pitot tube.
CO5	Understand and apply the knowledge of Dimensional analysis, lift and drag in airfoil.

Text Books:	
1	**Munson, Young, Okiishi & Huebsch, "Fundamentals of Fluid Mechanics",** 6th Edition, John Wiley Publications, 2009.
2	**Yunus A. Cengel John M.Cimbala, "Fluid Mechanics (SI Units)",** 3rd Edition, Tata McGraw Hill, 2014.
Reference Books:	
1	**Fox, McDonald, "Introduction to Fluid Mechanics",** 8th Edition, John Wiley Publications, 2011.
2	**John F. Douglas, Janul and M. Gasiosek and John A. Swaffield, "Fluid Mechanics",** 5th Edition, Pearson Education Asia, 2006.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	INSTRUMENTATION AND METROLOGY	Semester	IV
Course Code	MVJ20ME46	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 Hours

Course objective is to:

- To provide a basic knowledge about measurement systems and their components.
- To learn about various sensors used for measurement of mechanical quantities.
- To learn about system stability and control.
- To integrate the measurement systems with the process for process monitoring and Control.

Module-1	RBT Level L1	08 Hours

Prerequisites: Basics of measurements and measuring systems.

Basic Concepts of Measurement and Metrology: Definition and significance of measurement, Generalized measurement system, Performance characteristics of measuring instruments (Only static characteristics), Inaccuracy of Measurements, Definition and objectives of metrology. Standards, Subdivision of standards, Line and end standard, Imperial standard yard, Wave length standard, International Prototype meter, Transfer from line to end standard. Calibration of end bars, Slip gauges, Wringing phenomena, Numerical problems on building of slip gauges.

Laboratory Sessions/ Experimental learning:

- Building dimensions using slip gauges and angle gauges.

Applications: Measurement and manufacturing of other processes, defect detection, Calibration and quality Control.

Video link / Additional online information :

https://lake.videoken.com/nptel/search/Metrology%20/video/BqAmlOl8uzs?tocitem=4

Module-2	RBT Level L1,L2	08 Hours

Prerequisites: Basics of limits, types of fits, holes and shafts.

System of Limits, Fits, Tolerances and Gauging: Definition of tolerance, specification in assembly, Principle of inter-changeability and selective assembly. Concept of limits of size and tolerances, Compound tolerances, accumulation of tolerances. Definition of fits, types of fits. Hole basis system and shaft basis system, Geometric dimensioning and tolerance.
Classification of gauges, Basic concept of design of gauges (Taylor's principles), wear allowance on gauges. Types of gauges -plain plug gauge, ring gauge, snap gauge, gauge materials. Gauge Design and numerical problems.

Laboratory Sessions/ Experimental learning:

- Study and use of; plug gauge and ring gauges, calculation of wear allowance.

Applications: Providing Allowances and clearance for various applications of holes and shafts.

Video link / Additional online information:
https://lake.videoken.com/nptel/search/System%20of%20Limits%20and%20Fits

Module-3	RBT Level L1,L2	08 Hours

Prerequisites: Basics of comparators, pressure gauges, screw thread, and gears.
Comparators: Characteristics and classification of comparators. Mechanical comparators-Johnson Mikrokator, Sigma Comparators, Optical Comparators -principles, Zeiss ultra-optimeter, Electric and Electronic Comparators, LVDT, Pneumatic Comparators, Solex Comparator, Back Pressure gauges.
Metrology of Screw Thread and Gear: Measurement of basic elements of thread, Screw threads: 2- wire and 3-wire methods. Gear tooth terminology, Base-tangent method, Constant chord method, Measurement of pitch, Gear roll tester. Basic concepts of Coordinate measuring machines-construction and applications.

Laboratory Sessions/ Experimental learning:

- Study and Operation of different comparators and pressure gauge.
- Experimental Verification of base tangent method and constant chord method.
- Study of Coordinate measuring machines, its applications.
- Measurement of screw thread and Gear parameters.

Applications: Compare voltages and currents to measure minute and micro displacements.

Video link / Additional online information : https://lake.videoken.com/nptel/search/Comparators%20		
Module-4	RBT Level L1,L2	08 Hours
Prerequisites: Basic of sensors, transducers, amplifiers and CRO. **Transducers**: Introduction, Transfer efficiency, Loading effect, Primary and Secondary transducers, classification of transducers with examples. Advantages of each type transducers. Signal Conditioning: Mechanical systems, Electrical intermediate modifying devices, Input circuitry simple current sensitive circuit, Electronic amplifiers, Filters, Types of filters, telemetry, Cathode ray oscilloscope, Oscillographs. **Laboratory Sessions/ Experimental learning**: • Application of oscillograph and CRO. **Applications**: Automation and control of Electronic circuits, wireless communication and broadcasting. **Video link / Additional online information** : https://lake.videoken.com/nptel/search/Transducers/		
Module-5	RBT Level L1,L2,L3	08 Hours
Prerequisites: Basic of strain, force, torque and temperature. **Strain Measurement**: Methods of strain measurement, Strain gauges, Preparation and mounting of strain gauges, Gauge factor. **Measurement of Force**: Introduction, Proving ring. **Measurement of Torque**: Introduction, Prony or Brake Dynamometer, Hydraulic dynamometer. **Measurement of Pressure**: Introduction, Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani Gauge. **Temperature Measurement**: Resistance thermometers, Wheatstone bridge circuit, Thermocouple, Laws of thermocouple, Thermocouple materials. Pyrometers, Optical pyrometers. **Laboratory Sessions/ Experimental learning**: • Study of strain gauge and application. Study of thermistors, resistance thermometers and its operation. Study of pyrometer, thermocouple and its use.		

Applications: measurement of strain in load bearing structures along load paths, temperature/pressure gradient in high pressure vessels. **Video link / Additional online information:** https://lake.videoken.com/nptel/search/Strain%20gauge/	
Course outcomes:	
CO1	Understand the objectives of metrology, methods of measurements, selection of measuring instruments, standards of measurement and calibration of end bars.
CO2	Describe the slip gauges, wringing of slip gauges and building of slip gauges, angle measurement using sine bar, sine center, angle gauges, optical instruments and straightness measurement using Autocollimator.
CO3	Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.
CO4	Understand the principle of Johnson mikrokator, sigma comparator, dial indicator, LVDT, back pressure gauge, solex comparator, Zeiss Ultra comparator, functioning of force, torque, pressure, strain and temperature measuring devices.
CO5	Describe measurement of major diameter, minor diameter, pitch, angle, effective diameter of screw thread, understand laser interferometers and coordinate measuring machines.

Text Books:	
1	**E.O. Doebelin, "Measurement Systems (Applications and Design)",** 5th ed.- -McGraw Hill.
2	**Beckwith Marangoni and Lienhard, "Mechanical Measurements"** Pearson Education, 6th Ed., 2006.
Reference Books:	
1	**Richard S Figliola, Donald E Beasley "Theory and Design for Mechanical Measurements",** 3rd edition, WILEY India Publishers.
2	**R.K. Jain, "Engineering Metrology",** Khanna Publishers, Delhi, 2009.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	MACHINE SHOP LAB	Semester	IV
Course Code	MVJ20MEL47	CIE	50
Total No. of Contact Hours	20 L : T : P :: 0: 1: 3	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	02	Exam. Duration	3 hrs

Course objective is to:

- To guide students to use cutting tools to perform different cutting operations.
- To provide an insight to different machine tools, accessories and attachments.
- To train students into milling operations to enrich their practical skills.
- To inculcate team qualities and expose students to shop floor activities.
- To impart skills in fitting of models to students.

EXPERIMENTS	
PART-A	
1.	Preparation of three models on lathe involving - Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning. Exercises should include selection of cutting parameters and cutting time estimation.
PART-B	
2.	Cutting of V Groove/ dovetail / Rectangular groove using a shaper. Cutting of Gear Teeth using Milling Machine. Exercises should include selection of cutting parameters and cutting time estimation.
3.	Preparation of at least two fitting joint models by proficient handling and application of hand tools- V block, marking gauge, files, hack saw drills etc.
PART-C	
4.	Study & Demonstration of power tools. Demonstration on CNC milling and turning operations.

Course outcomes:

CO1	Read and understand the engineering drawings for different shapes and models to be turned on lather machine.

CO2	Prepare fitting models according to drawings using hand tools- V-block, marking gauge, files, hack saw, drills etc.
CO3	Demonstrate practical and working knowledge of Machine Tools and operations
CO4	Demonstrate machining skills with appropriate selection of tools.

Reference Books:	
1.	Serope Kalpakjian, Steuen. R, Sechmid, "*Manufacturing Technology*" Pearson Education Asia, 5th Ed. 2006.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1	One question is to be set from either Part-A (COMPULSORY) – 20 Marks
2	One question is to be set from Part-B (EITHER Sl. No. 2 OR Sl. No. 3) – 20 Marks
3	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	1	1	1	1	3	1	3
CO2	3	3	1	1	2	1	1	1	1	1	1	1
CO3	3	3	1	1	2	1	1	1	1	1	2	1
CO4	3	3	3	1	2	1	1	2	2	1	2	1
CO5	3	3	3	2	2	1	1	1	1	1	3	3

High-3, Medium-2, Low-1

Course Title	INSTRUMENTATION AND MEASUREMENT LAB	Semester	IV
Course Code	MVJ20MEL48	CIE	50
Total No. of Contact Hours	20 L : T : P :: 00: 01: 03	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	02	Exam. Duration	3 hrs

Course objective is to:

- To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
- To provide students with the necessary skills for calibration and testing of different gauges and instruments.
- To provide students with the necessary skills to collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures using various metrology instruments.

EXPERIMENTS	
PART-A	
1.	Calibration of Micrometre using slip gauges
2.	Calibration of Pressure Gauge
3.	Calibration of Thermocouple
4.	Calibration of LVDT
5.	Calibration of Load cell
6.	Calibration of Thermocouple
PART-B	
7	Measurements of Thread parameters using Optical Projector / Toolmakers' Microscope.
8.	Measurement of angle using Sine Centre / Sine bar / bevel protractor
9.	Measurement of alignment using Autocollimator / Roller set
10.	Measurement of cutting tool forces using: Lathe tool Dynamometer Drill tool Dynamometer.
11.	Measurements of Screw thread parameters using two wire or three-wire methods.
12.	Measurements of surface roughness using Tally Surf/Mechanical Comparator
13.	Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer
14.	Determination of elastic modulus of materials using strain gauges.
15.	Measurement of Flatness of the optical specimens using Optical Flats

Course outcomes:	
CO1	Demonstrate the necessary skills for calibration and testing of different gauges and instruments.
CO2	Apply concepts of Measurement of angle using Sine Centre/ Sine Bar/ Bevel Protractor, Alignment using Autocollimator/ Roller set.
CO3	Demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.
CO4	Analyse Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth Vernier/Gear tooth micrometre
CO5	Demonstrate the necessary skills to collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures using various metrology instruments.

Reference Books:	
1.	Beckwith Marangoni and Lienhard *"Mechanical Measurements"* Pearson Education 6th Ed., 2006.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1	One question is to be set from Part-A: 20 marks.
2	One question is to be set from either Part-B: 20 Marks
3	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	1	1	1	1	3	1	3
CO2	3	3	1	1	2	1	1	1	1	1	1	1
CO3	3	3	1	1	2	1	1	1	1	1	2	1
CO4	3	3	3	1	2	1	1	2	2	1	2	1
CO5	3	3	3	2	2	1	1	1	1	1	3	3

High-3, Medium-2, Low-1

Lathe Machines in Machine Shop Lab

Profile Projector in the Instrumentation and Measurement Lab

Course Title	PROGRAMMING USING C++	Semester	IV
Course Code	Bridge course	CIE	-
Total No. of Contact Hours	30 L: T : P :: 03 :00 :00	SEE	-
No. of Contact Hours/week	03	Total	-
Credits	-	Exam Duration	-

Course objective: This course will enable students to:

- Define Encapsulation, Inheritance and Polymorphism.
- Solve the problem with object-oriented approach.
- Analyse the problem statement and build object-oriented system model.
- Describe the characters and behaviour of the objects that comprise a system.
- Explain function overloading, operator overloading and virtual functions.
- Discuss the advantages of object-oriented programming over procedure-oriented programming.

Module-1	RBT Level L1, L2	6 Hrs.

Beginning with C++ and its features: Introduction, Applications and structure of C++ program, Different Data types, Variables, expressions, operator overloading and control structures in C++.

Applications:

- Banking Applications
- Cloud/Distributed Systems

Video link / Additional online information:

https://www.youtube.com/watch?v=LZFoktwiars&list=PL0gIV7t6l2iIsR55zsSgeiOw9Bd_IUTbY

https://www.youtube.com/watch?v=efXI8anQwXo&list=PLEAYkSg4uSQ2qzihjdDEseWrrY1DyxH9P

https://www.youtube.com/watch?v=pQKPUD4_6gA&list=PLOzRYVm0a65eklyMDXGSWObRA-7lCdkSm

Module-2	RBT Level L1, L2, L3	6 Hrs.

Functions, classes, and Objects: Functions, Inline function, function overloading, Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, member functions.

Laboratory Sessions/ Experimental learning: Programming using C++ to calculate the area and volume of a room.

Applications:

- Object oriented programming for structuring the data.

Video link / Additional online information:

https://www.youtube.com/watch?v=1puaGnJ9pyA

https://www.youtube.com/watch?v=xVdCE8huGeU

Module-3	RBT Level L1, L2, L3	6 Hrs.

Constructors, Destructors and Operator overloading: Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, defining operator overloading, Overloading Unary and binary operators.

Laboratory Sessions/ Experimental learning: Programming using C++ for structuring simple datasets related to mechanical engineering domain.

Applications: Google file system, Google Chromium browser, and MapReduce large cluster data processing are all written in C++.

Video link / Additional online information:

https://www.youtube.com/watch?v=LZFoktwiars&list=PL0gIV7t6l2iIsR55zsSgeiOw9Bd_IUTbY

https://www.youtube.com/watch?v=hAA8FBq2bA4

Module-4	RBT Level L1, L2, L3	6 Hrs.

Inheritance, Pointers, Virtual Functions, Polymorphism: Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, Virtual and pure virtual functions.

Laboratory Sessions/ Experimental learning: Students will write simple programs using C++.

Applications: Many windows apps that you regularly use are written in C++.

Video link / Additional online information:

https://www.youtube.com/watch?v=hEc7gAL8OwA

https://www.youtube.com/watch?v=c_wvVDZEJmE

Module-5	RBT Level L1, L2, L3	6 Hrs.

Streams and working with files: C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file.

Laboratory Sessions/ Experimental learning: Students will learn C++ stream classes and file stream operations through simple exercises.

Applications: Many windows apps that you regularly use are written in C++.

Video link / Additional online information:	
https://www.youtube.com/watch?v=sc3mse4jpig https://www.youtube.com/watch?v=fnFQWtZZE-4	
Course outcomes:	
CO1	Variables / types of variables, Input / output streams and validation of data
CO2	Operators - arithmetic, assignment, logical, bitwise, Conditions like if / else / switch.
CO3	Arrays / multi-dimensional arrays, Loops - for / while / do-while.
CO4	Functions, overloading functions, passing variables to functions etc.
CO5	Structures, References, Pointers.

Text Books:	
1.	E. Balagurusamy – Object Oriented Programming with C++, Fifth edition, Tata McGraw Education Hill, 2011.
2.	Ashok N. Kamthane, Object oriented Programming with ANSI & Turbo C++, First Edition, Pearson India
Reference Books:	
1.	Robert Lafore, Object Oriented Programming in Turbo C++, First Edition, Galgotia Publications.
2.	D Ravichandran, Programming with C++, Second edition, Tata McGraw- Hil

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Course Title	Additional Mathematics-II (Common to all branches)	Semester	IV
Course Code	MVJ20MATDIP41*	CIE	50
Total No. of Contact Hours	40 L : T : P :: 2* : 1*: 0	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	-	Exam. Duration	3 Hours

Course objective is to: This course viz., aims to prepare the students:

- To familiarize the important and basic concepts of Differential calculus and Differential Equation, ordinary/partial differential equations and Vector calculus and analyse the engineering problems.

Module-1	RBT Level L1,L2	8 Hrs.

Linear Algebra:

Introduction, Rank of a matrix-echelon form. Solution of system of linear equations – consistency. Gauss-elimination method and problems. Eigen values and Eigen vectors of square matrix and Problems.

Video Link:

https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdf

https://nptel.ac.in/content/storage2/courses/122104018/node18.html

Module-2	RBT Level L1,L2	8 Hrs.

Differential calculus:

Tangent and normal, sub tangent and subnormal both Cartesian and polar forms. Increasing and decreasing functions, Maxima and Minima for a function of one variable. Point of inflections and Problems

Beta and Gamma functions:

Beta functions, Properties of Beta function and Gamma function, Relation Between beta and Gamma function-simple problems.

Video Link:

https://www.youtube.com/watch?v=6RwOoPN2zqE

https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11

http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx

Module-3	RBT Level L1,L2	8 Hrs.

Analytical solid geometry :

Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems.

Video Link:

https://www.toppr.com/guides/maths/three-dimensional-geometry/

https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/

Module-4	RBT Level L1,L2,L3	8 Hrs.

Probability:

Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical distribution- Binomial distribution, Mean and variance Binomial distribution - Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems.

Video Link:

https://nptel.ac.in/courses/111/105/111105041/

https://www.mathsisfun.com/data/probability.html

Module-5	RBT Level L1,L2,L3	8 Hrs.

Partial differential equation: Formation of PDE's by elimination of arbitrary constants and functions.

Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Video Link: http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx

https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method-of- variation-of-parameters

Course outcomes:

CO1	Apply the knowledge of Matrices to solve the system of linear equations and to understand the concepts of Eigen value and Eigen vectors for engineering problems.

CO2	Demonstrate various physical models ,find Maxima and Minima for a function of one variable., Point of inflections and Problems .Understand Beta and Gamma function
CO3	Understand the 3-Dimentional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance.
CO4	Concepts OF Probability related to engineering applications.
CO5	Construct a variety of partial differential equations and solution by exact methods.

Text Books:	
1	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
2	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.
Reference Books:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014.
2	G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (8 marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	0	3	0	0	0	0	0	0	1	0
CO2	3	3	0	3	0	0	0	0	0	0	0	1
CO3	2	3	0	3	0	0	0	0	0	0	1	0
CO4	3	3	0	3	0	0	0	0	0	0	0	0
CO5	3	3	0	2	0	0	0	0	0	0	0	1

High-3, Medium-2, Low-1

Course Title	SAMSKRUTHIKA KANNADA	Semester	III/IV
Course Code	MVJ20SK39/49	CIE	50
Total No. of Contact Hours	20 L: T: P 1:0:0	SEE	50
No. of Contact Hours/week	1	Total	100
Credits	1	Exam. Duration	3 Hrs

Course objective : This course will enable students to understand Kannada and communicate in Kannada language

- Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada)
- Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha)
- Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha)
- Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu)
- Activities in Kannada.

ಅಧ್ಯಾಯ -೧
ಕನ್ನಡ ಭಾಷೆ-ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ.
ಅಧ್ಯಾಯ -೨
ಭಾಷಾ ಪ್ರಯೋಗಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ.
ಅಧ್ಯಾಯ -೩
ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ.
ಅಧ್ಯಾಯ -೪
ಪತ್ರ ವ್ಯವಹಾರ.
ಅಧ್ಯಾಯ -೫
ಆಡಳಿತ ಪತ್ರಗಳು.
ಅಧ್ಯಾಯ -೬
ಸರ್ಕಾರದ ಆದೇಶ ಪತ್ರಗಳು
ಅಧ್ಯಾಯ -೭
ಸಂಕೀಪ್ತ ಪ್ರಬಂಧ ರಚನೆ, ಪ್ರಬಂಧ ಮತ್ತು ಭಾಷಾಂತರ
ಅಧ್ಯಾಯ -೮
ಕನ್ನಡ ಶಬ್ದಸಂಗ್ರಹ
ಅಧ್ಯಾಯ -೯
ಕಂಪ್ಯೂಟರ್ ಹಾಗೂ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನ

ಅಧ್ಯಾಯ -೧೦
ಪಾರಿಭಾಷಿಕ ಆಡಳಿತ ಕನ್ನಡ ಪದಗಳು ಮತ್ತು ತಾಂತ್ರಿಕ/ಕಂಪ್ಯೂಟರ್ ಪಾರಿಭಾಷಿಕ ಪದಗಳು.

Scheme of Evaluation:		
Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks Obtained in each test) / 3	CIE(50)	30
ASSIGNMENT		20
Semester End Examination	SEE (50)	50
	Total	100

Course Title	**Balike Kannada**	Semester	3rd/4th
Course Code	MVJ20BK39/49	**CIE**	50
Total No. of Contact Hours	20 L:T:P::1:0:0	**SEE**	50
No. of Contact Hours/week	1	**Total**	100
Credits	1	**Exam. Duration**	3Hrs

Course objective : This course will enable students to understand Kannada and communicate in Kannada language

- Vyavharika Kannada –Parichaya (Introduction to Vyavharika kannada)
- Kannada Aksharamaale haagu uchcharane(Kannada Alphabets and Pronounciation.
- Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).
- Kannada Grammar in Conversations(Sambhasaneyalli Kannada Vyakarana)
- Activities in Kannada

CHAPTER-1
Vyavharika Kannada –Parichaya (Introduction to Vyavharika kannada)
CHAPTER-2
Kannada Aksharamaale haagu uchcharane(Kannada Alphabets and Pronounciation
CHAPTER-3
Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).
CHAPTER-4
Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)
CHAPTER-5
Activities in Kannada

Scheme of Evaluation:

Details		Marks
Average of three Internal Assessment (IA) Tests of 30 Marks each i.e. Σ (Marks Obtained in each test) / 3	CIE(50)	30
ASSIGNMENT		20
Semester End Examination	SEE (50)	50
	Total	100

Course Title	CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW	Semester	III/IV
Course Code	MVJ20CPH39/49	CIE	50
Total No. of Contact Hours	15 L : T : P :: 1 :0 : 0	SEE	50
No. of Contact Hours/Week	01	Total	100
Credits	01	Exam. Duration	2 hrs

Course objective is to:

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.
- To provide overall legal literacy to the young technocrats to manage complex societal issues in the present scenario.
- To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.

Module-1	RBT Level L1,L2,L3	03 Hours

Introduction to Indian Constitution

The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.

Module – II	RBT Level L1,L2,L3	03 Hours

Union Executive and State Executive

Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.

Module – III	RBT Level L1,L2,L3	03 Hours

Elections, Amendments and Emergency Provisions

Elections, Electoral Process, and Election Commission of India, Election Laws.

Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements).

Emergency Provisions, types of Emergencies and it's consequences.

Constitutional Special Provisions:

Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.

Module – IV	**RBT Level** L1,L2,L3	03 Hours

Professional / Engineering Ethics

Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility.Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

Module – V	**RBT Level** L1,L2,L3	03 Hours

Internet Laws, Cyber Crimes and Cyber Laws:

Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.

Course Outcomes: On completion of this course, students will be able to	
CO1	Have constitutional knowledge and legal literacy
CO2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO3	Understand the cyber crimes and cyber laws for cyber safety measure.

Text Books:	
1.	Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher
Reference Books:	

1.	Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20th Edn., (Latest Edition) or 2008.
2.	Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.
3	M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. Ltd. New Delhi, 2004.
4.	M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
5.	Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests

- Assignment (10 marks)

SEE Assessment:

i. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus.

ii. Ten questions must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	2	2	1	1	1	1	2
CO2	1	2	2	1	1	2	1	1	1	1	1	2
CO3	2	1	2	1	1	1	1	1	1	1	1	2
CO4	2	2	1	1	1	1	1	1	1	1	1	2
CO5	2	2	1	1	1	2	1	1	1	1	1	2

High-3, Medium-2, Low-1

Scheme for V Semester B.E.(Mechanical Engineering)												
S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
	Type	Code			Theory Lecture L	Tutorial T	Practical/Drawing P	Duration in Hours	CIE Marks	SEE Marks	Total marks	
1	HSMC	MVJ20TEM51	Technical Management & Entrepreneurship	Humanities	3	0	0	3	50	50	100	3
2	PCC	MVJ20ME52	Design of Machine Elements-I	ME	3	2	0	3	50	50	100	4
3	PCC	MVJ20ME53	Turbo Machinery	ME	3	2	0	3	50	50	100	4
4	PCC	MVJ20ME54	Dynamics of Machines	ME	2	2	0	3	50	50	100	3
5	PE	MVJ20ME55X	Professional Elective - 1	ME	3	0	0	3	50	50	100	3
6	PCC	MVJ20MEL56	Fluid Mechanics and Fluid Machinery-Lab	ME	0	1	3	3	50	50	100	2
7	PCC	MVJ20MEL57	Energy conversion-Lab	ME	0	1	3	3	50	50	100	2
8	PCC	MVJ20MEL58	Computational Techniques Lab	ME	0	1	3	3	50	50	100	2
9	HSMC	MVJ20ENV59	Environmental Studies	Humanities	1	0	0	3	50	50	100	1
10	HSMC	MVJ20UHV510	Universal Human Values – II	Humanities	2	0	0	3	50	50	100	2
				Total	17	9	9	30	500	500	1000	26

Note: 1. PCC: Professional Core Course , PE: Professional Elective, HSMC: Humanity and Social Science
2. Audit Course of Application development using Python to be taught in V Semester.
3. Students can take up Certification Course of 45 (30+15) hours duration on HVAC for 2 credits in the V Semester to be offered in association with the Alpine Coach Tree - HVAC Training Institute.

Professional Elective - 1:

1. MVJ20ME551: Industrial Internet of Things
2. MVJ20ME552: Advanced Manufacturing Technology,
3. MVJ20ME553: Composite Materials,
4. MVJ20ME554: Total Quality Management

Course Title	TECHNICAL MANAGEMENT & ENTREPRENEURSHIP	Semester	V
Course Code	MVJ20TEM51	**CIE**	50
Total No. of Contact Hours	40 L: T: P: 3:0:0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 hrs.

Course objective is to:

- To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.
- To impart knowledge, with respect to concepts, principles, and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions

Module-1	**RBT Level** L1,L2	8 Hrs

Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches – Modern management approaches. Planning: Nature, importance, and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

Laboratory Sessions/ Experimental learning:
Students will understand the key roles and implementation characteristics of management skills through case studies.

Application: Management of organizations, institutions, and industries.

Video link / Additional online information:

https://nptel.ac.in/courses/122/106/122106031/

https://nptel.ac.in/courses/110/105/110105067/

https://nptel.ac.in/courses/110/106/110106141/

https://nptel.ac.in/courses/110/106/110106141/

Module-2	**RBT Level** L1,L2	8 Hrs.

Organizing and Staffing: Nature and purpose of organization Principles of organization - Types of organization - Departmental Committees, Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE Nature and importance of staffing--Process of Selection & Recruitment.

Laboratory Sessions/ Experimental learning:
Demonstration to students on the Organization behavioural skills will be given through case studies.

Applications-Organizing, Staffing and Coordinating in an organization

Video link / Additional online information:

https://nptel.ac.in/courses/122/106/122106031/

https://nptel.ac.in/courses/110/105/110105067/

https://nptel.ac.in/courses/110/106/110106141/

https://nptel.ac.in/courses/110/106/110106141/

Module-3	RBT Level L1,L2	8 Hrs

Directing & controlling: Meaning and nature of directing - Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co - Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control.

Laboratory Sessions/ Experimental learning:
Demonstration to students on the Directing and Controlling will be given through case studies.

Applications-Directing, Controlling the activities of an organization.

Video link / Additional online information:

https://nptel.ac.in/courses/122/106/122106031/

https://nptel.ac.in/courses/110/105/110105067/

https://nptel.ac.in/courses/110/106/110106141/

https://nptel.ac.in/courses/110/106/110106141/

Module-4	RBT Level L1,L2	8 Hrs.

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers.

Laboratory Sessions/ Experimental learning:
Entrepreneurship development programs will be conducted to simulate and motivate the interests of students to become entrepreneurs.

Applications-Applying the concepts of entrepreneurship to become successful entrepreneurs and establish enterprises.

Video link / Additional online information:

https://nptel.ac.in/courses/122/106/122106031/

https://nptel.ac.in/courses/110/105/110105067/

https://nptel.ac.in/courses/110/106/110106141/

https://nptel.ac.in/courses/110/106/110106141/

Module-5	RBT Level L1,L2	8 Hrs

Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5-year plans.

Preparation of project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

Laboratory Sessions/ Experimental learning:

Students will be given an assignment for preparation of a project report for establishing a Small Scale Industry

Applications- Establishment and successful implementation of the concepts for running Industries.

Video link / Additional online information:

https://nptel.ac.in/courses/122/106/122106031/

https://nptel.ac.in/courses/110/105/110105067/

https://nptel.ac.in/courses/110/106/110106141/

https://nptel.ac.in/courses/110/106/110106141/

Course outcomes:

CO1	Understand needs, functions, roles, scope and evolution of Management
CO2	Understand importance, purpose of Planning and hierarchy of planning and also analyse its types.
CO3	Discuss Decision making, Organizing, Staffing, Directing and Controlling.
CO4	Students are able to understand the meaning of Entrepreneur, Role of entrepreneurs in Economic Development.
CO5	Students are able to Prepare the project reports effectively.

Text Books:

1.	Principles of Management Tripathy and Reddy Tata McGraw Hill 3rd edition 2006.
2.	Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson

3.	**Entrepreneurship Development** - S.S.Khanka - S.Chand & Co.
Reference Books:	
1.	**Management - Stephen Robbins - Pearson Education/PHI - 17th Edition, 2003**
2.	**Dynamics of Entrepreneurial Development & Management** Vasant Desai - Himalaya Publishing House
3.	**Entrepreneurship Development** – Poornima. M. Charantimath Small Business Enterprises - Pearson Education - 2006 (2 & 4).

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	1	-	-	-	-	-	-	-	2	2	1	3	2	2
CO2	1	-	-	-	-	-	-	-	2	2	1	3	2	2
CO3	1	-	-	-	-	-	-	-	2	2	1	3	2	2
CO4	1	-	-	-	-	-	-	-	2	2	1	3	2	2
CO5	1	-	-	-	-	-	-	-	2	2	1	3	2	2

High-3, Medium-2, Low-1

Course Title	DESIGN OF MACHINE ELEMENTS-I	Semester	V
Course Code	MVJ20ME52	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 : 2:0	SEE	50
No. of Contact Hours/week	05	Total	100
Credits	04	Exam. Duration	3 Hrs.

Course objective is:

- To design simple machine elements subjected to static and dynamic loads using the concepts of stress analysis and theories of failure.
- To study the material behaviour in the presence of crack.
- To effectively understand the fracture behaviour of materials.
- To design the riveted and welded joints.
- To design joints and couplings.

Module-1	RBT Level L1,L2,L3	10 Hrs

Stress Analysis: Types of stresses, stress-strain diagram in tension, mechanical properties of materials, static stress equation in axial, bending and torsional loading, criteria for failure, factor of safety.

Combined Stresses: Combination of normal stresses, eccentric loading of members, combination of normal and shear stresses, principal stresses.

Laboratory Sessions/ Experimental learning:

1. Stress and Strains: Stress strain plots for different materials like Al, Zinc.

Applications:

1. Study of materialistic properties, related to static analysis.

Video link / Additional online information:

https://nptel.ac.in/courses/112105125/

https://nptel.ac.in/courses/112/106/112106247/

https://nptel.ac.in/content/storage2/courses/112105125/pdf/Module-2_Lesson-2.pdf

https://nptel.ac.in/courses/112/107/112107146/

Module-2	RBT Level L1,L2,L3	10 Hrs.

Variable Loads: Mechanism of fatigue failure (in brief)-fatigue limit and fatigue strength, S-N curves, types of stress variations, terminology, Soderberg, Goodman and Gerber equations, stress raisers, stress concentration factor, notch sensitivity factor, factors affecting fatigue limit, finite life, equivalent stress, combined variable stress. Stresses due to impact loading.

Laboratory Sessions/ Experimental learning:

1. Impact load: Experiment on impact loading.
2. Fatigue: Demonstration with model.

Applications:

1. Study the effect of different loads under design considerations.
2. Failure analysis of different materials.

Video link / Additional online information:

https://nptel.ac.in/courses/112105125/

https://nptel.ac.in/content/storage2/courses/112105125/pdf/Module-3_lesson-4.pdf

https://nptel.ac.in/course.html

https://nptel.ac.in/courses/111/104/111104095/

Module-3	RBT Level L2,L3, L4	10 Hrs

An Overview of Fracture Mechanics Design: Three modes of crack opening, stress intensity factor, significance of fracture mechanics in design

Design of Shafts and Couplings: Forces on shafts due to gears, belts and chains, estimation of shaft size based on strength and critical speed. Couplings-types and applications, Design of square keys-use of standards, rigid couplings, flexible flange couplings - selection.

Laboratory Sessions/ Experimental learning:

1. Couplings: Model making and demonstration on couplings.

Applications:

1. Practical application of different couplings usages.

Video link / Additional online information:

https://nptel.ac.in/courses/112105125/

https://nptel.ac.in/courses/112/106/112106065/

https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-me23/

https://onlinecourses.nptel.ac.in/noc19_me42/preview

Module-4	RBT Level L3,L4,L5	10 Hrs.

Riveted and Welded Joints: Strength equations, efficiency, design of riveted joints lap joint,butt joint,-joints of uniform strength, eccentrically loaded riveted joints. Types of welded joints-weld symbols, strength of welds, centrally loaded, unsymmetrical sections, axially loaded, eccentrically loaded joints.

Laboratory Sessions/ Experimental learning:

1. Riveting: To do a tank by riveting.

Applications:

1. Design of rivets on requirement view.

Video link / Additional online information:		
https://nptel.ac.in/courses/112105125/ http://www.nptelvideos.in/2012/12/design-of-machine-elements.html https://www.yumpu.com/en/document/view/11310280/design-of-eccentrically-loaded-bolted-riveted-joints-nptel https://nptel.ac.in/courses/112/105/112105124/		
Module-5	**RBT Level** L3,L4,L5	10 Hrs
Design of Bolted Joints, Cotter and Knuckle joints, Couplings. ***Design of threaded fasteners.*** Design of Power Screws: Types of power screws, efficiency and self-locking, Design of power screw, Design of screw jack: (Complete Design). **Laboratory Sessions/ Experimental learning:** 1. Bolts: Loading and testing bolts. 2. Model on mounting and lifting mechanism. **Applications:** 1. Study of various stresses in bolts design and design considerations. 2. Comparative study of hydraulic jack and screw jack. **Video link / Additional online information:** https://nptel.ac.in/courses/112105125/ https://nptel.ac.in/courses/112/105/112105124/ http://www.nptelvideos.in/2012/12/design-of-machine-elements.html https://nptel.ac.in/courses/112/104/112104228/		

Course outcomes:	
CO1	Students are able to apply basic stress-strain analysis and failure theories to design machine elements.
CO2	Students are capable of analyzing and solving problems on machine elements subjected to dynamic Loads.
CO3	Students can able to Design shaft and couplings.
CO4	Students are able to Design of threaded fasteners, welded and riveted joints.
CO5	Students are able to perform design of Bearings.

Text Books:	
1.	**Shigley and Mischke, "*Mechanical Engineering Design*",** McGraw Hill Publishers Co. Ltd., New Delhi, 2000.
2.	**Faculty of Mechanical Engineering, PSG College of Technology, "*Design Data Book*",**

	M/s. DPV Printers, Coimbatore, 2000.
3.	John M Barson and Stanely T Rolfe, "*Fracture and Fatigue Control in Structures*", Prentice-Hall Inc., New Jersey, 1987.
Reference Books:	
1.	Jacobson B O, Bernard J Hamrock and Steven R Schmid, "*Fundamentals of Machine Elements*", Mcgraw Hill, Inc., Second Edition, 2006.
2.	Machine Design Data hand book Vol 1, Vol 2 by K Lingaiah, Suma Publishers.
3.	Bandari V B, "*Design of Machine Elements* ", Tata McGraw Hill Publishers Co. Ltd., New Delhi, 2003.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	2	-	-	-	-	-
CO2	3	3	2	2	-	-	2	-	-	-	-	-
CO3	3	3	2	2	-	-	2	-	-	-	-	-
CO4	3	3	2	2	-	-	2	-	-	-	-	-
CO5	3	3	2	2	-	-	2	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	TURBO MACHINERY	Semester	V
Course Code	MVJ20ME53	**CIE**	50
Total No. of Contact Hours	50 L: T : P :: 3: 2 : 0	**SEE**	50
No. of Contact Hours/week	05	**Total**	100
Credits	04	**Exam. Duration**	3 hrs

Course objective is to:

- Enhance knowledge about working of Turbo machines like power absorbing and power generating machines and recognize typical designs of Turbo Machines.
- Application of working principles of general Turbo Machines to specific types of machines.
- Understand the concept of ideal velocity triangles in Turbo machinery stages operating at design and off design conditions.
- Apply the concepts of ideal velocity triangles to various kinds of Turbo machines to design and estimate performance parameters.
- Recognize and discuss today's and tomorrow's use of Turbo machines for enabling a sustainable society.

Module-1	RBT Level L1,L2,L3	10 Hrs.

Basics of Fluid Machines:

Prerequisites: Basics of fluid mechanics and dimensional analysis.

Definition of Turbo machine, parts of Turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynold's number, Unit and specific quantities. Application of first and second law's of thermodynamics to Turbo machines, Efficiencies of Turbo machines. Similarity, Model-Prototype concept and relation, latest trends in Turbo Machines. Numerical Examples.

Laboratory Sessions/ Experimental learning:

- Find specific speed of all Turbo machines available in Fluid Machinery lab based on speed and head conditions and compare them for performance.

Applications: Recognize and analyze typical designs of Turbo Machines in Industry.

Self-learning component: Classification of Aero-Foil section Blade terminology.

Video link / Additional online information:

https://youtu.be/TiJZp-KB6h8, https://youtu.be/1ggnDwCrhe8

https://nptel.ac.in/courses/112/106/112106303/

https://www.youtube.com/watch?v=wlPXZrP9vR8&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2

https://www.youtube.com/watch?v=C2sX9Wg6twI&list=PLbMVogVj5nJSurQymuzzJM9MwLpEb75lq

Module-2	RBT Level L1,L2,L3	10 Hrs.

General Analysis of Turbines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Numericals.

Laboratory Sessions/ Experimental learning:

- Apply Euler's Turbine equation to Turbines available in Turbo Machinery lab to know the practical application of the equation.
- Validation of Euler's turbine equation by the use of software tool.

Applications: Hydro, thermal and nuclear power stations.

Self-learning component: Basic parameters applied to Aero-Foil section blade terminology

Video link / Additional online information:

https://youtu.be/6Opq1_RfsOo

https://www.youtube.com/watch?v=VxqHj_JBG2M

https://www.youtube.com/watch?v=fDC0aNTsdHk

https://www.youtube.com/watch?v=9M4peF-_Bv8

https://www.youtube.com/watch?v=tIvs30Gi8XI

Module-3	RBT Level L1,L2,L3	10 Hrs.

Radial and axial flow compressors and pumps: need for radial flow compressors and pumps. Types of compressors and pumps, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer, degree of reaction and performance. Theoretical head – capacity relationship,

Axial flow compressors and pumps, degree of reaction, velocity triangles, Problems.

Laboratory Sessions/ Experimental learning:

- Find degree of reaction of centrifugal compressor.

Applications: Gas turbines and Jet propulsion systems.

Self-learning component: Effects of Cavitation and Prevention of Cavitation.

Video link / Additional online information:

https://nptel.ac.in/courses/112/106/112106200/

https://nptel.ac.in/courses/112/105/112105182/

https://www.youtube.com/watch?v=b1dyUVA19kQ

https://www.youtube.com/watch?v=NBY9oqAX-rY

https://www.youtube.com/watch?v=kHHTaHvo1LQ

Module-4	RBT Level L1,L2,L3	10 Hrs.

Hydraulic Turbines: Classification, Pelton turbine –velocity triangles, design parameters, different efficiencies and Maximum efficiency. Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters. Problems.

Centrifugal pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Laboratory Sessions/ Experimental learning:

- Find operating parameters of hydraulic turbines like efficiency and specific speed at different preset conditions.
- Performance analysis of Pelton, Francis and Kaplan turbine in fluid mechanics lab.

Applications: Hydro-electric power plants.

Self-learning component: Basis for selection of Hydraulic turbine.

Video link / Additional online information:

https://youtu.be/9jAZ2eWy-Q4, https://youtu.be/JB_VwxhAeGU

https://www.youtube.com/watch?v=9jAZ2eWy-Q4

https://www.youtube.com/watch?v=GQHCnWl2U6I

https://www.youtube.com/watch?v=Dao9V8YsSB8

Module-5	RBT Level L1,L2,L3	10 Hrs.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems.

Steam turbines Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical Problems.

Laboratory Sessions/ Experimental learning:

- Programming of velocity triangle profile for compressors using software tool.

Applications:.Steam power plants.

Self-learning: Classification of Compressors.

Video link / Additional online information:

https://youtu.be/T3PYZsQevHU, https://youtu.be/6aCKxtHqH-s

https://nptel.ac.in/courses/112/106/112106061/

https://www.youtube.com/watch?v=ELQDTKrioX8

https://www.youtube.com/watch?v=UYMDm4yB1QA https://www.youtube.com/watch?v=fNPPwmfE-SY&list=PL6Qggk0O9yRItYPKm51jEnZoM-mSOM4XA

Course outcomes:	
CO1	Understand and analyse model studies of turbomachines.
CO2	Study and analyse the performance of turbines.
CO3	Construct velocity diagrams and analyse their applicability
CO4	Analyse various kinds of Turbo machines to estimate performance parameters.
CO5	Analyse and understand various type of compressors and steam turbine.

Text Books:	
1.	R.K.Turton, *"Principles of Turbomachinery"*, E & F N Spon Publishers, London & New York.
2.	Gopalakrishnan G, Prithvi Raj D, "*A treatise on Turbomachines*", Scitec Publications, Chennai, 2002.
3.	S.M. Yahya, "*Turbines, Compressors and Fans"*, Tata McGraw Hill.
Reference Books:	
1.	V. Kadambi and Monohar Prasad, "An introduction to energy conversion: Volume III –Turbomachinery," New Age International Private Limited, 2011, ISBN: 978-8122431896.
2	D. G. Shepherd, "Principles of Turbo Machinery," Macmillan Company, 1964
3.	A Valan Arasu, "Turbomachines," Vikas Publishing House Pvt Ltd, 2009, ISBN: 9788125908401.
4.	B K Venkanna, "Fundamentals of Turbomachinery," PHI Learning Pvt Limited, 2009, ISBN: 978-8120337756.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	-	-	-	1	1	1	1
CO2	3	2	1	2	2	1	-	-	1	1	1	1
CO3	3	3	2	2	2	1	-	-	2	1	2	1
CO4	3	3	2	3	3	1	1	-	2	1	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Course Title	DYNAMICS OF MACHINES	Semester	V
Course Code	MVJ20ME54	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 2 : 2 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hrs

Course objective is to:

- Gain the knowledge of static and dynamic equilibrium conditions of mechanisms subjected forces and couple with and without friction.
- Understand and analyse the balancing principles of rotating and reciprocating masses.
- Comprehend the working principles of governors and gyroscopes.
- Understand the friction concept and flat belt drives.
- Understand the concept of energy storage in flywheel and its energy fluctuation.

Module-1	**RBT Level** L1, L2, L3	08 Hrs.

Static force Analysis:

Prerequisites: Four bar mechanism, slider crank mechanism and velocity triangles

Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, Static force analysis of four bar mechanism and Slider-crank mechanism with and without friction.

Dynamic force Analysis: D'Alembert's principle, Inertia force, Inertia torque. Dynamic force analysis of four-bar mechanism and Slider crank mechanism without friction.

Laboratory Sessions/ Experimental learning:

- Study of static and dynamic force analyses of mechanisms other than four bar mechanism and slider crank mechanism.

Applications: I C Engines, Reciprocating Compressors, Whitworth quick return mechanism, Rotary engines, etc.

Video link / Additional online information :

1. https://www.youtube.com/watch?v=fEdz91oWrts&list=PL46AAEDA6ABAFCA78&index=4&t=0s
2. https://nptel.ac.in/courses/112/104/112104114/
3. https://nptel.ac.in/courses/112/101/112101096/
4. http://www.nptelvideos.in/2012/12/dynamics-of-machines.html

Module-2	RBT Level L1, L2, L3	08 Hrs.

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, Single cylinder engine, balancing in multi cylinder-inline engine (primary and secondary forces).

Laboratory Sessions/ Experimental learning:

- Study of balancing of two stroke and four stroke in line engine and balancing of V engines.

Applications: In-line engine, V-engines, Radial engines, etc.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=p1JDMvWGdsk
2. https://www.youtube.com/watch?v=aRulDXMuNDc&list=PL46AAEDA6ABAFCA78&index=9&t=0s
3. https://www.youtube.com/watch?v=HKVvJWArgg8&list=PL46AAEDA6ABAFCA78&index=10&t=0s
4. https://www.youtube.com/watch?v=GPDZ4izcS2M&list=PL46AAEDA6ABAFCA78&index=15&t=0s

Module-3	RBT Level L1, L2, L3	08Hrs.

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force, Stability, Sensitiveness, Isochronism, Effort and Power.

Laboratory Sessions/ Experimental learning:

- Study of Watt Governor, Proell Governor and Wilson-Hartnell Governor.

Applications: Automotive vehicles

Video link / Additional online information :

1. https://www.youtube.com/watch?v=ANl8Sai7Lqg
2. https://www.youtube.com/watch?v=L8wSm_WrGK8
3. https://www.youtube.com/watch?v=n8ObpsDfdTE

Module-4	RBT Level L1, L2, L3	08 Hrs.

Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on plane disc, aeroplane, ship, stability of two wheelers and four wheelers

Laboratory Sessions/ Experimental learning:

- Experimental study of Gyroscope.
- Study of Gyroscopic analysis of a disc fixed rigidly to a rotating shaft at certain angle.

- Study of Gyroscopic analysis of Grinding Mill.

Applications: Airplanes, Ships, Ground vehicles.

Video link / Additional online information :

1. https://www.youtube.com/watch?v=FydJu1A1oeM&list=PL46AAEDA6ABAFCA78&index=8&t=0s
2. https://www.youtube.com/watch?v=T1Zc0gJw9fU
3. https://www.youtube.com/watch?v=XPUuF_dECVI
4. https://www.youtube.com/watch?v=ZAkYYjYSCQ4

Module-5	RBT Level L2, L3, L4	08Hrs.

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension power transmitted.

Flywheel: Turning moment diagrams Fluctuation of Energy. Determination of size of flywheels.

Laboratory Sessions/ Experimental learning:

- Analysis of friction of Nutt and Screw.
- Study of maximum effective tension and H. P. Transmitted of belt drive.
- Study of flywheel for punching press.

Applications: All mating surfaces, power transmission systems, IC engines, etc.

Video link / Additional online information :

1. https://www.youtube.com/watch?v=qPtpsARSZIs
2. https://www.youtube.com/watch?v=oZhR1HPdvR4&list=PL46AAEDA6ABAFCA78&index=18&t=0s
3. https://www.youtube.com/watch?v=oQURLrZFU2k
4. https://www.youtube.com/watch?v=outh87jHrl8

Course outcomes:

CO1	Determine the forces and couples for static and dynamic conditions of four bar and slider crank mechanisms to keep the system in equilibrium.
CO2	Determine magnitude and angular position of balancing masses under static and dynamic condition of rotating masses in same and different planes.
CO3	Determine sensitiveness, isochronism, effort and power of porter and hartnell governors.
CO4	Determine gyroscopic couple and effects related to 2, 4 wheeler, plane disc, ship and aeroplanes.
CO5	Determine the coefficient of friction between belt and the pulley and fluctuation in energy of flywheel.

Text Books:	
1	**Theory of Machines: Kinematics and Dynamics**, Sadhu Singh Pearson Third edition 2019.
2	**A. G. Ambedkar, "*Mechanism and Machine Theory*"**, PHI, 2007.
Reference Books	
1.	**Rattan S.S., "*Theory of Machines*"**, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.
2.	**Mechanisms and Machines Kinematics,** Dynamics and Synthesis Michael M Stanisic Cengage Learning 2016

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	2	1	1	1	1	1
CO2	3	3	3	2	2	2	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1	1	1
CO4	3	3	3	3	3	2	2	1	1	1	1	1
CO5	3	3	3	3	2	2	1	2	1	1	1	1

High-3, Medium-2, Low-1

Course Title	INDUSTRIAL INTERNET OF THINGS (IIoT)	Semester	V
Course Code	MVJ20ME551	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	**03**	**Exam. Duration**	03 Hrs

Course objective is to:

- Explore the basic components of IIoT.
- Study the principles of IIoT and its controlling factors.
- Extend experience in IIoT to understand about drives and control.
- Identify design parameters for a typical IIoT architecture.

Module-1	**RBT Level** L1, L2	8 Hrs.

Introduction to IoT - The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Laboratory Sessions/ Experimental learning:

- Demonstration of IoT in Data Management and Security.

Applications: IoT for Industrial Automation.

NPTEL/Additional Videos Link:

https://www.youtube.com/watch?v=AQdLQV6vhbk

Module-2	**RBT Level** L1, L2,L3	8 Hrs.

Industrial IoT: Introduction to Industrial IoT, Business Model and Reference Architecture, IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking.

Laboratory Sessions/ Experimental learning:

- Demonstration of Application of IIoT in a production facility.

Applications: Airbus: Factory of the Future

NPTEL/Additional Videos Link:

https://www.youtube.com/watch?v=Qs7bs2g7Usc

https://www.youtube.com/watch?v=9Wh4PUN-viE

Module-3	RBT Level L2, L3	8 Hrs.

Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis.

Laboratory Sessions/ Experimental learning:

- Demonstration of the some basic exercises related to sensors.

Applications: ABB: Smart robotics

NPTEL/Additional Videos Link:

https://www.youtube.com/watch?v=wgWRLu8p90M

Module-4	RBT Level L1, L2, L3	8 Hrs.

Developing IoT: Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi, Implementation of IoT with Arduino and Raspberry, CloudComputing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

Laboratory Sessions/ Experimental learning:

- Demonstration of functioning of different IoT tools

Applications: IoT for Smart Cities and Smart Vehicles

NPTEL/Additional Video Links:

https://www.youtube.com/watch?v=wgWRLu8p90M

Module-5	RBT Level L2, L3	8 Hrs.

Intelligent Manufacturing for Industry 4.0: Introduction to Intelligent Manufacturing, Three Dimensions of Intelligent Manufacturing - (1) Demand Driven and Integrated Supply Chains;(2) Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations); (3) Real Time, Sustainable Resource Management, intelligent energy demand management, production energy optimization, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes.

Laboratory Sessions/ Experimental learning:

Case Studies on the application of IIoT in Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies : Milk Processing and Packaging Industries, Manufacturing Industries

Applications: Smart Factories, Smart Products and Smart Services

NPTEL/Additional Video Links:

https://www.youtube.com/watch?v=gq0VWSXvG0s

Course outcomes:	
CO1	Understand general concepts of Internet of Things (IoT) (Understand)
CO2	Recognize various devices, sensors and applications (Knowledge)
CO3	Apply design concept to IoT solutions (Apply)
CO4	Analyse and Evaluate design issues in IoT applications (Analyse and Evaluate).
CO5	Create IoT solutions using sensors, actuators and Devices (Create).

Text Books:	
1.	The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication).
2.	Industrial Internet of Things: Cybermanufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication).
Reference Books	
1.	Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Wiley Publications.
2.	Arsheep Bahga, Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback – Universities Press Publication, January 2015 Edition.
3.	Raj Kamal, Internet of Things: Architecture and Design Principles, Tata McGraw Hill, 2017 Edition, ISBN-13: 9789352605224.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)

- Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	2	2	-	-	-	-	2
CO2	3	3	2	-	-	2	2	-	-	-	-	2
CO3	3	3	2	-	-	2	2	-	-	-	-	2
CO4	3	3	2	-	-	2	2	-	-	-	-	2
CO5	3	3	2	-	-	2	2	-	-	-	-	2

High-3, Medium-2, Low-1

Course Title	ADVANCED MANUFACTURING TECHNOLOGY	Semester	V
Course Code	MVJ20ME552	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0: 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hrs

Course objective is to:

- To analyze and determine material fabrication processes.
- To understand and analyse various science and technologies involved in the production of integrated circuits.
- To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.
- To understand and identify fundamentals of metallic and non-metallic materials with special emphasis on applications.

Module-1	**RBT Level** L1,L2,L4	08 Hrs.

Manufacturing Of Composites:

Manufacturing of Polymer Matrix Composites (PMCs)-hand lay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state, vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) –hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces.

Laboratory Sessions/ Experimental learning: Case Studies/ Brain storming for selection criteria for different manufacturing processes

Video link / Additional online information:

https://www.youtube.com/watch?v=uO8EMAUh1po

Module-2	**RBT Level** L1,L3, L4	08 Hrs.

Processing Of Ceramics: Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fibre reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

Laboratory Sessions/ Experimental learning: Case studies for cost estimation of various advanced manufacturing processes.

Video link / Additional online information: https://www.youtube.com/watch?v=3pAajeRKufc		
Module-3	**RBT Level** L1,L2, L3	08 Hrs.
Fabrication Of Microelectronic Devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics. **Laboratory Sessions/ Experimental learning:** Case study of design for advance machining processes. **Video link / Additional online information:** https://www.youtube.com/watch?v=-M-941EcjC8		
Module-4	**RBT Level** L1,L2,L3	08Hrs.
Rapid Prototyping: Introduction to RP and advantages and limitations, Applications, Stereo lithography Apparatus (SLA), Fused Deposition Modelling, Laminated Object Manufacturing, Selective Laser Sintering, Laser Engineered Net Shaping (LENS). **Laboratory Sessions/ Experimental learning:** Case study of 3D Printing **Video link / Additional online information:** https://www.youtube.com/watch?v=sM67ict7TVM		
Module-5	**RBT Level** L2,L3,L4	08 Hrs.
Modern Metallic Materials*:** Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Managing Steel, Inter metallic, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials. ***Nonmetallic Materials: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, A12 O3, SiC, Si3 N4, CBN and Diamond – properties, Processing and applications. **Laboratory Sessions/ Experimental learning:** Case study of applications of modern materials in aerospace and aircraft industry. **Video link / Additional online information:** https://onlinecourses.nptel.ac.in/noc21_mm14/preview		

Course Outcomes:	
CO1	Ability to manufacture components of composite materials
CO2	Ability to manufacture components of ceramics

CO3	Ability to manufacture components of Electromechanical devices
CO4	Knowledge of Rapid prototyping
CO5	Knowledge of modern metallic and non-metallic materials

Text Books:	
1.	Gibson, R.F., *"Principles of Composite Material Mechanics"*, McGraw-Hill, 1994, Second Edition - CRC press in progress.
2.	*Manufacturing Engineering and Technology* IKalpakijian / Adisson Wesley, 1995.
Reference Books:	
1	Hyer, M.W., "*Stress Analysis of Fiber-Reinforced Composite Materials*", McGraw-Hill, 1998
2	*Process and Materials of Manufacturing* / R. A. Lindburg / 1th edition, PHI 1990.
3	*Microelectronic packaging* handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostr and Renihold,
4	*MEMS & Micro Systems Design and manufacture* / Tai — Run Hsu / TMGH

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	3
CO2	3	2	-	-	3	-	-	-	-	-	-	2
CO3	2	2	-	-	2	-	-	-	-	-	-	2
CO4	2	2	-	-	2	-	-	-	-	2	-	2
CO5	2	-	-	-	3	-	-	-	-	-	-	2

High-3, Medium-2, Low-1

Course Title	COMPOSITE MATERIALS	Semester	V
Course Code	MVJ20ME553	**CIE**	50
Total No. of Contact Hours	40 L: T:: P: 3: 0:0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	03 Hrs

Course objective is to:

- To obtain knowledge on classification, processing, characterization and applications of composite materials.
- To obtain knowledge on mechanical properties and failure mechanisms of composites under loading conditions for engineering applications.

Module-1	RBT Level L1 L2	08 Hrs.

Introduction To Composite Materials: Definition, history and classification of composite materials. Advantages and limitations, industrial scenario and applications. Materials - fibrous composites, laminated composites, particulate composites.

Fibre Reinforced Plastic (FRP) Processing: Layup and curing, fabricating process, open and closed mould process, Hand layup techniques, structural laminate bag moulding, production procedures for bag moulding, filament winding, pultrusion, pulforming, thermo-forming, injection moulding, blow moulding.

Laboratory / Experimental Sessions: Hand Layup Technique, Compression Moulding Technique, Bag Moulding.

Applications: Wind turbine, Aerospace Industries, Military Industries.

Video link / additional online information:

https://www.youtube.com/watch?v=kC5VRV8vWkM. MOOC & Open courseware.

Module-2	RBT Level L2 L3 L4	08 Hrs.

Characteristics of Fibre Reinforced Lamina: Unidirectional fibre composites: Fibre characteristics. Longitudinal strength and modulus of composites, minimum and critical fibre volume fractions, factors affecting strength, Transverse strength and modulus.

Introduction to Properties of Laminate and Failure Theories: Failure modes, Single and multiple fractures. Short-fibre composites: Stress transfer, critical fibre length. Modulus and strength. Whiskers and whisker reinforced composites.

Laboratory / Experimental Sessions: Fiber characteristics – Unidirectional fibre, Bidirectional fibre, Multidimensional fibre, minimum and critical fibre for finding out Longitudinal & Transverse strength and modulus, failure modes.

Applications: Fibre Reinforced Plastics in Industries, Plastic industries, Manufacturing industries. **Video link / additional online information:** https://www.youtube.com/watch?v=S_hJw7ai76A, https://www.youtube.com/watch?v=R4SkUOzVDJA, MOOC & Open courseware.		
Module-3	**RBT Level L1 L2 L3**	08 Hrs.
Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application. **Fabrication Process for MMC's:** Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques. **Laboratory / Experimental Sessions:** Analysis of Mechanical Properties using Stir Casting, Characterization analysis using optical microscope. **Applications:** Aeronautical and Aerospace Industries, Automobile Industries. **Video link / additional online information:** https://www.youtube.com/watch?v=RihoVfzEfWI, MOOC & Open courseware.		
Module-4	**RBT Level L1 L2 L4**	08 Hrs.
Ceramic Matrix Composites: Engineering ceramic materials, properties, advantages, limitations, Monolithic ceramics, Need for CMC, Ceramic matrix, Various types of Ceramic Matrix composites, oxide ceramics, non-oxide ceramics, aluminium oxide, silicon nitride reinforcements, particles, fibres, whiskers. Sintering, Hot pressing, Cold isostatic pressing (CIPing), Hot isostatic pressing (HIPing). **Advanced Composites:** Nano composites, hybrid composites, sandwich composites, in-situ composites, smart composites, self-healing composites, and carbon - carbon composites. **Laboratory / Experimental Sessions:** Analysis of Mechanical Properties using Powder Metallurgy, Ceramic shell casting, Slip casting. **Applications:** Glass industries, Ceramic Industries. **Video link / additional online information:** https://youtu.be/ACPDEy3evqE, MOOC & Open courseware.		
Module-5	**RBT Level L2 L3 L4**	08 Hrs.
Testing and Characterization: Different tests tensile, compression, shear, fatigue, pull-out test, fracture toughness, metallographic preparation with special emphasis to metal matrix composites, XRD and SEM. **Secondary Processes and Applications:** Secondary processing like machining, joining, extrusion of composites - Application and case studies. **Laboratory / Experimental Sessions:** Different types of tests on finding out mechanical properties and fracture analysis, Characterization analysis using optical microscope.		

Applications: Wind turbine, Aerospace Industries, Military Industries, Glass industries, Ceramic Industries. **Video link / additional online information:** https://www.youtube.com/watch?v=ZMJ7O4vs-Q8, MOOC & Open courseware.	
Course outcomes:	
CO1	Knowledge on classification, processing, characterization and applications of various composite materials.
CO2	Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications.
CO3	Ability to decide the manufacturing methods for producing different types of MMC's.
CO4	Ability to understand the properties, manufacturing methods of CMC's and to differentiate various types of advanced composite materials.
CO5	Select suitable testing procedures, characterization of composite materials and knowledge of secondary processing of composites.

Text Books:	
1.	Madhijit Mukhopadhay, Mechanics of Composite Materials & Structures, Universities Press, 2004.
2.	Michael W Hyer, Stress analysis of fibre Reinforced Composite Materials, Mc-Graw Hill International, 2009.
Reference Books:	
1.	Fibre Reinforced Composites, P C Mallik, Marcel Decker, 1993.
2.	Composite Materials: Science and Engineering, Krishan K Chawla, Springer.
3.	Autar K Kaw, Mechanics of Composite materials, CRC Taylor & Francis, 2nd Ed, 2005.
4.	Robert M Jones, Mechanics of Composite Materials, Taylor & Francis, 1999

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
CO3	3	3	3	1	2	1	1	1	1	2	1	1
CO4	3	3	2	1	2	1	1	1	1	2	1	1
CO5	3	3	3	1	3	1	1	1	1	3	1	1

High-3, Medium-2, Low-1

Course Title	TOTAL QUALITY MANAGEMENT	Semester	V
Course Code	MVJ20ME554	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hrs

Course objective is to:

- To understand the concept of Total Quality Management.
- To Know the Customer, his Quality perception and his demands.
- To identify useful quality improvement techniques.
- To know the need of Leadership qualities and Team development in TQM
- To understand the need of Quality, ISO Certification and its procedure.

Module-1	**RBT Level** L1, L2	08 Hrs

Introduction: Definition, Quality Dimensions, Quality aspects – Quality of Design, Quality of Conformance and Quality of Performance, TQM Cultural change, Historical Review, Discussion on Benefits of TQM, Quality, Garvin's Nine dimensions of Quality, TQM frame work, Contribution of Quality Gurus-Juran (Quality Triology), Discussion on Deming's (14 Principles of Management), Contribution of Crosby, Ishikawa and Taguchi.

Laboratory Sessions/ Experimental learning:

- The impact of total quality management (TQM) on productivity-A case study

Applications: It guides to know about quality-based production.

Video link / Additional online information:

1. https://nptel.ac.in/courses/110104080/
2. https://studentsfocus.com/ge6757-tqm-notes-total-quality-management
3. https://pec.ac.in/programmes/pg/structure/tqm
4. https://www.scribd.com/document/354054705/Total-Quality-Management

Module-2	**RBT Level** L1, L2	08 Hrs

Customer Orientation-Customer Focus, Customer satisfaction model Quality Function Deployment (QFD), Customer Satisfaction Measurement, Kano Model.

Problem Solving Tools-Problem Solving Process, Seven QC Tools, Seven Management tool.

Laboratory Sessions/ Experimental learning:

- Customer Satisfaction through TQM Approach: A case study

Applications: It helps in reaching the customer related to queries of the product.

Video link / Additional online information:

https://studentsfocus.com/ge6757-tqm-notes-total-quality-management

Module-3	RBT Level L2, L3	08 Hrs

Continuous Improvement Strategies-Deming Wheel, Zero Defect Concept, Benchmarking, Six sigma,

Preventive Techniques-Failure Mode Effect Analysis, Poke Yoke.

Quality Ambience- Five S for Quality Ambience, Time Management.

Quality Control – Offline quality control, statistical quality control Statistical Quality Control – Causes of Variation in Quality, Central limit Theorem, Control charts for variables and attribute (simple problems only), Process capability studies (theory only) & Z-Score.

Laboratory Sessions/ Experimental learning:

- A case study on Continuous Improvement Process

Applications: It is used in quality control of the product to improve the productivity.

Video link / Additional online information: https://nptel.ac.in/courses/110104080/

Module-4	RBT Level L2, L3	08 Hrs

LEAN Six Sigma-Mapping; Kanban; team management; Process Improvement; process; six sigma; Leadership and Management; Lean Methods; lean six sigma; Trigonometric Integral.

Laboratory Sessions/ Experimental learning:

- Exercises related to Six Sigma in daily life

Applications: It guides to learn more skills related to leadership qualities.

Video link / Additional online information: https://www.youtube.com/watch?v=jHe5sezJ0cY

Module-5	RBT Level L2, L3	08 Hrs

Quality Certification-ISO 9000 series Certification ISO 9001: 2008 Certification, ISO 14000 Series Certification, Quality auditing, Quality Awards.

TQM Road Map: Measurement of Quality, TQM Road Map, TQM Implementation Strategy, When TQM Fails.

Laboratory Sessions/ Experimental learning:

- Importance of TQM in engineering projects

Applications: Applied to companies to get the standards of the product.

Video link / Additional online information:

https://studentsfocus.com/ge6757-tqm-notes-total-quality-management

Course outcomes:	
CO1	Understand the philosophy and core value to TQM
CO2	To determine the voice of customers and its impact on quality.
CO3	Apply and evaluate Various strategies, best practices for attainment of total quality.
CO4	Come to know the need of Leadership qualities and Team development in TQM
CO5	To do the ISO Certification and explain about its procedure

Text Books:	
1	Dale H Besterfield *"Total Quality Management"*, Pearson Education,3rd Edition
2	L. Suganthi & Anand, *"Total Quality Management"*, PHI-2004.
Reference Books:	
1.	Amitava Mitra *"Fundamentals of Quality Control and Improvement"*, Third Edition, John Wiley & Sons publication
2	Poornima M Charanthimath *"Total Quality Management"*, Pearson Education
3	Juran J.M, *"A History For Managing For Quality"*, ASQC Quality Press, 1995
4	A Mahajan *"Statistical Quality Control"*, Dhanapat Rai & Co. (P) Ltd.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	-	1	-	3	-	2	-	3
CO2	3	1	1	-	-	2	2	-	2	3	-	3
CO3	3	1	3	1	2	1	-	-	-	-	-	3
CO4	3	1	1	-	-	1	-	3	3	3	-	3
CO5	3	1	1	-	-	3	3	3	2	1	-	2

High-3, Medium-2, Low-1

Course Title	FLUID MECHANICS AND FLUID MACHINERY-LAB	Semester	V
Course Code	MVJ20MEL56	CIE	50
Total No. of Contact Hours	20 L: T: P: 0: 1: 3	SEE	50
No. of Contact Hours/week	02	Total	100
Credits	02	Exam. Duration	03 Hrs

Course Learning Objectives:

- To provide a basic understanding of the flow characteristics.
- To provide a basic understanding of the energy conversion principles.
- To provide an understanding of the significance of hydraulic machines and performance analysis.
- To provide an insight into the characteristic curves for flow through different equipment.

Sl. No	Experiments
	PART A
1	Determination of coefficient of friction of flow in a pipe.
2	Determination of minor losses in flow through pipes.
3	Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades.
4	Determination of coefficient of discharge of various flow measuring devices.
	PART B
5	Performance studies on Pelton. Francis and Kaplan wheel turbines.
6	Performance of Single and Multistage Centrifugal Pump.
7	Performance test on Reciprocating Pump.
8	Performance test on a two stage Reciprocating Air Compressor.
9	Performance test on an Air Blower.
Course outcomes:	
CO1	Perform experiments to determine the coefficient of friction of flow in a pipe.
CO2	Conduct experiments to determine minor losses in flow through pipes.
CO3	Determine coefficient of discharge of various flow measuring devices.
CO4	Conduct performance studies on Pelton, Francis and Kaplan wheel turbines.
CO5	Conduct performance test on pumps and compressors.

Reference Books:	
1.	Munson, Young, Okiishi & Huebsch, "*Fundamentals of Fluid Mechanics*", John Wiley Publications7th edition.

Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 20 marks
2.	One question is to be set from Part-B: 20 marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Course Title	ENERGY CONVERSION-LAB	Semester	V
Course Code	MVJ20MEL57	CIE	50
Total No. of Contact Hours	20L: T: P: 0: 1: 3	SEE	50
No. of Contact Hours/week	02	Total	100
Credits	02	Exam. Duration	03 Hrs

Course Learning Objectives:

- To provide basic understanding of the fuel properties to students.
- To provide insight into the Energy conversion principles, analysis and understanding of I C Engines.
- To provide insight into the application of the energy conversion principles.
- To carryout basic experiments on the performance characteristics of the IC Engines.
- To provide an insight into the Exhaust emissions of I C Engines and various emission standards.

Sl. No	Experiments
	PART A
1	Determination of Calorific value of fuel.
2	Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Marten's (closed) / Cleveland's (Open Cup) Apparatus.
3	Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4	Valve Timing Diagram of an I.C. Engine.
5	Use of a Planimeter
	PART B
5.	Performance Tests on Two stroke Petrol Engine, Four Stroke Petrol Engine, Four Stroke Diesel Engines with different loading.
6.	Performance test on 4-Stroke VCR(Variable Compression Ratio) Petrol Engine test rig
7.	Performance test on 4-Stroke Petrol Engine with Morse test rig
8.	Measurements of Exhaust Emissions of Petrol engine.
9.	Measurements of Exhaust Emissions of Diesel engine.
10.	Demonstration of measurements of P-θ, PV plots using IC Engine test rig.

Course outcomes:

CO1	Perform experiments to determine the properties of fuels and oils.
CO2	Conduct performance tests on IC Engines and draw the characteristic graphs.

CO3	Test basic performance parameters of I.C. Engine and implement the knowledge in industry.
CO4	Measure the Exhaust emissions of petrol and diesel engines.

Reference Books:	
1.	P. K. Nag, "*Power Plant Engineering*", Tata McGraw Hill Education Private Limited, New Delhi Third Edition, 2012.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 15 marks
2.	One question is to be set from Part-B: 25 Marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Course Title	COMPUTATIONAL TECHNIQUES LAB	Semester	V
Course Code	MVJ20MEL58	CIE	50
Total No. of Contact Hours	20L: T: P: 0: 1:3	SEE	50
No. of Contact Hours/week	02	Total	100
Credits	02	Exam. Duration	03 Hrs

Course Learning Objectives:

- To understand the MATLAB/Lab View environment.
- To do basic numerical calculations using MATLAB/Lab View.
- To apply a variety of numerical techniques to solve and visualize engineering-related problems.

Sl. No	Experiments
	PART A
1	Recapitulation of numerical techniques and introduction to MATLAB software.
2	To write a script to plot the deflection and potential energy of spring subjected to different load steps
3	To create a MATLAB function to calculate the capillary rise of liquid.
4	To find the initial velocity of a projectile by solving a system of linear equations.
5	To develop a model of the effect of temperature on viscosity by the use of curve fitting.
6	To develop a model of a steady flow of water in a circular pipe by the use of multiple linear regression.
	PART B
7	To solve a differential equation to calculate the deflection of the beam.
8	To display the temperature profile on a rectangular plate using partial differential equation.
9	To write a code to plot the animation of displacement of slider crank mechanism with respect to input angle.
10	To calculate the minimum drag on an airfoil by the use of optimization technique.
	PART C (OPTIONAL)
11	To solve a system of non-linear equations using Simulink.
12	To develop a Simulink model for simulation of hybrid-driven planar five-bar parallel mechanism.

Course outcomes:

CO1	Apply built-in functions in MATLAB to solve numerical problems

CO2	Develop code for solving problems involving different types of mathematical models and equations (ODE, PDE, Linear and nonlinear equations).
CO3	Solve simulation problems encountered in mechanical design, vibration analysis and CAD.
CO4	Model a system and develop a simulation code towards a mini project.

Reference Books:	
1.	Rudra Pratap, "*Getting started with MATLAB: A quick introduction for scientists and engineers*", Oxford University Press, Seventh Edition, 2016.
2.	Steven C. Chapra, "*Numerical Methods for Engineers*", McGraw-Hill Education, Sixth Edition, 2010.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 15 marks
2.	One question is to be set from Part-B: 25 Marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Pelton Wheel Turbine test rig in Fluid Mechanics and Fluid Machinery-Lab

Computerized VCR Diesel Engine Test Rig in Energy conversion Lab

Course Title	ENVIRONMENTAL STUDIES	**Semester**	V
Course Code	MVJ20ENV59	**CIE**	50
Total No. of Contact Hours	20 L: T: P: 1: 0: 0	**SEE**	50
No. of Contact Hours/week	01	**Total**	100
Credits	01	**Exam. Duration**	03 Hrs

Course objective is to: This course will enable the students to

- An interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including geosystems, biology, chemistry, economics, political science and international processes; Study drinking water quality standards and to illustrate qualitative analysis of water.
- Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability

Module-1	**RBT Level** L2, L3	04 Hrs

Introduction to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Rivers, Ocean and Lake.

Biodiversity: Types, Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Video link / Additional online information:

https://nptel.ac.in/courses/127/106/127106004/

https://www.youtube.com/watch?v=1TBrEVM1fXw

https://www.youtube.com/watch?v=djbcALTOyUs

Module-2	**RBT Level** L2, L3	04 Hrs

Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind.

Natural Resource Management (Concept and case-study): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Video link / Additional online information:

https://nptel.ac.in/courses/121/106/121106014/

https://www.youtube.com/watch?v=Sv-zeQ-VswI

Module-3	RBT Level L2, L3	04 Hrs
Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution. **Waste Management & Public Health Aspects**: Bio-medical Waste; Solid waste; Hazardous waste; E-waste. **Video link / Additional online information:** https://nptel.ac.in/courses/122/106/122106030/ https://nptel.ac.in/courses/105/103/105103205/ https://nptel.ac.in/courses/120/108/120108005/ https://nptel.ac.in/courses/105/105/105105160/		
Module-4	**RBT Level** L2, L3	04 Hrs
Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Fluoride problem in drinking water; Environmental Toxicology. **Video link / Additional online information:** https://nptel.ac.in/courses/122/106/122106030/ https://nptel.ac.in/courses/120108004/ https://onlinecourses.nptel.ac.in/noc19_ge23/preview		
Module-5	**RBT Level** L2, L3	04 Hrs
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO 14001. **Field work:** Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; Followed by understanding of process and its brief documentation. **Video link / Additional online information:** https://nptel.ac.in/courses/105/102/105102015/ https://nptel.ac.in/courses/120/108/120108004/ https://www.coursera.org/lecture/spatial-analysis-satellite-imagery-in-a-gis/what-is-remote-sensing-27nfo		
Course outcomes: On completion of the course, students would be able to		
CO1	Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.	

CO2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
CO3	Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components.
CO4	Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Text Books:	
1.	Environmental Studies Benny Joseph Tata Mc Graw – Hill. 2 nd Edition, 2012
2.	Environmental Studies S M Prakash Pristine Publishing House, Mangalore 3 rd Edition, 2018.
Reference Books:	
1.	Principals of Environmental Science and Engineering, Raman Siva Kumar, Cengage learning, Singapore. 2 nd Edition, 2005
2.	Environmental Science – working with the Earth G. Tyler Miller Jr. Thomson Brooks /Cole, 11thEdition, 2006
3.	Text Book of Environmental and Ecology Pratiba Sing, Anoop Singh& Piyush Malaviya Acme Learning Pvt. Ltd. New Delhi. 1 st Edition

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	-	2	2	1	1	-	2	1
CO2	3	3	2	1	-	1	2	-	1	1	2	1
CO3	3	3	2	1	-	2	2	-	1	1	2	1
CO4	3	3	2	2	-	2	2	-	1	1	2	1

High-3, Medium-2, Low-1

Course Title	UNIVERSAL HUMAN VALUES-II	Semester	V
Course Code	MVJ20UHV510	CIE	50
Total No. of Contact Hours	32 L:T:P::2:0:0	SEE	50
No. of Contact Hours/week	2	Total	100
Credits	2	Exam. Duration	3 Hours

Course objective is to:

- Appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- Facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Module-1	L1, L2, L3	10 Hours

Review on Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Self-exploration as the Process for Value Education, Happiness and Prosperity – Current Scenario,

Value Education: Understanding Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, , Method to Fulfill the Basic Human Aspirations,

Practical Sessions: Sharing about Oneself (Tutorial 1), Exploring Human Consciousness (Tutorial 2), Exploring Natural Acceptance (Tutorial 3)

Video link:

1. https://www.youtube.com/watch?v=85XCw8SU084
2. https://www.youtube.com/watch?v=E1STJoXCXUU&list=

PLWDeKF97v9SP_Kt6jqzA3p Z3yA7g_OAQz		
Module-2	**L1, L2, L3**	10Hours
Review on Understanding Human being as the Co-existence of the Self and the Body, The Body as an Instrument of the Self, Harmony of the Self with the Body. Harmony in the Human Being: Distinguishing between the Needs of the Self and the Body, Understanding Harmony in the Self, Programme to ensure self-regulation and Health. **Practical Sessions**: Exploring the difference of Needs of Self and Body (Tutorial 4), Exploring Sources of Imagination in the Self (Tutorial 5), Exploring Harmony of Self with the Body (Tutorial 6). **Video link:** 1. https://www.youtube.com/watch?v=GpuZo495F24 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Module-3	**L1, L2, L3**	10Hours
Review on Harmony in the Family – the Basic Unit of Human Interaction, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society. **Harmony in the Family and Society**: Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Vision for the Universal Human Order, **Practical Sessions**: Exploring the Feeling of Trust (Tutorial 7), Exploring the Feeling of Respect (Tutorial 8), Exploring Systems to fulfill Human Goal (Tutorial 9). **Video link:** 1. https://www.youtube.com/watch?v=F2KVW4WNnS8 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Module-4	**L1, L2, L3**	10Hours
Harmony in the Nature/Existence: Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence. **Practical Sessions**: Exploring the Four Orders of Nature (Tutorial 10), Exploring Co-existence in Existence (Tutorial 11).		

Video link: 1. https://www.youtube.com/watch?v=1HR-QB2mCF0 2. https://www.youtube.com/watch?v=lfN8q0xUSpw 3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		
Module-5	**L1, L2, L3**	10Hours
Review on Natural Acceptance of Human Values,Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Holistic Technologies, Production Systems and Management Models-Typical Case Studies. **Implications of the Holistic Understanding – a Look at Professional Ethics:** Definitiveness of (Ethical) Human Conduct, Competence in Professional Ethics, Strategies for Transition towards Value-based Life and Profession **Practical Sessions:** Exploring Ethical Human Conduct (Tutorial 12), Exploring Humanistic Models in Education (Tutorial 13), Exploring Steps of Transition towards Universal Human Order (Tutorial 14). Video link: 1. https://www.youtube.com/watch?v=BikdYub6RY0 2. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw		

Course outcomes:	
CO1	Explore themselves, get comfortable with each other and with the teacher
CO2	Enlist their desires and the desires are not vague.
CO3	Restate that the natural acceptance (intention) is always for living in harmony, only competence is lacking
CO4	Differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them
CO5	Present sustainable solutions to the problems in society and nature

Reference Books:	
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel

	Books, New Delhi, 2010
2	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4	The Story of Stuff (Book).

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	-	-	-	2	2	3	2	1	2	1
CO2	-	1	-	-	-	2	2	3	2	1	2	1
CO3	-	1	-	-	-	2	2	3	2	1	2	1
CO4	-	1	-	-	-	2	2	3	2	1	2	1
CO5	-	1	-	-	-	2	2	3	2	1	2	1

High-3, Medium-2, Low-1

Course Title	APPLICATION DEVELOPMENT USING PYTHON	Semester	V
Course Code	Audit Course – MVJ20MEAUD1	**CIE**	-
Total No. of Contact Hours	40 L: T: P :: 2 : 2 : 0	**SEE**	-
No. of Contact Hours/week	04	**Total**	-
Credits	-	**Exam. Duration**	-

Course objective is to:

- Learn the syntax and semantics of Python programming language.
- Illustrate the process of structuring the data using lists, tuples and dictionaries.
- Demonstrate the use of built-in functions to navigate the file system.
- Implement the Object-Oriented Programming concepts in Python.
- Appraise the need for working with various documents like Excel, PDF, Word and Others.

Module-1	**RBT Level** L1, L2	08 Hrs.

Why should you learn to write programs, Entering Expressions into the Interactive Shell, Data Types, Variables, expressions and statements, Conditional execution, if condition, Iteration, while loop, for loop, Type conversion in python.

Laboratory Sessions/ Experimental learning:

- Write and Implement Python Program on "guess the number" game

Applications:

- Data mining identify cross-sell opportunities
- Meeting software system deadlines

Video link / Additional online information:

https://automatetheboringstuff.com/

http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf

http://greenteapress.com/thinkpython2/thinkpython2.pdf

Module-2	**RBT Level** L1, L2, L3	08 Hrs.

Local and Global scope, Data encapsulation, Importing Modules, Functions, Pure functions, Function Overloading, Program exceptions, Exception handling, Working with Strings, Operator Overloading, File Handling in Python.

Laboratory Sessions/ Experimental learning:

- Password Locker

Applications:

- Adding Bullets to Wiki Markup

Video link / Additional online information:

https://www.youtube.com/watch?v=j0cPnbtp1_w

https://www.youtube.com/watch?v=APY_pYeMRkw

https://www.youtube.com/watch?v=2IsF7DEtVjg

Module-3	RBT Level L1, L2, L3	08 Hrs.

Lists, The List Data Type, Working with Lists, Augmented Assignment Operators, Tuples, The Tuples Data Type, Working with Tuples, References, Dictionaries, The Dictionary Data Type, Working with Dictionaries, Regular Expressions.

Laboratory Sessions/ Experimental learning:

- Debugging Coin Toss

Applications:

- Date Detection
- Strong Password Detection

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=sa-TUpSx1JA

https://www.youtube.com/watch?v=K8L6KVGG-7o

https://www.youtube.com/watch?v=cdgV4iCDWmw

Module-4	RBT Level L1, L2, L3	08 Hrs.

Classes and objects, Programmer-defined types, Attributes, Rectangles, Instances as return values, Objects are mutable, Printing objects, Operator overloading Classes and functions, Classes and methods, Inheritance, Single inheritance, Multiple inheritance, Multilevel inheritance.

Laboratory Sessions/ Experimental learning:

- Operator Overloading

Applications:

- Polymorphism
- Inheritance

Video link / Additional online information (related to module if any):

https://www.youtube.com/watch?v=8O5kX73OkIY

https://www.youtube.com/watch?v=_uYorV9ebLg

https://www.youtube.com/watch?v=mrhccLHtyN4

Module-5	RBT Level L1, L2, L3	08Hrs.

Networked programs, Using Web Services, using databases and SQL, Data Science and Python, Understanding Python's Role in Data Science, Considering the emergence of data science Outlining the core competencies of a data scientist.

Laboratory Sessions/ Experimental learning:

- Encrypting PDFs

Applications:

• Copying Pages *Video link / Additional online information (related to module if any):* https://www.youtube.com/watch?v=ooj84UP3r6M https://www.youtube.com/watch?v=0_VZ7NpVw1Y https://www.youtube.com/watch?v=XVv6mJpFOb0

Course outcomes:	
CO1	Demonstrate proficiency in handling of loops and creation of functions.
CO2	Identify the methods to create and manipulate lists, tuples and dictionaries.
CO3	Discover the commonly used operations involving regular expressions and file system.
CO4	Interpret the concepts of Object-Oriented Programming as used in Python.
CO5	Determine the need for scraping websites and working with CSV, JSON and other file formats.

Text Books:	
1.	Gowrishankar S, Veena A, **"Introduction to Python Programming"**, 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372
Reference Books:	
1.	Allen B. Downey, **"Think Python: How to Think Like a Computer Scientist"**, 2nd Edition, Green Tea Press, 2015. (Available under CC-BY-NC license at http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Chapters 13, 15, 16, 17, 18) (Download pdf/html files from the above links)
2.	Al Sweigart,**"Automate the Boring Stuff with Python"**,1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/), (Chapters 1 to 18)

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Course Title	HVAC	Semester	V
Course Code	CERTIFICATE COURSE	CIE	-
Total No. of Contact Hours	30 L: T : P :: 2 : 0: 0	SEE	-
No. of Contact Hours/week	03	Total	-
Credits	02	Exam. Duration	-

Course objective is to:

- Introduce the concepts of Heating Ventilation and Air-Conditioning to students.
- Expose the students to HVAC systems and air conditioners.
- Introduce the concepts of cold storage and ventilation designs.

Module-1	RBT Level L1,L2,L3	06 Hrs.

Introduction

Introduction to HVAC systems, Working of an air-conditioner, Reverse adiabatic cycle, Evaporator, Compressor, Condenser, Expansion valves and Thermostat.

Types of Compressors used in the HVAC, Reciprocating Air Conditioner Compressor, Screw AC Compressor, Rotary and Centrifugal Air conditioners.

Laboratory Sessions/ Experimental learning: Students will be exposed to various components of air conditioners through hands on experience.

Applications: Air conditioners

Video links: https://www.youtube.com/watch?v=GzEMdQk1QTk

Module-2	RBT Level L1,L2,L3	06 Hrs.

Refrigerants used in Heating and Cooling systems

Basics of Thermodynamics, Heat transfer, Sensible heat, Latent heat, Psychometric chart, Dry bulb temperature, wet bulb temperature, Relative humidity, humidity ratio, dew point.

Heating and Air Conditioning – Load Calculations

Laboratory Sessions/ Experimental learning: Students will be exposed to Heating and Air Conditioning load calculations using E-20 form and HAP software.

Applications: Design of Air Conditioning Systems based on the load conditions.

Video links: https://www.youtube.com/watch?v=9-K9Y5b8M5c

Module-3	RBT Level L1,L2,L3	06 Hrs.

Equipment Selection

Types of Heating and Air Conditioning System, DX system, VRF/VRV system, Package units, Roof top units, Chiller Systems, Air Cooled Chillers, Water Cooled Chillers.

Air Distribution System – Air terminals, Ducting, Duct types, Duct sizing criteria, Calculating the overall duct, static pressure calculation in ducting system, Duct supports and insulation. **Laboratory Sessions/ Experimental learning:** Students will be exposed to air terminals and ducting systems through real time examples. **Applications:** Air duct systems for centralized air conditioners. **Video links:** https://www.youtube.com/watch?v=5y_VBiTiuAY		
Module-4	**RBT Level L1,L2,L4**	**06 Hrs.**
Variable Refrigerant Flow – Introduction to VRF system, Difference between single and dual compressor system, Piping design for VRF system. **Hydronic heating and cooling system** – Open loop system design - water requirement, pipe sizing, finding the critical path, friction loss, pump capacity. Closed loop system design – water requirement, pipe sizing, friction loss and head loss calculation, pump capacity. **Laboratory Sessions/ Experimental learning:** Students will be exposed to hydronic heating and cooling system through real-time examples. **Applications:** Centralized heating and cooling systems. **Video links:** https://www.youtube.com/watch?v=Y-8EWK1Moh0		
Module-5	**RBT Level L3,L4,L5**	**06 Hrs.**
District heating and cooling systems – Introduction, General components, Centrifugal pumps, motors, pipes, valves and heat exchangers. **Cold storage design, -** Introduction, General components, design, and development, storage capacity, load calculations. **Ventilation design -** Toilet ventilation, Commercial ventilation design, Commercial kitchen ventilation design, car parking ventilation design, Exhaust and Fresh air calculations, ASHRAE standards, Stair case pressurization, Green HVAC, HVAC designer check list, preparing bill of quantity. **Laboratory Sessions/ Experimental learning:** Students will be exposed to ASHRAE standards, and ventilation designs through real time examples. **Applications:** Cold storage systems and Building Ventilation systems. **Video links:** https://www.youtube.com/watch?v=dO05FwVYLVM		

Course outcomes:	
CO1	Recognize the concepts of Heating, Ventilation and Air Conditioning.
CO2	Recognize the role of basic load calculations for the design of HVAC systems.
CO3	Infer the importance of equipment selection and air distribution systems.
CO4	Recognize the role of hydronic heating and cooling systems for real time applications.

CO5	Carryout the exhaust and fresh air calculations for ventilation systems.

Reference Books:	
1.	C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publications, New Delhi, 2nd edition, 2000.
2.	W.F. Stoeker, J. P. Jones, Principles of Refrigeration and Air Conditioning, Tata McGraw Hill Publications, New York, 2nd edition, 1982.
3.	McQuistion, Heating,Ventilation and Air Conditioning, Wiley Students edition,5thedition 2000.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	2	-	-	-	2	1	1	1
CO2	3	3	1	2	2	1	-	-	2	1	1	1
CO3	3	3	2	3	3	1	-	-	2	1	2	1
CO4	3	3	2	3	3	1	1	-	2	1	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Scheme for VI Semester B.E.(Mechanical Engineering)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	PCC	MVJ20ME61	Heat and Mass Transfer	ME	3	2	0	3	50	50	100	4
2	PCC	MVJ20ME62	Design of Machine Elements-II	ME	3	2	0	3	50	50	100	4
3	PE	MVJ20ME63X	Professional Elective -2	ME	3	0	0	3	50	50	100	3
4	PE	MVJ20ME64X	Professional Elective -3	ME	3	0	0	3	50	50	100	3
5	OE	MVJ20ME65X	Open Elective – 1	ME	3	0	0	3	50	50	100	3
6	PCC	MVJ20MEL66	CAMA-Lab	ME	0	1	3	3	50	50	100	2
7	PCC	MVJ20MEL67	Heat Transfer Lab	ME	0	1	3	3	50	50	100	2
8	Proj	MVJ20MEP68	Mini-Project	ME				3	50	50	100	2
				Total	15	6	6	24	400	400	800	23
Note: PCC: Professional Core Course , PE: Professional Elective, OE: Open Elective, Proj: Project Work												

Professional Elective -2:

1. MVJ20ME631: Refrigeration and Air-Conditioning,
2. MVJ20ME632: Plastic Processing,
3. MVJ20ME633: Smart Materials and Structures,
4. MVJ20ME634: Finite Element Method

Professional Elective -3:

1. MVJ20ME641:Design of Experiments
2. MVJ20ME642: Computer Integrated Manufacturing,
3. MVJ20ME643: Material Characterisation Techniques,
4. MVJ20ME644: Theory of Elasticity

Open Elective – 1:

1. MVJ20ME651: Automotive Electronics
2. MVJ20ME652: Operation Management
3. MVJ20ME653: Engineering Economics

Note: 1. Audit Course of Machine Learning to be taught in VI Semester.

Course Title	HEAT & MASS TRANSFER	Semester	VI
Course Code	MVJ20ME61	**CIE**	50
Total No. of Contact Hours	50 L : T : P :: 3 : 2 : 0	**SEE**	50
No. of Contact Hours/week	05	**Total**	100
Credits	04	**Exam. Duration**	03 Hrs

Course objective is to:

- Build a strong foundation in heat transfer basics of conduction, convection and radiation modes, two dimensional steady and unsteady heat transfer.
- Work on governing equations and solution procedures for the three modes along with solution of practical problems using empirical correlations.
- Analysis and design of the heat exchangers.
- Boiling and condensation heat transfer.

Module-1	**RBT Level** L1, L2, L4	10 Hrs.

Introduction to three modes of heat transfer, derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness.

Lab sessions: Thermal conductivity experiment in HMT lab.

Write a code/program to estimate the intermediate temperatures in composite wall.

Applications: Insulation of industrial pipelines.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785&index=1

Module-2	**RBT Level** L1, L2, L4	10Hrs.

Lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Lab sessions: Determination of Effectiveness on a Metallic fin.

Experiment on Transient Conduction Heat Transfer.

Applications: CPU cooling, Transformer cooling and engine cooling in automobiles.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=QcTr0-QrSMY&list=PL5F4F46C1983C6785&index=2

Module-3	RBT Level L1, L2, L4	10Hrs.

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Lab sessions: Determination of Heat Transfer Coefficient in free Convection

Determination of Heat Transfer Coefficient in a Forced Convection

Applications: Heat exchangers, Gas turbine and steam turbine cooling, Refrigeration and air conditioning.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=ACjR7MIFaFw&list=PL5F4F46C1983C6785&index=3

Module-4	RBT Level L2, L3, L4	10 Hrs.

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method

Lab sessions: Determination of Emissivity of a Surface.

Determination of Stefan Boltzmann Constant

Applications: Solar power applications, electrical bulbs, microwave oven.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=hjrHtAnW4Ac

Module-5	RBT Level L1, L2, L4	10 Hrs.

Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and & NTU methods, Boiling and Condensation heat transfer, Pool boiling curve, Introduction mass transfer, Similarity between heat and mass transfer.

Lab sessions:

1. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
2. Experiments on Boiling of Liquid and Condensation of Vapour

Applications: Boilers, condensers, radiators, nuclear reactor cooling.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=V8Fa-b6Yx0k

Experiential learning exercise:
1. Take a glass of water. Boil it in a bowl to its saturation temperature. Find the amount of heat transfer both convection and radiation mode from source to water 2. What is the amount of heat loss through radiation in above process? 3. When hot water is poured from a glass to bowl to reduce heat, mention the heat transfer process and find practically the amount of heat transfer 4. Identify a composite wall in the institute and find the heat transfer rate from atmosphere when the sunlight is peak. 5. Heat released from your mobile phones or laptops when used continuously for long time.

Course outcomes:	
CO1	After completing the course, the students will be able to formulate and analyse a heat transfer problem involving any of the three modes of heat transfer.
CO2	The students will be able to estimate heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.
CO3	The students will be able to calculate radiation heat transfer between surfaces using radiative properties.
CO4	The students will be able to design thermal device such as heat exchangers.
CO5	The students will be able to understand better the boiling and condensation phenomenon and study pool boiling curves.

Text Books:	
1	Nag, P.K., "*Heat Transfer*", Tata McGraw Hill, New Delhi, 2002
2	Yunus A. Cengel, "*Heat Transfer A Practical Approach*", Tata McGraw Hill, 2010
3	Holman, J.P., "*Heat and Mass Transfer*", Tata McGraw Hill, 2000
Reference Books:	
1	Ozisik, M.N., "*Heat Transfer*", McGraw Hill Book Co., 1994.
2	Kothandaraman, C.P., "*Fundamentals of Heat and Mass Transfer*", New Age International, New Delhi, 1998.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	2	1	-	1	1	-	2
CO2	3	3	2	2	-	2	1	-	1	1	-	2
CO3	3	3	2	2	-	2	1	-	1	1	-	2
CO4	3	3	2	2	-	2	1	-	1	1	-	2
CO5	3	3	2	1	-	2	1	-	1	1	-	2

High-3, Medium-2, Low-1

Course Title	DESIGN OF MACHINE ELEMENTS-II	Semester	VI
Course Code	MVJ20ME62	CIE	50
Total No. of Contact Hours	50 L: T: P: 3: 2: 0	SEE	50
No. of Contact Hours/week	05	Total	100
Credits	04	Exam. Duration	3 Hrs

Course objective is:

- To understand various elements involved in a mechanical system.
- To analyse various forces acting on the elements of a mechanical system and design them using appropriate techniques, codes, and standards.
- To select transmission elements like gears, belts, pulleys, bearings from the manufacturer's catalogue.
- To design a mechanical system integrating machine elements.
- To produce assembly and working drawings of various mechanical systems involving machine elements like belts, pulleys, gears, springs, bearings, clutches and brakes.

Module-1	RBT Level L1, L2	10 Hrs.

Springs: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads. Leaf Springs: Stresses in leaf springs, equalized stresses, and nipping of leaf springs. Introduction to torsion and Belleville springs.

Belts: Materials for construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition. Selection of flat and V belts-length & cross section from manufacturers' catalogues. Construction and application of timing belts.

Wire ropes: Construction of wire ropes, stresses in wire ropes, and selection of wire ropes.

Laboratory Sessions/Experimental learning:

- Design project should enable the students to design a mechanical spring system, a belt drive system and a wire rope testing under loads.

Applications:

Springs are used to absorb the shocks or Vibration as in-car springs, railway buffers, etc. To measure the forces as in a spring balance. To apply forces in brakes and clutches to stop the vehicles.

Belt drives are used in cars to deliver power to various components such as alternator, air conditioning system etc. Timing Belts are used in industrial automation machines. Used in generator to transfer from one shaft to another.

Wire ropes are used dynamically for lifting and hoisting in cranes and elevators, and for transmission of mechanical power. Wire rope is also used to transmit force in mechanisms, such as a Bowden cable or the control surfaces of an airplane connected to levers and pedals in the cockpit.

Video link/Additional online information: MOOC and Open courseware:

https://www.youtube.com/watch?v=kAOjuP6X87w,https://www.youtube.com/watch?v=jAawhg6JtyY

https://www.youtube.com/watch?v=MQ5Kcwc83bs,https://www.youtube.com/watch?v=0mb_XMGja_c

https://www.youtube.com/watch?v=knZbWUmitPw,https://www.youtube.com/watch?v=G_D0ceaKQFM

Module-2	RBT Level L1, L2	10 Hrs.

Gear drives: Classification of gears, materials for gears, standard systems of gear tooth, lubrication of gears, and gear tooth failure modes.

Spur Gears*:* Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear.

Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.

Laboratory Sessions/Experimental learning:

- Design project should enable the students **to design a spur gear**, **helical gear**.

Applications:

Gears are used in place of belt drives and other forms of drives when exact speeds and power transmission must be accurately maintained. Gears can be used between two or more shafts where the centre lines are parallel or at any angle relative to each other, and they may or may not be in the same plane.

Spur gears can be used to increase or decrease the torque, or power, of a given object. Spur gears are used to this effect in washing machines, blenders, clothes dryers, construction equipment, fuel pumps and mills.

Some of the industries where the *helical gears* are commonly used are: Printing, earth-moving and fertilizer industries. Port and power industries, steel and rolling mills. Textile industries, food industries, plastic industries, elevators, conveyors, compressors, blowers, cutters and oil industries.

Video link/Additional online information: MOOC and Open courseware:

https://www.youtube.com/watch?v=AS0zQhMfJUw&list=PLSGws_74K01_e499POG3gczxcnlJEHMWE

https://www.youtube.com/watch?v=i788-2pq1HA,https://www.youtube.com/watch?v=9XYeur-iVAs

https://www.youtube.com/watch?v=oiBU7yxkpzc,https://www.youtube.com/watch?v=0rnTh6c19HM

Module-3	RBT Level L2, L3	10 Hrs.

Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear.

Worm Gears: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.

Laboratory Sessions/Experimental learning:

- Design project should enable the students **to design a bevel gear**, **worm gear**.

Applications:

Bevel gears are used in differential drives, which can transmit power to two axles spinning at different speeds, such as those on a cornering automobile. Bevel gears are used as the main mechanism for a hand drill. Applications of Worm Gear Drives: Gate control mechanisms, Hoisting machines, Automobile steering mechanisms, Lifts, Conveyors, Presses.

Video link/Additional online information: MOOC and Open courseware:

https://www.youtube.com/watch?v=a5A4LeqPtyg

https://www.youtube.com/watch?v=L7i_QDehseg

https://www.youtube.com/watch?v=gj2szHk0OCU

https://www.youtube.com/watch?v=K5_ivdkRXp0

Module-4	RBT Level L1, L2	10 Hrs.

Design of Clutches: Necessity of a clutch in an automobile, types of clutch, friction materials and its properties. Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories.

Design of Brakes: Different types of brakes, Concept of self-energizing and self-locking of brakes. Practical examples, Design of band brakes, block brakes and internal expanding brakes.

Laboratory Sessions/Experimental learning:

- Design project should enable the students **to design a clutch**, **brake.**

Applications:

A *clutch* is a mechanical device which engages and disengages power transmission especially from driving shaft to driven shaft. In the simplest application, clutches connect and disconnect two rotating shafts (drive shafts or line shafts).

A *brake* is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished

by means of friction.

Video link/Additional online information: MOOC and Open courseware:

https://www.youtube.com/watch?v=gOuLq2haqLY,https://www.youtube.com/watch?v=wCu9W9xNwtI

https://www.youtube.com/watch?v=pqF-aBtTBnY,https://www.youtube.com/watch?v=bMg_j5_AGMg
https://www.youtube.com/watch?v=g5n8OqS1Fow,https://www.youtube.com/watch?v=wCu9W9xNwtI
https://www.youtube.com/watch?v=SOgoejxzF8c,https://www.youtube.com/watch?v=8Jr44ybyS7U
https://www.youtube.com/watch?v=devo3kdSPQY,https://www.youtube.com/watch?v=rOT4O-lwzu8
https://www.youtube.com/watch?v=98DXe3uKwfc,https://www.youtube.com/watch?v=6c4deRAhqcA

Module-5	RBT Level L2, L3	10 Hrs.

Lubrication and Bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated and heat dissipated. Numerical examples on hydrodynamic journal and thrust bearing design.

Antifriction bearings*:* Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship; selection of deep grove ball bearings from the manufacturers' catalogue; selection of bearings subjected to cyclic loads and speeds; probability of survival.

Laboratory Sessions/Experimental learning:

- Design project should enable the students to design a lubrication system, antifriction bearing system.

Applications:

Lubricants are primarily used to reduce friction stress between surfaces. They have the following uses: As antiwear, antioxidants, and antifoaming agents. As demulsifying and emulsifying agents. Typical applications include: crane hooks, pulverisers, cone crushers and other heavy-load, medium-speed applications. Tapered roller bearings use tapered rollers between tapered inner and outer ring raceways. These rollers are angled, so their surfaces converge at the bearing's axis.

Applications of *Rolling Contact Bearing*: Industrial and automotive gear boxes and at different automobile, Electric motors, Machine tool spindle, small size centrifugal pumps, Automobile front and rear axles.

Video link/Additional online information: MOOC and Open courseware:

https://www.youtube.com/watch?v=grfLkzjyc-o,https://www.youtube.com/watch?v=TsXQsw8EVgA
https://www.youtube.com/watch?v=gxFRlkZMcJY,https://www.youtube.com/watch?v=VwgBSQ5tF3Y
https://www.youtube.com/watch?v=wpretUMnW9g,https://www.youtube.com/watch?v=tP8nzvnqrPY

Guidelines for Laboratory Sessions/Experimental learning:

A group of students (maximum number in a group should be 4) should submit assembly drawing and part drawings, completely dimensioned, indicating the necessary manufacturing tolerances, surface finish symbols and geometric tolerances wherever necessary. Design project must be completed using appropriate solid modelling software. Computer generated drawings must be submitted. Design calculations must be hand written and should be included in the report.

Course outcomes:	
CO1	Apply design principles for the design of mechanical systems involving springs, belts, pulleys, and wire ropes.
CO2	Design different types of gears and simple gear boxes for relevant applications.
CO3	Understand the design principles of brakes and clutches.
CO4	Apply design concepts of hydrodynamic bearings for different applications and select Anti-friction bearings for different applications using the manufacturers, catalogue.
CO5	Apply engineering design tools to product design. Become good design engineers through learning the art of working in a team.

Text Books:	
1.	Machine Design- an integrated approach Robert L. Norton Pearson Education 2nd edition
2.	Shigley's Mechanical Engineering Design Richard G. Budynas,and J. Keith Nisbett McGraw-Hill Education 10th Edition, 2015
Reference Books:	
1.	Design of Machine Elements V. B. Bhandari Tata Mcgraw Hill 4th Ed 2016.
2.	Design Data Hand Book, K.Lingaiah, McGraw Hill, 2nd edition, 2003.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	2	-	-	-	2	1	1	1
CO2	3	3	1	2	2	1	-	-	2	1	1	1
CO3	3	3	2	3	3	1	-	-	2	1	2	1
CO4	3	3	2	3	3	1	1	-	2	1	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Course Title	REFRIGERATION AND AIR-CONDITIONING	Semester	VI
Course Code	MVJ20ME631	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	03 Hrs

Course objective is to:

- Study the basic definition, ASHRAE Nomenclature for refrigerating systems
- Understand the working principles and applications of different types of refrigeration systems
- Study the working of air conditioning systems and their applications
- Identify the performance parameters and their relations of an air conditioning system

Module-1	RBT Level L1, L2	08 Hrs.

Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications: Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air. Industrial Refrigeration-Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous.

Laboratory Sessions/ Experimental learning:

- Recognize important standards of Refrigeration and Air conditioning systems available in Heat transfer lab.

Applications: International and Indian Standards and nomenclatures are required to be understood.

Video link / Additional online information:

https://youtu.be/4mWsRUr0A7A

Module-2	RBT Level L2,L3	08 Hrs.

Vapour Compression Refrigeration System(VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle– liquid-suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP – Ewing's construction and Gosney's method. Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure, Multi-

evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

Laboratory Sessions/ Experimental learning:

- An experiment to be conducted on VCR experimental setup available in Heat transfer lab to illustrate the working of a typical VCR system.

Applications: The practical difficulties in application of working principles and applications of VCR refrigeration system.

Video link / Additional online information:

https://youtu.be/XO2PBDMEHfs,

https://youtu.be/WodVKkkWz90

Module-3	RBT Level L2,L3	08 Hrs.

Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems. Other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermoacoustic refrigeration systems.

Laboratory Sessions/ Experimental learning:

- An experiment to be conducted on VAR experimental setup available in Heat transfer lab to illustrate the working of a typical VAR system.

Applications: The practical difficulties in application of working principles and applications of VAR refrigeration system.

Video link / Additional online information:

https://youtu.be/4w3Obp8ILpA

Module-4	RBT Level L2,L3,L4	08 Hrs.

Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures. Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Laboratory Sessions/ Experimental learning:

- Find a suitable refrigerant for requirements of refrigeration system.

Applications: Identify suitable refrigerant for various refrigerating systems.

Video link / Additional online information:

https://youtu.be/6_ePn_LkIQM

Module-5	RBT Level L2,L3,L4	08 Hrs.

Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, ASHRAE Nomenclature pertaining to Air-Conditioning, Applications of Air-Conditioning, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Psychrometry Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air- Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems. Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships.

Laboratory Sessions/ Experimental learning:

- Design an Air-condition system for requirements provided.

Applications: Compute and Interpret cooling and heating loads in an air-conditioning system.

Video link / Additional online information:

https://youtu.be/nvUhiXD63Eg,

https://nptel.ac.in/courses/112/105/112105128/

Course outcomes:

CO1	Illustrate the principles, nomenclature and applications of refrigeration systems.
CO2	Explain vapor compression refrigeration system and identify methods for performance improvement.
CO3	Study the working principles of air, vapour absorption, thermoelectric and steam-jet and thermo- acoustic refrigeration systems.
CO4	Identify suitable refrigerant for various refrigerating systems
CO5	Compute and Interpret cooling and heating loads in an air-conditioning system.

Text Books:

1.	Stoecker W.F., and Jones J.W., "*Refrigeration and Air-conditioning*", Mc Graw - Hill, New Delhi 2nd edition, 1982
2.	Roy J. Dossat, "*Principles of Refrigeration*", Wiley Limited

Reference Books:

1.	Mc Quistion, *"Heating, Ventilation and Air Conditioning"*, Wiley Students edition,5th edition 2000.

2.	Arora C.P., "*Refrigeration and Air-conditioning*", Tata Mc Graw –Hill, New Delhi, 2nd Edition, 2001.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	2	-	-	-	1	1	1	1
CO2	3	2	3	2	2	1	-	-	1	1	1	1
CO3	3	3	2	2	3	2	-	-	2	1	2	1
CO4	3	3	2	2	3	1	1	-	2	2	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Course Title	PLASTIC PROCESSING	Semester	VI
Course Code	MVJ20ME632	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	03 Hrs

Course objective is to:

- Introduce various processes involved in manufacturing of plastic products.
- Expose students to the basics of moulding and forming techniques in plastic manufacturing.
- Evolve the methods for fabrication of plastics.

Module-1	**RBT Level** L1, L2, L3	08 Hrs.

Plastic Processing: Basic principle of processing, shape and size, processing parameters, their effect and behavior, Rheology ideal fluids, and real polymers, Effects of melt behavior on processing and product performance.

Injection Moulding: Principles, process variables, moulding cycle, machinery used, parts and function, specification, construction and maintenance of injection moulding machine, start up and shut down procedure, cylinder, nozzles, interaction of moulding variables, press capacity, projected area, shot weight, concepts and their relationship to processing, trouble shooting in injection moulding, microprocessors-controlled injection moulding machines.

Laboratory Sessions/ Experimental learning:

1. Model making of Injection Moulding.
2. Identifying different grades of plastics used for different applications.

Applications: Plastic products used in day-to-day life.

Video link / Additional online information:

1. https://www.youtube.com/watch?reload=9&v=qn16JtE_vLc
2. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-me17/
3. https://nptel.ac.in/courses/112/107/112107221/
4. https://www.youtube.com/watch?v=iUH_EdNNtDU

Module-2	**RBT Level** L1, L2, L3	08 Hrs.

Extrusion: Basic principles of extruders, and extrusion process, different types of extrudes i.e. barrel, screw, drive mechanics, head, constructional features of dies, sizing and haul-off

equipment for extruders of mono filaments and tubes, blown film lines, wire and cable covering system, pipe profile extrusion, co-extrusion, process variables in extrusion like heating, temperature control, dies well, and melt fracture, spacing and orientation, treating, printing and sealing, quality of extruder products, fault, causes and remedy.

Laboratory Sessions/ Experimental learning:

1. Model making of Extrusion process setup.

Applications: Plastic products used in day-to-day life.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=k7lb-w7o06s
2. https://www.youtube.com/watch?v=iUH_EdNNtDU
3. https://www.youtube.com/watch?v=SoTfSOFj6q0
4. https://nptel.ac.in/courses/112/107/112107221/

Module-3	RBT Level L1, L2, L3	08 Hrs.

Rotational Moulding: Basic principle, charge size, wall thickness, temperature control, fault causes,

Blow Moulding: Blow moulding process, processing parameter, materials used, hand operated and automatic blow moulding machine, extrusion blow moulding, moulding cycle, faults and remedies.

Thermo Forming: Basic principles, types of thermoforming, thermoforming moulds, processing parameters, faults and remedies.

Laboratory Sessions/ Experimental learning:

1. Model making using blow moulding, rotational and thermo forming processes.

Applications: Household and industrial applications

Video link / Additional online information:

1. https://www.youtube.com/watch?v=Qr5qIMvJSnw
2. https://www.youtube.com/watch?v=8W6P5KU5ONQ
3. https://www.youtube.com/watch?v=alq3RDZN4jo
4. https://nptel.ac.in/courses/112/107/112107221/

Module-4	RBT Level L1, L2, L3	08 Hrs.

Calendaring: Basic principle, process variable, end product properties and applications, secondary processing techniques like powder coating, casting, machining, and joining of plastics, metalizing, printing.

Compression and Transfer Moulding: Techniques, various types of compression moulds, machinery used, and common moulding faults and remedies. Transfer moulding, its advantage over compression moulding, equipment used, press Capacity, integral mold, and auxiliary mould, moulding cycle, ram pressure, clamping pressure, faults and remedies.

Laboratory Sessions/ Experimental learning:

1. Making models using calendering, compression and transfer moulding processes.

Applications: Plastic components used in piping industries/applications.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=pOGpXZ-UMfo
2. https://www.manufacturingguide.com/en/calendering
3. https://www.youtube.com/watch?v=2DUB9DoIoi8
4. https://nptel.ac.in/courses/112/107/112107221/

Module-5	RBT Level L1, L2, L3	08 Hrs.

Processing of Engineering Plastics: precautions, and start up procedure, preheating, shutdown procedure, quality control, and waste management. Ram Extrusion of PTFE, Processing of reinforced plastics, like filament winding, Hand-lay-up, spray moulding, SMC, DMC, Centrifugal casting, pultrusion, resin transfer moulding

Laboratory Sessions/ Experimental learning:

1. Model making of Engineering Plastics.

Applications: Plastic products used in engineering applications

Video link / Additional online information:

1. https://nptel.ac.in/courses/112/107/112107221/
2. https://www.youtube.com/watch?v=qn16JtE_vLc
3. https://www.youtube.com/watch?v=tvk2yWh0cco
4. https://www.youtube.com/watch?v=_m29-u37TI8

Course outcomes:

CO1	understanding of plastic processing and Injection Moulding.
CO2	Understand the principle of extrusion process.
CO3	Understanding of Rotation, blow moulding and thermo forming.
CO4	To describe the methods of Calendering, Compression and transfer moulding.
CO5	Understand the processing of engineering plastics.

Text Books:

1.	**Rubin. J. Irvin,** "Injection Moulding Theory & Practice" , New York John Wiley & Sons.

Reference Books:

1.	Rosato, D., Rosato, A., DiMattia, D "Blow Moulding Hand Book", New York-Oxford University- Hanser Publishers.
2.	Paul F. Bruins "Basic Principles of Rotational Moulding Process", Gordon and Breach Publishers, 1971

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	-	-	-	-	1	1	1
CO2	3	3	2	1	-	-	-	-	-	1	1	1
CO3	3	3	2	1	-	-	-	-	-	1	2	1
CO4	2	2	3	2	-	-	-	-	-	1	2	2
CO5	2	3	2	1	-	-	-	-	-	2	3	3

High-3, Medium-2, Low-1

Course Title	SMART MATERIALS AND STRUCTURES	Semester	VI
Course Code	MVJ20ME633	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	03 Hrs

Course objective is to:

- Introduce smart materials, piezoelectric materials structures and its characteristics.
- Learn smart structures and modelling which helps in Vibration control for various applications.

Module-1	**RBT Level** L1, L2, L3	08 Hrs.

Introduction: Definition of Structures, Overview of Smart materials, Introduction of Smart Structures, Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect, Processing and characteristics.

Shape Memory Alloys: Introduction, Phenomenology, and Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators.

Laboratory Sessions/ Experimental learning:

- Model making of Piezo based sensor.
- Model to demonstrate shape memory effect.
- Model making of Actuators.

Applications: Sensors and actuators used in automation.

Video link / Additional online information:

https://www.youtube.com/watch?v=QYp9rIJRM8s

Module-2	**RBT Level** L1, L2, L3	08 Hrs.

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.

Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Biomimetic sensing, Challenges and opportunities.

Laboratory Sessions/ Experimental learning:

2. Model making of Vibration absorber using waste Rubber

Applications*:* Damping of industrial machines or structures.

Video link / Additional online information:

https://www.youtube.com/watch?v=DkUzLMwQxZI

Module-3	RBT Level L1, L2, L3	08 Hrs.

Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).

Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors.

Laboratory Sessions/ Experimental learning:

- Model making of ER/MR fluid damper

Applications: Automobiles and military vehicles

Video link / Additional online information :

https://www.youtube.com/watch?v=eOSaIJY7AKo

Module-4	RBT Level L1, L2, L3	08 Hrs.

MEMS: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. ***Microfabrication***: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design.

Piezoelectric Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles.

Laboratory Sessions/ Experimental learning:

- Model making of magnetic actuator

Applications: Sensors and actuators used in robotics.

Video link / Additional online information:

https://www.youtube.com/watch?v=CNmk-SeM0ZI

Module-5	RBT Level L1, L2, L3	08 Hrs.

Polymer MEMS & Microfluidics: Introduction, Polymers in MEMS (Polyimide, SU-8, LCP, PDMS, PMMA, Parylene, Others) Applications (Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics.

Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition.

Laboratory Sessions/ Experimental learning:

- Model making of Polymer based MEMS.

Applications: MEMS devices

Video link / Additional online information :

https://www.youtube.com/watch?v=H7qtR5hlIXo

Course outcomes:	
CO1	Understand various smart materials and its properties.
CO2	Identify different vibration absorbers and its applications.
CO3	Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.
CO4	To describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.
CO5	Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.

Text Books:	
1.	A.V.Srinivasan, "*Smart Structures –Analysis and Design*", Cambridge University Press, New York, 2001, (ISBN:0521650267).
Reference Books:	
2.	M.V.Gandhi and B.S.Thompson, "*Smart Materials and Structures*" Chapmen & Hall, London, 1992 (ISBN:0412370107)
3.	Chang Liu "*Foundation of MEMS*", Pearson Education. (ISBN:9788131764756)

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	-	-	-	-	-	-	-	-
CO2	3	3	2	1	-	-	-	-	-	-	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	-
CO4	2	2	3	2	-	-	-	-	-	-	-	-
CO5	2	3	2	1	-	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	FINITE ELEMENT METHOD	Semester	VI
Course Code	MVJ20ME634	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hrs

Course objective is to:

- To learn basic principles and methodologies of finite element analysis.
- To understand the theory and characteristics of finite elements used in analysis of complexed engineering problems.
- To introduce formulation of engineering problems into FEM by discretization process, polynomial, interpolation, application of boundary conditions, assembly of global arrays, solution of the resulting algebraic systems.
- To apply finite element solutions to structural, thermal, dynamic problems to develop the knowledge and skills needed to effectively evaluate finite element analysis.

Module-1	RBT Level L1, L2	08 Hrs.

Pre-requisites: Mechanics of Materials, Engineering Mathematics.

Introduction to Finite Element Method: General description of the finite element method, Steps involved in FEM, Engineering applications of finite element method. Discretization process, Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Convergence criteria.

Finite Element Formulation method: Galerkin's method, Potential energy method, Rayleigh Ritz method, Convergence criteria, Discretisation process, Displacement method of finite element formulation.

Basic Procedures: Force terms: Body force, Traction force and point loads, Equilibrium equations, Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions.

Introduction to Boundary conditions in FEM: Homogeneous and non-homogeneous boundary conditions for structural, heat transfer and fluid flow problems.

Laboratory Sessions/ Experimental learning:

- Develop a Matlab code for imposition of boundary conditions using penalty and elimination approach.

Applications: Stress analysis in solids and automotive design.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=KR74TQesUoQ
2. https://www.youtube.com/watch?v=LCTp7H6Tb8w

3. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/lecture-notes/
4. http://mech.iust.ac.ir/files/mech/madoliat_bcc09/pdf/yijun_liu___nummeth_20040121_fem.pdf

Module-2	RBT Level L1, L2	08 Hrs.

Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of global coordinates, Linear interpolation polynomials in terms of local coordinates for 1D, 2D elements, Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant Strain Triangle (CST), Four-Nodded Tetrahedral Element, Eight-Nodded Hexahedral Element, Iso, Super and Sub parametric elements.

Numerical integration: Gaussian quadrature: one point, two-point formulae, 2D integrals.

Interpolation and Polynomial approximation: Interpolation – Linear Regression, Lagrange interpolation functions and approximation methods.

Laboratory Sessions/ Experimental learning:

- Develop a Matlab code for performing numerical integration on single and double variable equations.

Applications: Structural analysis of aircraft wing.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=pCSpBYfbYYA
2. https://nptel.ac.in/courses/112/104/112104115/
3. https://www.youtube.com/watch?v=em1JdaEGXaQ
4. https://www.youtube.com/watch?v=JphRVN9Eezc

Module-3	RBT Level L1, L2, L3	08 Hrs.

Analysis of Bars: Stiffness matrix formulation for bar element, Solution for displacements, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach. Temperature effects.

Trusses: Stiffness matrix formulation for truss element, load vector, Solution for truss members.

Torsion of Shafts: Finite Element Analysis of shafts, determination of stress and twists in circular shafts.

Beams: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load.

Laboratory Sessions/ Experimental learning:

- Stress analysis of bar of constant and tapered cross section area.

- Structural analysis of stepped bar.
- Finite element analysis of beam and truss.

Applications: Structural analysis of a bridge.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=MldJ6WHCsvQ
2. https://www.youtube.com/watch?v=UsMyQ7yPHk8
3. https://nptel.ac.in/courses/112/104/112104193/
4. https://www.youtube.com/watch?v=yfyElneBW98

Module-4	RBT Level L1, L2, L3	08 Hrs.

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Fluid flow analysis: Introduction to Computational Fluid Dynamics (CFD), Computational analysis of flow through uniform, tapered and stepped pipes, porous medium, channels and hydraulic networks.

Laboratory Sessions/ Experimental learning:

- Develop a FE Matlab program for solving steady-state and transient temperature distribution and heat loss through 2D-fin.

Applications: Structural analysis of an advertising roof sign subject to pressure loads from 120km/h winds.

Video link / Additional online information:

1. https://youtu.be/l8t-7-pODN4?list=PLbMVogVj5nJRjnZA9oryBmDdUNe7lbnB0
2. http://www.nptelvideos.in/2012/11/finite-element-analysis.html
3. https://www.youtube.com/watch?v=9MddG4RqOqU
4. https://www.youtube.com/watch?v=DYTg71UACfI

Module-5	RBT Level L1, L2, L3	08 Hrs.

Axis-Symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to point loads.

Dynamic Analysis: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam.

Finite element – formulation to 3 D problems in stress analysis, convergence requirements, mesh generation techniques, and introduction to fully automatic use of Finite Element Software packages like ANSYS, NISA, and LS DYNA etc.

Laboratory Sessions/ Experimental learning:

- Static structural analysis of plates and axisymmetric problems.
- Modal analysis of bar and beam.

Applications: Structural analysis of a structure subject to gyroscopic dynamic effects.

Video link / Additional online information:

1. https://youtu.be/_iB21ry4tj0?list=PLA4CBD0C55B9C3878
2. http://www.nptelvideos.in/2012/12/introduction-to-finite-element-method.html
3. https://www.youtube.com/watch?v=6LrjKsg2iI0
4. https://www.youtube.com/watch?v=7dKIdPB9bJM

Course outcomes:

CO1	Recognize the importance of FEM and its concepts for real time applications.
CO2	Analyse different variational methods to solve the problem
CO3	Understand use of FEA in Structural and thermal problem
CO4	Learn how to do analysis and learn the various concepts and types of analysis
CO5	Learn finite element modelling techniques.

Text Books:

1	Rao, S. S., *"Finite Element Method In Engineering"*, 5th Edition, Pergaman Int. Library of Science, 2010.

Reference Books:

1.	Logan, D. L., *"A First Course In The Finite Element Method"*, 6th Edition, Cengage Learning, 2016.
2.	Chandrupatla T. R., *"Finite Elements in Engineering"*, 2nd Edition, PHI, 2013.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	-	-	-	-	-	-	1
CO2	3	3	2	1	1	-	-	-	-	-	-	-
CO3	3	3	3	2	2	-	-	-	-	-	-	-
CO4	2	3	3	3	2	-	1	-	-	-	-	-
CO5	3	3	3	3	3	-	2	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	DESIGN OF EXPERIMENTS	Semester	VI
Course Code	MVJ20ME641	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	SEE	50
No. of Contact Hours/week	3	Total	100
Credits	3	Exam. Duration	3 Hrs

Course objective is to:

- Understand the significance of Design of Experiments in Research.
- Develop the optimization models for the experiments.
- Apply the concepts of optimization in their project work.

Module-1	RBT LEVEL L1, L2	08 Hrs.

Introduction – Principles of optimization, Formulation of objective function, design constraints- classification of optimization problems. Single variable unconstraint optimization – Boundary phase method- Fibonacci search method- Golden section search method – Newton – Raphson method.

Laboratory Sessions/ Experiential learning:

- Demonstration of classical optimization techniques in open source software packages.

Applications: Optimization of the set of experiments for practical conduction.

Video link: https://www.youtube.com/watch?v=p5I_vRPyUc0

Module-2	RBT LEVEL L1, L2	08 Hrs.

Multi variable unconstraint optimization- classical method-Optimization with Equality and Inequality constraints Simplex search method– Conjugate gradient method – Variable-metric method. (Applications of these techniques in Design problems).

Laboratory Sessions/ Experiential learning:

- Developing a multi variable unconstrained model for optimization.

Applications: Design of Experiments for optimization of the process parameters.

Video link: https://www.youtube.com/watch?v=qzXPaWI-BzM

Module-3	RBT LEVEL L1, L2	08 Hrs.

Multi variable constraint optimization: Lagrange's multipliers - Kuhn-Tucker conditions – Penalty function method – Frank-Wolfe method– Generalized projection method. (Applications of these techniques in Design problems).

Laboratory Sessions/ Experiential learning:

- Developing a multi variable constrained model for optimization.

Applications: DOE for the FMCG industry during its product development phase

Video link: https://www.youtube.com/watch?v=niEtQin_D30

Module-4	RBT LEVEL L1, L2, L3	08 Hrs.

Multi objective optimization: Conjugate gradient method - reduced Conjugate gradient method– Newton – Raphson method (Applications of these techniques in Design problems) Integer Programming – Branch and bound method, Introduction to Geometric programming and Dynamic programming.

Laboratory Sessions/ Experiential learning:

- Studying the multi objective optimization techniques for dynamic programming.

Applications: Multiple criteria decision making

Video link: https://www.youtube.com/watch?v=Hm2LK4vJzRw

Module-5	RBT LEVEL L1, L2, L3	08 Hrs.

Stochastic method: Genetic algorithms (GAs): working principle – difference between GAs and traditional methods – GAs for constrained optimization – Simulated annealing- Ant colony algorithm.

Laboratory Sessions/ Experiential learning:

Demonstration of the Genetic Algorithms in MATLAB/Open Source Software packages.

Applications: Stochastic methods for process optimizations.

Video link: https://www.youtube.com/watch?v=aprcWHKDaqw

Course Outcomes:

CO1	Explain energy sources such as fuels, flowing water, wind, ocean, tides, waves, geochemical, nuclear energy and Analyze the load estimation, use factor and demand factor.
CO2	Summarize the working principle of Hydro-electric power plant and different types of stokers and oil burners in thermal power plant.
CO3	Explain generation of steam by using high pressure boilers and solve height and efficiency of Chimney.
CO4	Explain Steam Generator Accessories, Method of starting Diesel Engine to generate power, Cooling and Lubrication System and Layout of diesel Power plant.
CO5	Define the Principles of Release in Nuclear Energy and Explain different types of nuclear Reactors.

Text Books:	
1.	**Arora& S Domkundwar, AV Domkundwar**, "A course in Power Plant Engineering", Dhanpatrai & co. Pvt.ltd.2014, ISBN:9788177001075
2.	**P. K. Nag**, "Power Plant Engineering" Tata McGraw Hill, INDIA 4TH edition. 2014, ISBN:9789339204044
Reference Books:	
1.	**F.T. Morse**, "Power Plant Engineering", G. Van Nostrand. 3rd edition 1953, ISBN:9780442055561
2.	**Barrows**, Water power Engineering, TMH, New Delhi, 3rd edition, 1998
3.	**Stanierr,** Plant Engineering, Hand Book, McGraw Hill. 1998
4.	**JagadishLal,** "Hydraulic Machines" Metropollitan Book Co. Pvt Ltd., 1994.ISBN: 9788120000261

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	2	1	-	-	-	-	1
CO2	3	2	2	2	2	-	1	-	-	-	-	1
CO3	3	2	1	-	2	-	-	-	-	-	-	1
CO4	3	2	1	3	3	-	2	-	-	-	-	1
CO5	2	2	3	3	2	2	2	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	COMPUTER INTEGRATED MANUFACTURING	Semester	VI
Course Code	MVJ20ME642	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3Hrs

Course objective is to:

- To impart knowledge of CIM and Automation and different concepts of automation by developing mathematical models.
- The students will get the knowledge of high-quality production, the manufacturing and assembly line balancing and computerized manufacturing planning system.
- To expose the students to CNC Machine Tools, CNC part programming
- To impart the knowledge of computer aided quality control and shop floor control will help the students to compete with the present technology.

Module-1	RBT Level L1,L2	08 Hrs.

Computer Integrated Manufacturing System & High Volume Production System: Introduction, Production concepts, Mathematical Models, Production economics, Costs in manufacturing, Break even analysis, Unit cost of production, Cost of MLT and WIP. Automated flow lines, work part Transport, Transfer Mechanism and Buffer Storage.

Laboratory Sessions/ Experimental learning:

- Making manufacturing operations readily scalable for different levels of output. Allowing customization and reconfiguration of manufacturing processes with minimal downtime and cost.

Applications: Production planning and control in Manufacturing Industries, Statistical Quality control in production Industries

Video link / Additional online information:

https://nptel.ac.in/content/storage2/112/104/112104288/MP4/mod01lec03.mp4

https://nptel.ac.in/content/storage2/MP4/112104289/mod01lec01.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod01lec02.mp4

https://www.youtube.com/watch?v=pPwyYFvRLts

Module-2	RBT Level L2, L3	08 Hrs.

Analysis of Automated Flow line and Line Balancing: Analysis of Transfer Lines without storage and with storage, Partial Automation, Manual Assembly Lines, Methods of Line balancing, Computerized Line Balancing. Automated Material Handling System, Automated guided vehicle system.

Laboratory Sessions/ Experimental learning:

- Providing management with detailed and timely information about the manufacturing process. Enabling manufacturers to coordinate their work processes with those of their suppliers and customers to maximize efficiency and minimize costs.

Applications: Automated flow line control and line balancing

Video link / Additional online information:

https://www.youtube.com/watch?v=9fqygvj-O2s

https://nptel.ac.in/content/storage2/112/104/112104288/MP4/mod01lec05.mp4

https://nptel.ac.in/content/storage2/112/104/112104288/MP4/mod01lec04.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec48.mp4

Module-3	RBT Level L2, L3	08 Hrs.

Computerized Manufacturing Planning System and Flexible Manufacturing Systems: Computer Aided Process Planning: retrieval types, Generative type, Material Requirement Planning, Fundamental concepts of MRP, Inputs to MRP, Capacity Planning. Group technology. Flexible Manufacturing Systems, types of FMS, FMS components.

Laboratory Sessions/ Experimental learning:

- Integration of automated assignment and reporting of factory floor operations through machine and material handling equipment sensors and software

Applications: Flexible manufacturing system in production industries.

Video link / Additional online information

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod06lec26.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod07lec28.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod07lec29.mp4

https://www.youtube.com/watch?v=20_K7c65Swg

Module-4	RBT Level L2, L3	08 Hrs.

CNC Machining Centers: Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning. Programming with canned cycles. Cutter radius compensations.

Shop Floor Control & Computer Aided Quality Control: Factory, Data Collection System, Automatic identification system. Inspection methods, Non-Contact inspection methods, Co-ordinate measuring machine

Laboratory Sessions/ Experimental learning:

- Apply data insights to upgrade quality and lower inspection costs. Achieving a highly automated manufacturing process with rigorous computerized monitoring and management of quality and productivity.

Applications: CNC Machine Tools, CNC part programming, Quality control and Processing.

Video link / Additional online information:

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod03lec12.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod03lec13.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod03lec14.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec49.mp4

Module-5	RBT Level L2, L3	08 Hrs.

Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, Introduction to Industrial Internet of things (IIOT), supply chain optimization, supply-chain and logistics, cyber-physical manufacturing systems.

Laboratory Sessions/ Experimental learning:

- Use IoT and plant-floor data to predict and prevent equipment failure improve reliability and reduce downtime. Better use of capital resources through work automation.

Applications: Smart Appliances, Smart energy meters, Wearable devices.

Video link / Additional online information:

https://youtube/WUYAjxnwjU4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec48.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec49.mp4

Course Outcomes:	
CO1	Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyse different types of automated flow lines.
CO3	Analyse the automated flow lines to reduce down time and enhance productivity.
CO4	Explain the use of different computer applications in Shop Floor Control & computer aided quality control, and able to prepare part programs for simple jobs on CNC machine tools.
CO5	Visualize and appreciate the modern trends in Manufacturing like additive manufacturing, Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

Text Books:	
1.	Mikell P Groover, "*Automation, Production Systems and Computer-Integrated Manufacturing*", 4th Edition, 2015, Pearson Learning.
2.	P N Rao "*CAD / CAM Principles and Applications*", 3rd Edition, 2015, Tata McGraw-Hill.
Reference Books:	
1	P. Radhakrishnan, "*CAD/CAM/CIM*" 3rd edition, New Age International Publishers, New Delhi.
2.	Arshdeep Bahga and Vijay Madisetti, "*Internet of Things: A Hands-on Approach*", (Universities Press).

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	-	2	-	1	-	1	-	-	-
CO2	2	3	1	-	3	-	-	-	-	-	-	-
CO3	-	2	3	2	-	-	-	1	-	-	-	-
CO4	1	-	2	-	3	-	-	-	2	-	-	-
CO5	1	-	2	-	3	-	-	-	2	-	-	-

High-3, Medium-2, Low-1

Course Title	MATERIAL CHARACTERISATION TECHNIQUES	Semester	VI
Course Code	MVJ20ME643	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hrs

Course objective is to:

- Introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.
- Introduce the students to the importance of materials characterization and its need for real-time applications.
- Enable the students to understand the vacuum systems and the application of cryogenics for materials characterization.

Module-1	**RBT Level** L1, L2	08 Hrs.

Introduction to materials and methods, Fundamentals of Materials Characterization, Basic operation, sample preparation and interpretation of data. Basic failure analysis of materials using different characterization equipment. Importance of Material characterization, Classification of techniques for characterization.

Laboratory Sessions/ Experimental learning:

- Demonstration of the simple material characterization tests in material testing lab.

Applications: Tensile testing and Compression testing of the materials.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=8YflxVwm6cE
2. https://www.youtube.com/watch?v=nSuHuaNT8kE
3. https://www.youtube.com/watch?v=TnT7vXpsn6E
4. https://www.youtube.com/watch?v=y_1XFssBsGI

Module-2	**RBT Level** L1, L2	08 Hrs.

Vacuum systems: Vacuum range, Vacuum Pumps: Rotary, Sorption, Turbomolecular, Diffusion, Ion, Cryogenic systems. Vacuum measurement gauge: Pirani, Penning, Ionization etc. Use of Vacuum systems in Material Characterization techniques.

Thermal Analysis techniques: Principle, Working and application of DTA, TGA, TMA and DSC

Laboratory Sessions/ Experimental learning:

- Demonstration of thermogravimetric characterization techniques and its relevance through audio visuals.

Applications: Thermal characterization of the composites.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=mC0rYNlMz9Q
2. https://www.youtube.com/watch?v=QHMzFUo0NL8
3. https://www.youtube.com/watch?v=W_KO3ahVu4s
4. https://www.youtube.com/watch?v=CXmnvvoi4yA

Module-3	RBT Level L1, L2	08 Hrs.

Optical microscopy techniques: Metallurgical Microscopes, Aberration in Optical microscopy & its remedies, Polarized light in microscopy, Differential Interference Contrast Illumination, Hot Stage Microscopy, colour metallography, and image analysis techniques.

Electron microscopy: Electron beam. Principle, Construction and Working of TEM, SEM, STEM, with their merits, limitations and applications.

Laboratory Sessions/ Experimental learning:

- Activities with respect to microstructural characterization using optical microscopy in materials testing lab to help students gain more knowledge about microstructure will be carried out.

Applications: Microstructural characterization of the composites.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=VR9d6RnmZww
2. https://www.youtube.com/watch?v=CVusz4wHaic
3. https://www.youtube.com/watch?v=fuy0-yT8INU
4. https://www.youtube.com/watch?v=NG44AEWHtRQ

Module-4	RBT Level L1, L2	08 Hrs.

Atomic Microscopy: Field Ion Microscope, Working of AFM and STM with their merits, limitations and applications.

Spectroscopic Techniques for chemical analysis: UV-Visual (UV-VIS), IR, FTIR, & EDS, X-ray Fluoroscopy (XRF), Atomic absorption spectrometer (AAS), Atomic Emission spectroscopy (AES).

Laboratory Sessions/ Experimental learning:

- Activities related to the understanding of the significance of characterization of atomic arrangement of materials and its influence on properties of the materials will be demonstrated.

Applications: Spectroscopic characterization of the materials chemical analysis and morphological characterization.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=xnOqahYA6NU
2. https://www.youtube.com/watch?v=FQzUrbKTLVU
3. https://www.youtube.com/watch?v=GY9lfO-tVfE
4. https://www.youtube.com/watch?v=8TaXtCOZV4o

Module-5	RBT Level L1, L2	08 Hrs.

Diffraction method: Brags Law, X-ray diffraction methods, determination of crystal structure, lattice parameter, crystallite size, merits and demerits. Surface characterization: XPS (ESCA), UPS, Auger Electron Spectroscopy, Electron Probe Micro Analysis (EPMA).

Laboratory Sessions/ Experimental learning:

- Demonstration of the XRD techniques for phase characterization of the materials through audio visuals.

Applications: Characterization of the materials for crystal structure, phase, preferred crystal orientation (texture), and other structural parameters, such as average grain size, crystallinity, strain, and crystal defects.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=Z5aCuGxUPpI
2. https://www.youtube.com/watch?v=07iZ7-IEyYE
3. https://www.youtube.com/watch?v=lwV5WCBh9a0
4. https://www.youtube.com/watch?v=AqCz_b7VJK8

Laboratory Sessions

Design based Problems (DP)/Open Ended Problem:

1. Chart of different vacuum systems.
2. Chart of different thermal Analysis techniques.
3. Chart of different Optical microscopy techniques.
4. Chart of different electron and atom microscopy techniques.
5. Chart of different Spectroscopic Techniques for chemical analysis.
6. Problems based on brag's law.
7. Chart of different X-ray diffraction methods.
8. Chart of different Surface characterization techniques.
9. Collection and Study of various samples of coated & surface treated-materials, new alloys etc.
10. Group discussion and Presentations on Recent trend in material characterization.
11. Any other problem decided by faculty based on syllabus.

Course outcomes:	
CO1	Explain importance & Classification of Characterization Techniques.
CO2	Describe use of Vacuum systems in Material Characterization techniques & explain working of Thermal Analysis techniques.
CO3	Describe the principal and methods of different optical microscopy techniques for observation of Microstructure & Describe the principal and methods of different electron microscopy techniques.
CO4	Describe the principal and methods of different atom microscopy techniques & Explain Chemical & Elemental Analysis for a given engineering application.
CO5	Explain identification techniques of crystal structure, lattice parameter & crystallite size of different materials using X-ray diffraction & understand and explain surface morphologies of different Materials including coated & surface treated-materials, new alloys etc.

Text Books:	
1.	F. Weinberg, *"Tools & Techniques in Physical Metallurgy"*, Vol. I & II, Marcel Dekker.
2.	John P. Sibilia, *"A guide to Material Characterization & Chemical Analysis"*, VCH Publishers, 1988.
3.	J.M. Walls, *"Methods of Surface Analysis: Techniques & Applications"*, Cambridge University Press, 1990.
Reference Books:	
1.	B.D. Cullity, *"Elements of X-ray diffraction"*, Addison-Wesley Publishing Company, INC,.
2.	Bernhard Wounderlich, *"Thermal Analysis"*, Academic Press, INC, 1990.
3.	B.L. Gabriel, *"SEM: A user's manual for materials Science"*, American Society for Metals
4.	P. R. Khangaonkar *"An Introduction to Materials Characterization"*, Penram International Publishing (India) Pvt. Ltd.
	List of Open-Source Software/learning website:
1.	https://www.aif.ncsu.edu/mct/
2.	https://www.vssut.ac.in/lecture_notes/lecture1429901637.pdf
3.	https://www.researchgate.net/publication/327732057_Handbook_of_Materials_Characterization

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	2	3	2	1	-	-	1	-	-
CO2	1	2	-	3	3	2	1	-	-	1	-	-
CO3	1	2	-	3	3	2	1	-	-	1	-	-
CO4	1	2	-	3	3	2	1	-	-	1	-	-
CO5	1	2	-	3	3	2	1	-	-	1	-	-

High-3, Medium-2, Low-1

Course Title	THEORY OF ELASTICITY	Semester	VI
Course Code	MVJ20ME644	CIE	50
Total No. of Contact Hours	40 L: T : P :: 3 : 0 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	03 Hrs

Course objective is to:

- Gain knowledge of stresses and strains in 3D and their relations and thermal stresses.
- Understand the 2D analysis of elastic structural members.
- Analysis elastic members for the stresses and strains induced under direct loading conditions.
- Analyse the thermal stresses induced in disks and cylinders.

Module-1	RBT Level-L1,L2,L3	08Hrs.

Analysis of Stress: Definition and Notation for forces and stresses. Body force, surface force Components of stresses, equations of Equilibrium, Specification of stress at a point. Principal stresses maximum and minimum shear stress.

Mohr's Circle Diagram

Mohr's diagram in three dimensions. Boundary conditions. Stress components on an arbitrary plane, Stress invariants, Octahedral stresses, Decomposition of state of stress, deviator and spherical stress tensors, Stress transformation, Numericals.

Laboratory Sessions/ Experimental learning: conduction of Mohr's test for ductile materials.

Video link:

https://nptel.ac.in/courses/112/102/112102284/

Module-2	RBT Level-L1,L2,L3	08Hrs.

Deformation and Strain: Deformation, Strain Displacement relations, Strain components, The state of strain at a point, Principal strain, strain invariants, Strain transformation

Compatibility equations: Cubical dilatation, spherical and deviator strains, plane strain, Mohr's circle, and compatibility equation, Numericals.

Laboratory Sessions/ Experimental learning: Analyzing the different materials for their yielding stresses and strains using photo elasticity.

Video link:

https://www.youtube.com/watch?v=eICv1p8WjgI&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1

Module-3	RBT Level- L1, L2,L3	08Hrs.
Two Dimensional Problems in Cartesian Co-Ordinates: Airy's stress function, investigation of simple beam problems. Bending of a narrow cantilever beam under end load, simply supported beam with uniform load. Use of Fourier series to solve two dimensional problems. Existence and uniqueness of solution, Saint -Venant's principle, Principle of super position and reciprocal theorem **Laboratory Sessions/ Experimental learning:** Analyzing the different materials for their yielding stresses and strains using photo elasticity. **Video link:** https: www.youtube.com/watch?v=YpOy_z2oRDc&list=PL0bRAs68fCS310qm-k2ccRa6fZTc0kxCR		
Module-4	RBT Level- L1,L2.L4	08Hrs.
Two Dimensional Problems in Polar Co-Ordinates: General equations, stress distribution symmetrical about an axis, Strain components in polar co-ordinates, Rotating disk and cylinder, Concentrated force on semi-infinite plane, Stress concentration around a circular hole in an infinite plate. **Laboratory Sessions/ Experimental learning:** Analyzing the different materials for their yielding stresses and strains using photo elasticity. **Video link:** https: www.youtube.com/watch?v=YpOy_z2oRDc&list=PL0bRAs68fCS310qm-k2ccRa6fZTc0kxCR		
Module-5	RBT Level- L3,L4,L5	08Hrs.
Relations and the General Equations of Elasticity: Generalized Hooke's law in terms of engineering constants. Formulation of elasticity Problems. **Thermal Stresses:** Introduction, Thermo-elastic stress -strain relations, thin circular disc, long circular cylinder. **Laboratory Sessions/ Experimental learning**: Analyzing the different materials for their thermal stresses and strains. **Video link:** https: www.youtube.com/watch?v=YpOy_z2oRDc&list=PL0bRAs68fCS310qm-k2ccRa6fZTc0kxCR		

Course Outcomes:	
CO1	Describe the state of stress and strain in 2D and 3D elastic members subjected to direct loads and thermal loads.
CO2	Analyse the structural members: beam, rotating disks, columns
CO3	Analyse the thermal stresses induced in disks and cylinders.

Text Books:	
1.	Timoshenko and Goodier, "Theory of Elasticity"-'Tata McGraw Hill, New Delhi,3rd edition , 1970.
Reference Books:	
1.	L S Srinath "Advanced Mechanics of Solids"- Tata McGraw Hill, New Delhi, 3rd edition, 2010
2.	G. Thomas Mase, Ronald E. Smelser, George. E. Mase, Continuum Mechanics for Engineers, 3rd Edition, CRC Press,Boca Raton, 2010.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	-	-	-	-	2	1	1	1
CO2	3	3	1	2	-	-	-	-	2	1	1	1
CO3	3	3	2	3	-	-	-	-	2	1	2	1

High-3, Medium-2, Low-1

Course Title	AUTOMOTIVE ELECTRONICS	Semester	6
Course Code	1MJ20ME651	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hrs

Course objective is to:

- Basics of electronic control of internal combustion engines and the drives
- Understand principle of working of sensors and actuators used in automobiles for control
- To understand functions and operations of sensor
- Understand MEMS and Piezoelectric sensing and actuating
- Diagnostics and safety systems in automobiles.

Module-1	**RBT Level** L1, L2	08 Hrs.

Automotive Fundamentals Overview –Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle.

Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Diesel Engine, Drive Train -Transmission, Drive Shaft, Differential, Brakes, Steering System, Starter Battery –Operating principle

Laboratory Sessions/ Experimental learning:

- Building automobile Layout

Applications:

- Car transmissions
  https://www.motorbiscuit.com/4-types-of-car-transmissions-and-how-they-work/

Video link / Additional online information:

- How an engine works - comprehensive tutorial animation featuring Toyota engine technologies.
  https://www.youtube.com/watch?v=zA_19bHxEYg&t=6s
- Coursera
  https://www.coursera.org/lecture/modeling-debugging-embedded-systems/segment-1-automotive-1-WguSX

- Coursera
  https://www.coursera.org/lecture/industrial-iot-markets-security/segment-1-automotive-and-transportation-iQpo1
- Fundamentals of Automotive Systems
  https://onlinecourses.nptel.ac.in/noc20_de06/preview

Module-2	RBT Level L1, L2	08 Hrs.

The Basics of Electronic Engine Control – Motivation for Electronic Engine Control – Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition.

Control Systems - Automotive Control System applications of Sensors and Actuators – Typical Electronic Engine Control System, Variables to be measured.

Laboratory Sessions/ Experimental learning:

- To build an ECU to show its function on fuel injection.

Applications:

- PowerTRONIC ECU on the Royal Enfield Himalayan
  https://www.youtube.com/watch?v=xHQBxG-9V00

Video link / Additional online information:

- Automotive Electronic Modules Types
  https://www.youtube.com/watch?v=BG4N2dBgJrQ
- Coursera
  https://www.coursera.org/lecture/energy-environment-life/how-things-work-the-engine-in-your-car-r7tHF
- Coursera
  https://www.coursera.org/learn/motors-circuits-design
- Introduction to control Systems
  https://nptel.ac.in/courses/107/106/107106081/

Module-3	RBT Level L1, L2, L4	08 Hrs.

Automotive Sensors –Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor (TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O2/EGO), Lambda Sensors, Piezoelectric Knock Sensor. Automotive Actuators– Solenoid, Fuel Injector, EGR Actuator, Ignition.

Laboratory Sessions/ Experimental learning:

- Study on sensor in MMM Lab or Build a small sensor to show its operations / functions useful in automobile applications.

Applications: All automatic switches

- Manifold Absolute Pressure (MAP) Sensor
  https://www.youtube.com/watch?v=bHY7wu45AuU

Video link / Additional online information:

- How car sensors work
  https://www.youtube.com/watch?v=jyQuRgQHGCk
- Coursera
  https://www.coursera.org/specializations/embedding-sensors-motors
- Coursera
  https://www.coursera.org/lecture/internet-of-things-history/iot-automotive-0vJj5

Module-4	RBT Level L1, L2	08 Hrs.

Automotive Diagnostics–Timing Light, Engine Analyzer, On-board diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems. **Future Automotive Electronic Systems** –Alternative Fuel Engines, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation – Navigation Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialling, Advanced Cruise Control, Stability Augmentation, Automatic driving Control.

Laboratory Sessions/ Experimental learning:

- Build a model on any one to diagnose.

Applications:

- Vehicle Diagnostics: Off-Board vs On-Board Diagnostics
  https://www.youtube.com/watch?v=RogF0ohkMJ4

Video link / Additional online information:

- Diagnosing with The Lab Scope - Why Every Tech Needs To Be Using This Tool
  https://www.youtube.com/watch?v=cLOFxmEXrWs
- Coursera
  https://www.coursera.org/lecture/arduino/5-13-diagnostics-vm8Ph
- Coursera
  https://www.coursera.org/lecture/modeling-debugging-embedded-systems/segment-2-automotive-2-mezgS

Module-5	RBT Level L3, L4,L5	08 Hrs.

Electrical vehicles- History of electric vehicles, Introductions to electrical vehicles, Configurations of Electric Vehicles, Performance of Electric Vehicles, types of batteries used in Electric Vehicles

Hybrid Electric Vehicles- Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains.

Laboratory Sessions/ Experimental learning:

- Build a proto type electrical vehicle

Applications:

- Electrical vehicles
  https://www.youtube.com/watch?v=s9NT_YBqujc

Video link / Additional online information:

- Overview of Electric Vehicles in India
  https://www.youtube.com/watch?v=3E1SXG7VkQk
- Coursera
  https://www.coursera.org/lecture/future-of-energy/electric-vehicles-and-storage-technologies-part-1-UHkV7
- Coursera
  https://www.coursera.org/lecture/electric-utilities/5-5-electric-vehicles-vPV6a
- BMS Design of Electric Vehicle
  https://www.youtube.com/watch?v=cS5tkvbC4ts

Course outcomes:	
CO1	Students will understand basic of automobiles
CO2	Detail idea of electronic and control system in automobiles
CO3	Understand Working / functions of sensors used in automobiles
CO4	To know importance of Automotive diagnostics
CO5	Understand about Electrical Vehicles

Text Books:	
1.	**William B.Ribbens, "*Understanding Automotive Electronics*"**, 6th Edition, Elsevier Publishing.
2.	**Robert Bosch Gmbh (Ed.) "*Bosch Automotive Electrics and Automotive Electronics Systems and Components*"**, Networking and Hybrid Drive, 5th edition, John Wiley& Sons Inc., 2007.
Reference Books:	
1.	**A.V.Srinivasan**, "***Smart Structures –Analysis and Design***", Cambridge University Press, New York, 2001, (ISBN: 0521650267).
2	**Modern Electric, Hybrid Electric & Fuel Cell Vehicles -** Mehrdad Ehsani

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	1	-	-	2	1	1	1	2
CO2	3	3	1	2	1	-	-	2	1	1	1	2
CO3	3	3	1	2	1	-	-	2	1	1	1	2
CO4	3	3	1	2	1	-	-	2	1	1	1	2
CO5	3	3	1	2	1	-	-	2	1	1	1	2

High-3, Medium-2, Low-1

Course Title	OPERATION MANAGEMENT	Semester	VI
Course Code	MVJ20ME652	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	03 Hrs

Course objective is to:

- This course will give details about various engineering management system in the production industry.
- To study the about optimistic utility of the available resources like material and time.

Module-1	**RBT Level** L1,L2	08Hrs.

Production and Operations Management: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity, contemporary issues and development

Decision Making: The decision process, characteristics of operations decisions, use of models, decision making environments, graphical linear programming, analysis and trade-offs.

Video link / Additional online information:

https://nptel.ac.in/courses/110/107/110107141/

Module-2	**RBT Level** L1,L2	08Hrs.

Forecasting: Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast.

Video link / Additional online information:

https://www.youtube.com/watch?v=DVEbZ__FNRg

Capacity & Location Planning: Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout - need for layout decisions, types of processing.

Video link / Additional online information:

https://www.youtube.com/watch?v=1AN_L_8-x84

Module-3	RBT Level L2,L3	08 Hrs.

Aggregate Planning and Master Scheduling: Aggregate planning - Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning - graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

Video link / Additional online information:

https://www.youtube.com/watch?v=Ic_El2DkpjA

https://www.youtube.com/watch?v=VjSgga4E6VY

Inventory Management: Types of Inventories, independent and dependent demand, reasons for holding inventory, objectives of inventory control, requirements for effective inventory management - information, cost, priority system. Inventory control and economic-order-quantity models.

Video link / Additional online information:

https://www.digimat.in/nptel/courses/video/110105095/L01.html

Module-4	RBT Level L2,L3	08 Hrs.

Material Requirement Planning (MRP): Dependent versus independent demand, an overview of MRP - MRP inputs and outputs, MRP processing, An overview of MRP-II and ERP capacity requirement planning, benefits and limitations of MRP.

Video link / Additional online information:

https://www.youtube.com/watch?v=E4OYh890IRE

Purchasing and Supply Chain Management (SCM): Introduction, Importance of purchasing and SCM, The procurement process, Concept of tenders, Approaches to SCM, Vendor development, Measures of purchasing and SCM, Make or buy decision, Types of buying, E-procurement.

Video link / Additional online information:

https://www.youtube.com/watch?v=Z1zi7fMLmV4

Module-5	RBT Level L1,L2	08Hrs.

Introduction: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement).

Methods And Philosophy of Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on

control charts, warning limits, Average Run Length-ARL). **Video link / Additional online information:** https://www.youtube.com/watch?v=TbPUiJKyxqw
Laboratory Sessions:
• Students can be given the group task assigning some case study related to industry • Students can be asked as a group to come with the model/flow chart to explain the utility of available resources like material, man power and time.

Course Outcomes:	
CO1	Students will be able to acquire the decision making ability in the production industry
CO2	Students will be able to visualise the future industrial demand in terms of product
CO3	Students will be able to control the inventory based on forecasting the demand
CO4	Students will be able to order the material based on the requirement and use it optimistically
CO5	Students will learn the quality tool like various charts to use in the industry

Text Books:	
1	**William J Stevenson,** "*Production and Operations Management*", 9th Ed., Tata McGraw Hill.
2	**B Mahadevan** "*Operations Management-Theory and Practice*", Pearson Education, 2007.
3	**Norman Gaither and Greg Frazier**," *Production and Operations Management*".
Reference Books:	
1	**R.B.Chase, N.J.Aquilino, F. Roberts Jacob** "*Operations Management for Competitive Advantage*" McGraw Hill Companies Inc., Ninth Edition.
2	**Everett E.Adams, Ronald J.Ebert,** "*Production & Operations Management*", Prentice Hall of India Publications, Fourth Edition.
3	**Joseph G Monks**, "*Production / Operations Management*", McGraw Hill Books.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	3	3	3	3
CO2	2	2	-	-	-	3	-	-	3	3	3	3
CO3	-	-	-	-	-	-	-	-	3	2	3	2
CO4	1	1	-	-	-	2	-	-	3	3	3	3
CO5	2	-	-	-	-	-	-	-	3	3	3	3

High-3, Medium-2, Low-1

Course Title	ENGINEERING ECONOMICS	Semester	VI
Course Code	MVJ20ME653	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 : 0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	03 Hrs

Course Objectives is to:

- Explain the importance of engineering economics, Law of demand and supply in engineering decision making.
- Describe various interest rate factors and implement the same for economic decision making.
- Discuss different component of costs, methods of cost estimation and different methods of computing depreciation.
- Discuss taxation concepts-income, corporate taxes and financial functions.

Module-1	**RBT Level** L1,L2	08 Hrs.

Introduction: Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Engineering Economic Decision. Law of demand and supply, Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Personal loans and EMI payment calculation with flexible interest rates, Exercises and Discussion.

Laboratory Sessions/ Experimental learning:

- Calculating the EMI for housing loan, auto loan & personal loans for different sectors

Applications: It gives idea to find out EMI costs for various loans, credit cards.

Video link / Additional online information:

http://nptel.ac.in/courses/112107209/

https://nptel.ac.in/courses/110/106/110106135/

https://youtu.be/KnZdHPs04EI

https://youtu.be/vPurJyt3wlE

https://video-tutorial/14539-engineering-economics-video

Module-2	**RBT Level** L2,L3, L4	08 Hrs.

Present-Worth Comparisons: Conditions for present worth comparisons, Basic Present worth comparisons, Present-worth equivalence, Net Present worth, Assets with unequal lives, infinite lives,

Future-worth comparison, Future-worth equivalence, Pay-back comparison, Exercises, Discussions and problems.

Laboratory Sessions/ Experimental learning:

- Finding out the present and future worth comparisons for various assets for economic analysis.

Applications: Compares the present and future worth amount of various loans, products and firms used generally by banks.

Video link / Additional online information:

http://nptel.ac.in/courses/105103023/

https://youtu.be/4rZ-DPszlZE

https://youtu.be/INpZiJOd_OU

https://youtu.be/WphRgFpEq-Y

https://youtu.be/i8BTMqZgqbQ

Module-3	RBT Level L2, L3,L4	08 Hrs.

Equivalent Annual-Worth Comparisons: Equivalent Annual-Worth Comparison methods, Situations for Equivalent Annual-Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Use of shrinking fund method, Annuity contract for guaranteed income, Exercises, Problems.

Laboratory Sessions/ Experimental learning:

- Finding out the annual worth comparisons for various assets for economic analysis.

Applications: It gives idea to know about annual amount of various assets for the financial year.

Video link / Additional online information:

http://nptel.ac.in/courses/105103023/

https://youtu.be/WYbC1-TsGis

https://youtu.be/tTk1-zI_nuM

Module-4	RBT Level L2, L3, L4	08 Hrs.

Costing and Depreciation: Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

Laboratory Sessions/ Experimental learning:

- Estimating the budget for any given project by means of costing and depreciation.

Applications: It is used in banking sector to find out different costs based on periodic time.

Video link / Additional online information:

http://nptel.ac.in/courses/110105067/

https://onlinecourses.nptel.ac.in/noc20_mg53/

https://youtu.be/-i30WCeQ7i8

Module-5	RBT Level L3, L4, L5	08 Hrs.

Introduction, Scope of Finance, Finance Functions: Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. Simple Numericals.

Financial Ratio Analysis: Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Comparative statements analysis. Simple Numerical.

Laboratory Sessions/ Experimental learning:

- Analysis the economy of the country to provide the balance sheet, profit & loss for any financial year resources.

Applications: It gives the clear picture for framing budget for any financial year to announce any scheme and funds from the Government.

Video link / Additional online information:

http://nptel.ac.in/courses/110105067/

https://youtu.be/Sx-dy96_tCQ

https://youtu.be/OqHEseiXcbg

https://youtu.be/9LcbamL2Xas

Course outcomes:

CO1	Understand engineering economics demand supply and its importance in economics decision making and problem solving.
CO2	Calculate present worth, annual worth and IRR for different alternatives in economic decision making.
CO3	Understand the procedure involved in estimation of cost for a simple component, product costing and depreciation, its methods.
CO4	Examine the different economic analysis methods for decision making.
CO5	Understand the procedure of financial statements and balance sheets.

Text Books:	
1.	Riggs J.L, "*Engineering Economy*", 4TH ed. , McGraw Hill, 2002
2.	Thuesen H.G., *"Engineering Economy"*, PHI , 2002
Reference Books:	
1.	Leland Blank & Anthony Tarquin, *"Basics of Engineering Economy"*, McGraw Hill Publication (India) Private Limited.
2.	R.Paneerselvam, *"Engineering Economics"*, PHI publication.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Course Title	COMPUTER AIDED MODELLING AND ANALYSIS LAB	Semester	VI
Course Code	MVJ20MEL66	CIE	50
Total No. of Contact Hours	20 L: T: P: 0:1: 3	SEE	50
No. of Contact Hours/week	02	Total	100
Credits	02	Exam. Duration	03

Course Learning Objectives:

- Get the basic understanding of Modelling and Analysis software
- To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations.
- To provide the basic knowledge about the principles of dynamic analysis.

Sl. No	Experiments
	PART A
1	Study of a FEA package and modelling and stress analysis.
2	Analysis of Bars of constant cross section area, tapered cross section area and stepped bar
3	Analysis of Trusses – (Minimum 2 exercises of different types)
4	Analysis of Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. (Minimum 6 exercises)
5	Stress analysis of a rectangular plate with a circular hole.
6	Demonstration of Static Structural analysis for different boundary conditions.
	PART B
7	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises of different types)
8	Dynamic Analysis to find: a) Natural frequency of beam with fixed – fixed end condition b) Response of beam with fixed – fixed end conditions subjected to forcing function c) Response of Bar subjected to forcing functions
	PART C (OPTIONAL)
9	Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver.
10	Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.
11	Demonstrate at least two different types of example to model and analyze bars or plates made from composite material.

Course Outcomes:	
CO1	Apply the concepts of FEM for solving problems on bars, beams and trusses.
CO2	Carry out static analysis to obtain deflection of beams subjected to point, uniformly distributed and varying loads and use the available results to draw shear force and bending moment diagrams.
CO3	Solve 1D and 2D heat transfer conduction and convection problems with different boundary conditions.
CO4	Demonstrate the ability to Carry out dynamic analysis and find natural frequencies of beams, plates, and bars for various boundary conditions.

Reference Books:	
1.	Finite Element Method in Engineering, Rao, S. S, Pergaman Int. Library of Science, 5th Edition 2010.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 20 marks
2.	One question is to be set from Part-B: 20 Marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Course Title	HEAT TRANSFER-LAB	Semester	VI
Course Code	MVJ20MEL67	CIE	50
Total No. of Contact Hours	20 L: T: P: 0:1: 3	SEE	50
No. of Contact Hours/week	02	Total	100
Credits	02	Exam. Duration	03

Course Learning Objectives:

- To impart knowledge on heat transfer through free and forced convection
- To provide a detailed experimental analysis for heat transfer through solids, fluids, and vacuum.
- To impart knowledge on convection, conduction, and radiation heat transfer in one and two dimensional steady and unsteady systems.

Sl. No	Experiments
	PART A
1	Emissivity measurement of radiating surfaces.
2	Heat transfer through forced convection.
3	Heat transfer through composite walls.
4	Heat transfer through pin fins.
5	Thermal conductivity of Metal Bar
6	Heat transfer by Natural (Free) Convection
	PART B
7	Determination of Stefan Boltzmann Constant.
8	Vapour compression Refrigerator
9	Parallel and Counter flow Heat Exchangers.
10	Boiling and Condensation Apparatus
	PART C (OPTIONAL)
11	Demonstration of Air Conditioner Trainer Kit.
12	Transient and Steady State heat transfer Analysis of plane slab and cylinder using numerical approach.

Course outcomes:

CO1	Determine the emissivity of radiating surfaces
CO2	Determine heat transfer through forced and free convections.
CO3	Determination of Stefan boltzman constants.
CO4	Determine LMTD and effectiveness of parallel and counter flow heat exchangers.
CO5	Performance test of refrigerators and airconditioners.

Reference Books:	
1.	Heat transfer, a practical Approach, Yunus A. Cengel, Tata Mc Graw Hill Fifth edition.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 20 marks
2.	One question is to be set from Part-B: 20 Marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	2	-	-	-	2	-	2	-	2
CO3	3	2	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	2	-	-	-	2	-	2	-	2
CO5	3	2	1	1	-	-	-	2	-	1	-	1

High-3, Medium-2, Low-1

Computer Aided Modelling and Analysis Lab

Test Facility in Heat Transfer Lab

Course Title	MINI PROJECT	Semester	VI
Course Code	MVJ20MEP68	CIE	50
Total No. of Contact Hours	-	SEE	50
No. of Contact Hours/week	-	Total	100
Credits	02	Exam. Duration	03 Hrs

Course Learning Objectives:

- To ensure graduates will be proficient in utilizing the fundamental knowledge of basic sciences, mathematics and Information Technology for the applications relevant to various streams of Engineering and Technology.
- To enrich graduates with the core competencies necessary for applying knowledge of computers and telecommunications equipment to store, retrieve, transmit, manipulate and analyze data in the context of business enterprise.
- To enable graduates to think logically, pursue lifelong learning and will have the capacity to understand technical issues related to computing systems and to design optimal solutions.
- To enable graduates to develop hardware and software systems by understanding the importance of social, business and environmental needs in the human context.
- To enable graduates to gain employment in organizations and establish themselves as professionals by applying their technical skills to solve real world problems and meet the diversified needs of industry, academia and research.

Course outcomes:

CO1	As a team, identify a real-world problem that can be solved using IT tools and techniques
CO2	Analyse existing artefacts and solutions and design novel effective approaches
CO3	To explore, select & deploy the appropriate tools for effective implementation of the design
CO4	To prepare the documentation for the design and implementation, write reports and make presentations justifying the choices made.
CO5	To develop the required collaboration and communication skills to work in a professional team and multi-disciplinary context.
CO6	To quickly develop Proof-of Concept of solutions to problems

Reference Books:

	IEEE papers, IEEE/ACM papers

Scheme of Examination:

1.	Project Report : 15 marks
2.	Project Model: 25 marks
3.	Viva – Voce: 10 marks

Course Title	MACHINE LEARNING	Semester	VI
Course Code	Audit Course – MVJ20MEAUD2	**CIE**	-
Total No. of Contact Hours	40 L: T:: P: 3: 0: 0	**SEE**	-
No. of Contact Hours/week	04	**Total**	-
Credits	-	**Exam. Duration**	-

Course objective is to:

- Obtain knowledge on well posed learning problems, perspectives and issues in machine learning.
- Obtain knowledge on concept learning tasks, artificial neural network and hypothesis testing.
- Ensure students develop competency in machine learning algorithms and apply for real time problems.

Module-1	RBT Level L1 L2	08Hrs.

Introduction:

Well posed learning problems, Designing a Learning system, Perspective and Issues in Machine Learning.

Concept Learning:

Concept learning task, Concept learning as search, Find-S algorithm, Version space, Candidate Elimination algorithm, Inductive Bias.

Laboratory / Experimental Sessions: Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.

Applications: To build analytical models, helping computers "learn" from data.

Video link / additional online information:

https://www.youtube.com/watch?v=GwIo3gDZCVQ

Module-2	RBT Level L2 L3 L4	08 Hrs.

Decision Tree Learning:

Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning.

Laboratory / Experimental Sessions: Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

Applications: A decision tree is a support tool with a tree-like structure that models probable outcomes, cost of resources, utilities, and possible consequences. **Video link / additional online information:** https://www.youtube.com/watch?v=qDcl-FRnwSU		
Module-3	**RBT Level L1 L2 L3**	08 Hrs.
Artificial Neural Networks: Introduction to Artificial Neural Networks, Neural Network representation, Appropriate problems, Perceptrons, Back propagation algorithm. **Laboratory / Experimental Sessions:** Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets. **Applications:** Machine translation, automation and data analytics. **Video link / additional online information:** https://www.youtube.com/watch?v=fv6Qll3laUU		
Module-4	**RBT Level L1 L2 L4**	08 Hrs.
Bayesian Learning: Introduction, Bayes theorem, Bayes theorem and concept learning, ML and LS error hypothesis, ML for predicting probabilities, MDL principle, Naive Bayes classifier, Bayesian belief networks, EM algorithm. **Laboratory / Experimental Sessions:** Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets. **Applications:** Optimization of process parameters in digital manufacturing, product development. **Video link / additional online information:** https://www.youtube.com/watch?v=E3l26bTdtxI		
Module-5	**RBT Level L2 L3 L4**	08 Hrs.
Evaluating Hypothesis: Motivation, Estimating hypothesis accuracy, Basics of sampling theorem, General approach for deriving confidence intervals, Difference in error of two hypothesis, Comparing learning algorithms. **Instance Based Learning:** Introduction, k-nearest neighbour learning, locally weighted regression, radial basis function, cased-based reasoning. **Reinforcement Learning:** Introduction, Learning Task, Q Learning		

Laboratory / Experimental Sessions: Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs. **Applications:** Hypothesis testing, experimental validations and development of computation models. **Video link / additional online information:** https://www.youtube.com/watch?v=c8NcmNNfe-w

Course outcomes:	
CO1	Ability to apply the concepts of machine learning for solving real-time problems.
CO2	Identify the problems for machine learning and select either the supervised, unsupervised or reinforcement learning.
CO3	Ability to decide the appropriate algorithms for optimization of the process.
CO4	Ability to apply artificial neural network for optimizing the process parameters.
CO5	Select suitable testing procedures for evaluating the hypothesis and estimating the hypothesis accuracy.

Text Books:	
1.	Ethem Alpaydın, Introduction to machine learning, second edition, MIT press.
Reference Books:	
1.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, h The Elements of Statistical Learning, 2nd edition, springer series in statistics.
2.	Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	1	1	1	1	2	1	1
CO2	3	3	2	1	2	1	1	1	1	2	1	1
CO3	3	3	3	1	2	1	1	1	1	2	1	1
CO4	3	3	2	1	2	1	1	1	1	2	1	1
CO5	3	3	3	1	3	1	1	1	1	3	1	1

High-3, Medium-2, Low-1

Scheme for VII Semester B.E.(Mechanical Engineering)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	PCC	MVJ20ME71	Mechanical Vibrations	ME	3	2	0	3	50	50	100	4
2	PCC	MVJ20ME72	Operation Research	ME	3	2	0	3	50	50	100	4
3	PE	MVJ20ME73X	Professional Elective -4	ME	3	0	0	3	50	50	100	3
4	PE	MVJ20ME74X	Professional Elective -5	ME	3	0	0	3	50	50	100	3
5	OE	MVJ20ME75X	Open Elective – 2	ME	3	0	0	3	50	50	100	3
6	PCC	MVJ20MEL76	Design -Lab	ME	0	1	3	3	50	50	100	2
7	PCC	MVJ20MEL77	CIM-Lab	ME	0	1	3	3	50	50	100	2
8	Proj	MVJ20MEP78	Project Phase-1	ME				-	50	-	50	2
				Total	15	6	6	21	400	350	750	23

Note: 1. PCC: Professional Core Course , PE: Professional Elective, OE: Open Elective, Proj: Project Work
2. Students can take up Certification Course of 40 (30+10) hours duration on Big Data Analytics for 2 credits in the VII Semester to be offered in association with the Console Lancer LLP

Professional Elective -4:
1. MVJ20ME731: Renewable Energy Sources
2. MVJ20ME732: CAD/CAM,
3. MVJ20ME733: Computational Mechanics,
4. MVJ20ME734: Theory of Plasticity

Professional Elective -5:
1. MVJ20ME741: Solar Energy
2. MVJ20ME742: Lean Manufacturing,
3. MVJ20ME743: Control Engineering,
4. MVJ20ME744: Tribology

Open Elective – 2:
1. MVJ20ME751: Energy Engineering,
2. MVJ20ME752: Smart Materials and Mems,
3. MVJ20ME753: Operation Research

Course Title	MECHANICAL VIBRATIONS	Semester	7
Course Code	MVJ20ME71	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3:2:0	SEE	50
No. of Contact Hours/week	05	Total	100
Credits	4	Exam. Duration	3 Hrs

Course objective is to:

- Gain the knowledge of static and dynamic equilibrium conditions of mechanisms subjected forces and couple with and without friction.
- Understand vibrations characteristics of single degree of freedom systems.
- Characterise the single degree freedom systems subjected to free and forced vibrations with and without damping.

Module-1	RBT Level L1, L2, L3	10 Hrs.

Introduction: Definitions, Types of vibrations, Simple Harmonic Motion (SHM), Work done by harmonic force, Principle of super position applied to SHM, Beats, Fourier theorem, Numerical on Fourier theorem, Components of vibratory systems.

Laboratory Sessions/ Experimental learning:

- Study of Numerical models and analysis of Fourier theorems and beats using MATLAB.

Applications: Most of the machines, Musical instruments, etc.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=yddIT1GnIfE
2. https://www.youtube.com/watch?v=KKel19UfNno
3. https://www.youtube.com/playlist?list=PL46AAEDA6ABAFCA78
4. https://www.youtube.com/watch?v=9_d8CQrCYUw

Module-2	RBT Level L2, L3	10 Hrs.

Un damped free Vibrations (Single Degree of Freedom):

Methods of analysis – (Newton's, Energy & Rayleigh's methods). Derivations for spring mass systems, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and problems.

Laboratory Sessions/ Experimental learning:

- Study of Numerical models and analysis of vibratory systems using MATLAB.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=QIdIcCn6YGc
2. https://www.youtube.com/watch?v=4DF5qCxhxpM

3. https://www.youtube.com/watch?v=BkgzEdDlU78
4. https://www.youtube.com/watch?v=QIdIcCn6YGc

Module-3	RBT Level L1, L2, L3	10 Hrs.

Damped Free Vibrations: Introduction, Types of damping, and Vibrations with viscous damping, under damped, over-damped and critically-damped systems, logarithmic decrement.

Modal analysis and condition monitoring: Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis.

Laboratory Sessions/ Experimental learning:

- Study of Numerical models and analysis of Damped vibratory systems using MATLAB.

Applications: Bridges, Buildings, etc.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=YpiSZxDj7ws
2. https://www.youtube.com/watch?v=USa0VYAEzug
3. https://www.youtube.com/watch?v=YpiSZxDj7ws
4. https://www.youtube.com/watch?v=iNuV8Q0ZaPk

Module-4	RBT Level L2, L3, L4	10 Hrs.

Forced Vibrations (Single Degree of Freedom):

Analysis of forced vibration with constant harmonic excitation, Magnification factor (M.F.), Vibration isolation - Transmissibility ratio, Excitation of support (absolute and relative), Numerical problems.

Vibration Measuring Instruments & Whirling Of Shafts: Vibrometer and accelerometer. Whirling of shafts with and without air damping, discussion of speeds above and below critical speeds.

Laboratory Sessions/ Experimental learning:

- Study of Two Degree Freedom systems like vehicle suspension and dynamic vibration absorber.

Video link / Additional online information:

1.https://www.youtube.com/watch?v=LbVL5O_bG9w
2. https://www.youtube.com/watch?v=4h5NOWTCVWM
3. https://www.youtube.com/watch?v=ETG6krVhN8w
4. https://nptel.ac.in/courses/112/103/112103111/

Module-5	RBT Level L3, L4, L5	10 Hrs.

Numerical Methods For Multi Degree Freedom Systems: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, method of matrix iteration - Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

Laboratory Sessions/ Experimental learning:

- Study of vibration analysis of real time application problems.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=TydULVPaFek
2. https://www.youtube.com/watch?v=M8bjJQFYMHU
3. https://nptel.ac.in/content/storage2/courses/112101096/download/lecture-29.pdf
4. https://www.youtube.com/watch?v=kT1c0iyFZmM

Course outcomes:

CO1	Understand types of vibration, SHM and methods of finding natural frequencies of simple mechanical systems.
CO2	Determine equation of motion, natural frequency, damping factor, logarithmic decrement of damped free vibration (SDOF) systems.
CO3	Determine the natural frequency, force and motion transmissibility of single degree freedom systems.
CO4	Determine equation of motion of rotating and reciprocating unbalance systems, magnification factor, and transmissibility of forced vibration (SDOF) systems.
CO5	Determine the equation of motion and degrees of freedom of multi-degree freedom system.

Text Books:

1.	**S.S. Rao, '*Mechanical Vibrations*',** Pearson Education Inc, 6th Edition, 2017. ISBN9780134361307.

Reference Books:

2.	**Leonanrd Meirovitch, '*Elements of Vibrations Analysis*',** TMH, Special Indian edition, 2007, ISBN-81-7700-047-0.
3.	**S.Graham Kelly, '*Mechanical Vibrations*',** Schaum's outline series, TMH, Special Indian Edition, 2007, ISBN-14-09780070616790.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	2	2	1	1	1	1	1
CO2	3	3	3	2	3	2	1	1	1	1	1	1
CO3	3	3	3	2	3	1	1	1	1	1	1	1
CO4	3	3	3	2	2	2	2	1	1	1	1	1
CO5	3	3	3	3	3	2	1	2	1	1	1	1

High-3, Medium-2, Low-1

Course Title	OPERATIONS RESEARCH	Semester	VII
Course Code	MVJ20ME72	**CIE**	50
Total No. of Contact Hours	50 L:T: P:: 3:2:0	**SEE**	50
No. of Contact Hours/week	05	**Total**	100
Credits	04	**Exam. Duration**	03 hrs

Course objective is to:

- To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
- To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and Machinery.

Module-1	**RBT Level L1, L2, L3**	10Hrs.

Introduction:

Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Laboratory Sessions/ Experimental learning: Case Studies for formulation of LLP to know the statistics for daily marketing of newspaper, banking sector, different firms.

Applications: Formulation can be used in agriculture, financial sector, marketing.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/111107128/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-2	**RBT Level L2, L4**	10Hrs.

Linear Programming Problems:

Simplex method, Canonical and Standard form of LPP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Laboratory Sessions/ Experimental learning: Case Studies for formulation of LLP to utilize minimum resources available to achieve the target for different sectors like supply chain management, marketing.

Applications: LPP can be used in defense, industries sectors and hospitals.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/112106134/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-3	RBT Level L2, L3, L4	10Hrs.

Transportation Problem:

Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem.

Assignment Problem:

Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems

Laboratory Sessions/ Experimental learning: Case Studies for different transportation system to obtain best optimal distance to reach the target.

Applications: These methods can be used in transportation of goods and any other services.

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

Module-4	RBT Level L1, L2, L4	10Hrs.

Network analysis:

Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Numerical Problems.

Queuing Theory:

Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

Laboratory Sessions/ Experimental learning: Building a different network activity for financial and marketing projects management.

Applications: Network and Queuing methods can be adopted in completing various projects within the given deadline to earn the profit and minimize the loss.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/110106062/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-5	RBT Level L2, L3,L5	10Hrs.

Game Theory:

Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2xN and Mx2 games by graphical method. Formulation of games.

Sequencing:

Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.

Laboratory Sessions/ Experimental learning: Collecting the statistical data to develop the project using Game theory and Sequencing.

Applications: These methods give the perfect results of any production of machines.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/112106131/

https://nptel.ac.in/courses/112/106/112106134/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

Course Outcomes:	
CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.
CO3	Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.

CO4	Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks. Solve waiting line problems for M/M/1 and M/M/K queuing models.
CO5	Solve problems on game theory for pure and mixed strategy under competitive environment. Determine minimum processing times for sequencing for different n jobs and m machines using Johnson's algorithm.

Text Books:	
1	Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications Pvt. Ltd. 2016.
2	Operations Research, P K Gupta and D S Hira, S. Chand and Company LTD. Publications, New Delhi – 2007.
Reference Books	
1	Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006
2	Operations Research, Paneerselvan, PHI

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	1	-	-	-	2	-	1	-	2
CO3	3	3	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	1	-	-	-	2	-	2	-	2
CO5	2	3	3	2	-	-	-	2	-	1	-	2

High-3, Medium-2, Low-1

Course Title	RENEWABLE ENERGY SOURCES	Semester	7TH
Course Code	MVJ20ME731	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 3:0:0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3hrs.

Course objective is to:

- Students will be able to understand various types and utilization of Non-conventional Energy Sources.
- Students will gain the knowledge about the utilisation and applications of solar energy.
- Students will be able to explain how solar radiation will be converted into Thermal Energy and working of Photovoltaic Cells.
- Students will understand how the Biomass (Natural Waste) is converted in useful energy and Geothermal Energy.
- Students will gain the knowledge about the generation of power from Wind Energy, Ocean Thermal Energy Conversion and Tidal Energy.

Module-1	RBT Level L1, L2&L4	8Hrs.

Introduction: Energy sources, India's production, and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, solar, thermal, photovoltaic. Waterpower, wind biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages, comparison (Qualitative and Quantitative).

Laboratory Sessions/ Experimental learning: Case Study on Different Energy Sources.

Applications: Energy Sector

NPTEL Link: https://nptel.ac.in/courses/121/106/121106014/

Video link: https://www.youtube.com/watch?v=e0nkkKDjY50&t=2s

https://www.youtube.com/watch?v=e0nkkKDjY50&t=2s

https://www.youtube.com/watch?v=EXcNXLv2W3A

Module-2	RBT Level L1,L2&L3	8Hrs.

Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data.

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident

beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sum, day length, numerical examples. Radiation Flux on a Tilted Surface. Solar radiation measurement devices.

Laboratory Sessions/ Experimental learning: Analysis of solar radiation data in different places across the country.

Applications: Solar Power Generation.

NPTEL Link: https://nptel.ac.in/courses/121/106/121106014/

Video link: https://www.youtube.com/watch?v=CRFpoZjeWa4

https://www.youtube.com/watch?v=E4S02rc9AvM

https://www.youtube.com/watch?v=ur5muGY5Gy4

Module-3	RBT Level L1,L2 &L3	8Hrs.

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis); sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems.

Photovoltaic Conversion: Description, principle of working and characteristics, applications. Study of solar power stations in India. Limitations of solar power.

Laboratory Sessions/ Experimental learning: Case study for design of solar panel for domestic applications & Case study on solar charging station.

Applications: Solar power stations.

NPTEL Link: https://nptel.ac.in/courses/121/106/121106014/

Video link: https://www.youtube.com/watch?v=mpHZWYpKDJg

https://www.youtube.com/watch?v=GzMuLpsRY-8

Module-4	RBT Level L1,L2&L3	8Hrs.

Energy from Biomass: Photosynthesis, photosynthetic oxygen production, energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages.

Geothermal Energy Conversion: Principle of working, types of geothermal station, geothermal plants in the world, scope of geothermal energy and challenges associated with geothermal energy conversion.

Laboratory Sessions/ Experimental learning: Visit to Biomass Gas Production Plant. Case study on design of bio-gas plant for 1Mw.

Applications: Production of Gas and Power Generation.

NPTEL Link: https://nptel.ac.in/courses/121/106/121106014/ **Video link:** https://www.youtube.com/watch?v=sJQwJX-YysY https://www.youtube.com/watch?v=JInatzTBiKA https://www.youtube.com/watch?v=adSkrlyd2rQ&t=1s		
Module-5	**RBT Level L1,L2&L3**	8Hrs.
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, aerodynamic considerations of windmill design, numerical examples. **Tidal Power:** Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, limitations. **Ocean Thermal Energy Conversion (OTEC):** Principle of working, Rankine cycle, OTEC power stations in the world, limitations of OTEC. **Laboratory Sessions/ Experimental learning:** Assignments on making models of windmills. **Applications**: Power Generation and Low heat Applications. **NPTEL Link:** https://nptel.ac.in/courses/121/106/121106014/ **Video link:** https://www.youtube.com/watch?v=-f88zBS8jlg&t=2s, https://www.youtube.com/watch?v=WZBiznycjns https://www.youtube.com/watch?v=F2YsrxpQPwE		

Course outcomes:	
CO1	Understand various types and utilization of Non-conventional Energy Sources.
CO2	To understand the impact of solar collector geometry.
CO3	Apply the knowledge of solar radiation for power generation and domestic applications.
CO4	Understand the Biomass (Natural Waste) conversion to useful energy and principles of geothermal Energy.
CO5	Gain the knowledge about the generation of power from Wind Energy, Ocean Thermal Energy Conversion and Tidal Energy.

Text Books:	
1.	Non-Conventional Energy Sources by G.D Rai K, Khanna Publishers, 2003
2.	Solar energy, by Subhas P Sukhatme – Tata McGraw Hill, 2nd Edition, 1996

3.	Renewable Energy Sources and Conversion Technology by N.K.Bansal, Manfred Kleeman & Mechael Meliss, Tata McGraw Hill, 2001.
Reference Books:	
1	Renewable Energy Resources, John W.Twidell Anthony D. Weir El, BG 2001.
2	Solar Power Engineering, P.K.Nag, Tata McGraw Hill, 2003.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	3	-	-	-	-	2
CO2	2	1	-	-	-	2	3	-	-	-	-	2
CO3	2	1	-	-	-	2	3	-	-	-	-	2
CO4	2	1	-	-	-	2	3	-	-	-	-	2
CO5	2	1	-	-	-	2	3	-	-	-	-	2

High-3, Medium-2, Low-1

Course Title	CAD/CAM	Semester	VII
Course Code	MVJ20ME732	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3:0:0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3hrs

Course objective is to:

- To know the fundamentals of Computer Aided Design (CAD)
- Information regarding various CAD hardware
- Programming concepts in Computer Numerical Control (CNC)
- To impart knowledge of computer aided quality control and shop floor control
- Robotics and their applications

Module-1	RBT Level: L1, L2	8 Hrs

Introduction: Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment. Introduction to CAD, Introduction to CAM. Advantages and disadvantages of CAD and CAM.

Hardware in CAD: Basic Hardware structure, working principles, usage and types of hardware for CAD - input and output Devices, memory, CPU, hardcopy and Storage devices.

Laboratory Sessions/ Experimental learning: Allowing customization and reconfiguration of manufacturing processes with minimal downtime and cost. Providing management with detailed and timely information about the manufacturing process

Applications: Computer aided designing. Computer aided manufacturing

Video link / Additional online information :

https://youtu.be/EgKc9L7cbKc

https://www.youtube.com/embed/1y2Vec5XdXg

https://www.youtube.com/embed/HJLuKbU11jY

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod02lec07.mp4

Module-2	RBT Level: L2, L3	8 Hrs

Computer Graphics: Software configuration of a graphic system, function of a Graphics package, construction of geometry, wire frame and solid modelling, CAD/CAM integration. Describe modelling facilities. Introduction to exchange of modelling data – Basic features of IGES, STEP, DXF and DMIS.

Laboratory Sessions/ Experimental learning: A model designed can be carried in a storage device along many others.Strengthens companies' ability to respond quickly to customers' demands

Applications:

Video link / Additional online information :

https://youtu.be/JuNDS4R-OwI

https://youtu.be/iWxS2zpaRjk.

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod02lec08.mp4

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod02lec09.mp4

Module-3	RBT Level : L2, L3	8 Hrs

CNC Tooling: Turning tools geometry, milling tooling systems, tool pre-setting, ATC work holding. CAM PROGRAMMING: Overview of different CNC machining centers, CNC turning centers, high speed machine tools, MCE.

CNC Programming: Part program fundamentals – steps involved in development of a part program. Manual part programming, milling, turning center programming.

Laboratory Sessions/ Experimental learning: CNC Tooling, CNC programming and operations

Applications:

Video link / Additional online information :

https://www.youtube.com/watch?v=pPwyYFvRLts

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod06lec31.mp4

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod06lec32.mp4

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod06lec33.mp4

Module-4	RBT Level : L1, L2	8 Hrs

Computerized Manufacturing Planning System and Flexible Manufacturing Systems: Computer Aided Process Planning: retrieval types, Generative type, Material Requirement Planning, Fundamental concepts of MRP, Inputs to MRP, Capacity Planning. Group technology. Flexible Manufacturing Systems, types of FMS, FMS components,

Shop Floor Control & Computer Aided Quality Control: Factory, Data Collection System, Automatic identification system. Inspection methods, Non-Contact inspection methods, Co-ordinate measuring machine

Laboratory Sessions/ Experimental learning: Integration of automated assignment and reporting of factory floor operations through machine and material handling equipment sensors and software

Applications: Reduces Total Cost of Ownership. Improves quality and consistency of inputs

Video link / Additional online information :

https://www.youtube.com/watch?v=20_K7c65Swg

http://www.youtube.com/watch?v=g-zMhN4S8yY

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod08lec43.mp4

https://nptel.ac.in/content/storage/112/104/112104188/MP4/mod08lec44.mp4

Module-5	RBT Level: L2, L3	8 Hrs

Introduction to Robotics: Introduction, Robot Configuration, Robot Motions, Programming the Robots, Robot- Programming Languages, End effectors, Work Cell, Control and Interlock, Robot Sensor, Robot Applications.

Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, Introduction to Industrial Internet of things(IIOT), supply chain optimization, supply-chain and logistics, cyber-physical manufacturing systems.

Laboratory Sessions/ Experimental learning: Robot programming and handling

Applications: Industry 4.0, Internet of Things (IOT) in different manufacturing industry

Video link / Additional online information :

https://www.youtube.com/watch?v=DaWMvEY3Qgc

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec48.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec49.mp4

https://nptel.ac.in/content/storage2/112/104/112104289/MP4/mod12lec50.mp4

Course outcomes:

CO1	Understand the concepts of CAD and the required hardware
CO2	Understand CAM and CNC machines
CO3	Program CNC machines
CO4	Explain the use of different computer applications in Shop Floor Control & computer aided quality control
CO5	Understand and program the robot.

Text Books:

1.	CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
2.	Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition,2015, Pearson Learning.
3	P N Rao "CAD / CAM Principles and Applications", 3rd Edition, 2015, Tata McGraw-Hill.

Reference Books:

1	P. Radhakrishnan, "CAD/CAM/CIM" 3rd edition, New Age International Publishers, New Delhi.
2	Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", (Universities Press).

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	-	2	-	1	-	1	-	-	-
CO2	2	3	1	-	3	-	-	-	-	-	-	-
CO3	-	2	3	2	-	-	-	1	-	-	-	-
CO4	1	-	2	-	3	-	-	-	2	-	-	-
CO5	1	-	2	-	3	-	-	-	2	-	-	-

High-3, Medium-2, Low-1

Course Title	COMPUTATIONAL MECHANICS	Semester	VII
Course Code	MVJ20ME733	CIE	50
Total No. of Contact Hours	40 L: T : P :: 3: 0 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	03

Course objective is to:

- Understand and systematize numerical solution techniques for the partial differential equations governing the physics of mechanical engineering problems.
- Understand the mathematical models used to describe behaviour and results of most numerical methods used in engineering mechanics.
- Writing codes using MATLAB, C, C++ etc to solve problems pertaining to engineering mechanics.

Module-1	RBT Level L1,L2,L3	8 Hrs.

Introduction, Conservation Laws and Model Equations, Conservation Laws, Euler Equations, Navier-Stokes Equations, Linear Convection and Diffusion Equation, Linear Hyperbolic Systems, Differential Form and Solution in Wave Space

Laboratory Sessions/ Experimental learning: Simulation of flow through a simple Convergent/Divergent Nozzle

Video link:

1. https://www.youtube.com/watch?v=vgFoleINnqU
2. https://www.youtube.com/watch?v=f856f2r3Btk
3. https://nptel.ac.in/courses/112/103/112103296/
4. https://www.youtube.com/watch?v=9uHOkjV68EY

Module-2	RBT Level L1,L2,L3	8 Hrs.

Finite-Difference Approximations, Space Derivative Approximations Finite-Difference Operators Constructing Differencing Schemes of Any Order, Fourier Error Analysis, Difference Operators at Boundaries.

The Semi-Discrete Approach, Reduction of PDE's to ODE's, Real Space and Eigen space.

Laboratory Sessions/ Experimental learning: Writing codes to solve ODE/PDE using MATLAB software.

Video link:

1. https://www.youtube.com/watch?v=g3Xw1r7QGOE

2. https://www.youtube.com/watch?v=f67jpwJu-d0
3. https://www.youtube.com/watch?v=UWqVvR8SmDA
4. https://www.youtube.com/watch?v=K5aYW0QUg7c

Module-3	RBT Level L1,L2,L3	8 Hrs.

Finite-Volume Methods, Model Equations in Integral Form, Multidimensional Examples

Finite-Element Methods, Approximation of Elliptic Problems, Piecewise Polynomial Approximation, A Posterior Error Analysis, Evolution Problems.

Laboratory Sessions/ Experimental learning: Write MATLAB codes to solve simple bar and beam problems using FEM methods

Video link:

1. https://nptel.ac.in/courses/112/103/112103295/
2. https://www.youtube.com/watch?v=o2Vlt1avXCs
3. https://www.youtube.com/watch?v=Jqa-aFE9-GI
4. https://www.youtube.com/watch?v=PBjGdQOghJE

Module-4	RBT Level L1,L2.L4	8 Hrs.

Time-Marching Methods for ODE's

Converting Time-Marching Methods to ODE's, The λ-σ Relation, Accuracy Measures of Time-Marching Methods, Linear Multistep Methods, Predictor-Corrector Methods, Implementation of Implicit Methods

Stability of Linear Systems, Dependence on the Eigen system, Inherent Stability of ODE's, Numerical Stability of ODE's, Time-Space Stability and Convergence of ODE's, Numerical Stability Concepts in the Complex σ-Plane, Numerical Stability Concepts in the Complex λh-Plane, Fourier Stability Analysis, Consistency.

Laboratory Sessions/ Experimental learning: Solving 1D linear wave equation by using Time-marching method of finite difference method.

Video link:

1.https://ocw.mit.edu/courses/chemical-engineering/10-34-numerical-methods-applied-to-chemical-engineering-fall-2015/class-videos/session-22-partial-differential-equations-1/

2. https://nptel.ac.in/courses/101/104/101104062/

3. https://www.youtube.com/watch?v=p0V1eSlM2xo

4. https://www.youtube.com/watch?v=ly4S0oi3Yz8

Module-5	RBT Level L3,L4,L5	8 Hrs.

Selecting a Time-Marching Method, Stiffness Definition for ODE's and Relation of Stiffness to Space Mesh Size, Practical Considerations for Comparing Methods, Comparing the efficiency of Explicit Methods, Coping with Stiffness

Relaxation Methods, Classical Relaxation, The ODE Approach to Classical Relaxation, Eigen systems of the Classical Methods, Nonstationary Processes

Laboratory Sessions/ Experimental learning: Eigenvalue problems and Mechanical Vibrations using MATLAB code.

Video link:

1. https://ocw.mit.edu/courses/chemical-engineering/10-34-numerical-methods-applied-to-chemical-engineering-fall-2015/class-videos/session-22-partial-differential-equations-1/
2. https://www.youtube.com/watch?v=OET0qwat15o
3. https://www.youtube.com/watch?v=NjoMoH51UZc
4. https://www.youtube.com/watch?v=TDc6J2R9h3Q

Course outcomes:	
CO1	Students will be able to develop mathematical models of physical phenomena.
CO2	Students will be able to solve ordinary and partial differential equations analytically as well as numerically.
CO3	Students will learn fundamentals and applications of algebra for engineering problems
CO4	Students will learn fundamentals of statistics and probability and its applications for engineering mechanics.
CO5	Students will be able to apply the concepts of engineering mechanics for real time engineering problems.

Text Books:	
1.	Advanced Engineering Mathematics, 9th edition, by Erwin Kreyszig JOHN WILEY & SONS, INC.
2.	Advanced Engineering Mathematics, 2nd edition, by M D Greenberg, Pearson Education
3.	Numerical Methods for Engineers by Stephen C Chapra, and Raymond C Canale McGraw-Hill
Reference Books:	
1.	Computational Continuum Mechanics 3rd edition by Ahmed A Shabana, Wiley publications.

2.	Continuum Mechanics using Mathematica by Antonio Romano, Renato Lancellotta and Addolorata Marasco.
3.	Mathematical Modeling in Continuum Mechanics, 2nd edition, by Roger Temam and Alain Miranville, Cambridge University Press.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	2	-	-	-	-	2	1	1	1
CO2	3	2	1	2	-	-	-	-	2	1	1	1
CO3	3	2	2	3	-	-	-	-	2	1	2	1
CO4	3	2	1	2	-	-	-	-	2	1	2	1
CO5	2	2	2	2	1	-	-	-	2	2	1	1

High-3, Medium-2, Low-1

Course Title	THEORY OF PLASTICITY	Semester	VII
Course Code	MVJ20ME734	CIE	50
Total No. of Contact Hours	40 L: T : P :: 3:0:0	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	03	Exam. Duration	03 Hours

Course objective is to:

- Introduce the concepts of Plasticity and mechanism of plastic deformation in metals.
- Expose the students to elasto-plastic problems involving plastic deformation of beams and bars.
- Introduce the concepts of slip line field theory.

Module-1	RBT Level L1,L2,L3	8 Hrs.

Brief review of fundamentals of elasticity: Concept of stress, stress invariants, principal Stresses, octahedral normal and shear stresses, spherical and deviatoric stress, stress transformation.

Concept of strain: engineering and natural strains, octahedral strain, deviator and spherical strain tensors, strain rate and strain rate tensor, Cubical dilation, generalized Hooke's law, Numerical problems.

Laboratory Sessions/ Experimental learning: Analyzing the different mechanical properties of materials using computerized universal testing machine in order to know the material behavior in elastic region.

Applications: Plasticity in Structural Engineering

Video links: https://nptel.ac.in/courses/112105123/

Module-2	RBT Level L1,L2,L3	8 Hrs.

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth,

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criterion, geometrical representation, yield surface, yield locus (two dimensional stress space), experimental evidence for yield criteria, problems

Laboratory Sessions/ Experimental learning: Analyzing the different mechanical properties of materials using computerized universal testing machine in order to know the material behavior in plastic region.

Applications: Plastic deformation of structural materials.

Video links: https://nptel.ac.in/courses/112105123/4

Module-3	RBT Level L1,L2,L3	8 Hrs.
Stress Strain Relations: Idealised stress-strain diagrams for different material models, empirical equations, Levy-Von Mises equation, Prandtl-Reuss and Saint Venant theory, experimental verification of Saint Venant's theory of plastic flow. Concept of plastic potential, maximum work hypothesis, mechanical work for deforming a plastic substance **Laboratory Sessions/ Experimental learning:** **Applications:** Theoretical evaluation of the deformation of a plastic **Video links:** https://nptel.ac.in/courses/112105123/6		
Module-4	**RBT Level L1,L2,L4**	**8 Hrs.**
Bending of Beams: Stages of plastic yielding, analysis of stresses, linear and nonlinear stress strain curve, problems. **Torsion of Bars:** Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, problems. **Laboratory Sessions/ Experimental learning:** Conduct of 2 point bending test and 3 point bending tests. **Applications:** Yielding of bridges under bending loads. **Video links:** https://nptel.ac.in/courses/112105123/6		
Module-5	**RBT Level L3,L4,L5**	**8 Hrs.**
Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flows, continuity equations, stresses in conditions of plain strain, convention for slip lines, geometry of slip line field, properties of the slip lines, construction of slip line nets. **Laboratory Sessions/ Experimental learning:** Demonstration of the geometry of slip line field in materials to students. **Applications:** Slip line field for stresses in conditions of plain strain. **Video links:** https://www.youtube.com/watch?v=gObbNJ6g1xQ		

Course outcomes:	
CO1	Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.
CO2	Understand plastic stress-strain relations and associated flow rules.
CO3	Perform stress analysis in beams and bars including Material nonlinearity.
CO4	Analyze the yielding of a material according to different yield theory for a given state of stress.
CO5	Interpret the importance of plastic deformation of metals in engineering problems

Text Books:	
1.	Timoshenko and Goodier, "Theory of Elasticity"-'Tata McGraw Hill, New Delhi,3rd edition , 1970.
2.	L S Srinath "Advanced Mechanics of Solids"- Tata McGraw Hill, New Delhi, 3rd edition, 2010.
Reference Books:	
1.	G. Thomas Mase, Ronald E. Smelser, George. E. Mase, Continuum Mechanics for Engineers, 3rd Edition, CRC Press,Boca Raton, 2010.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	2	-	-	-	2	1	1	1
CO2	3	3	1	2	2	1	-	-	2	1	1	1
CO3	3	3	2	3	3	1	-	-	2	1	2	1
CO4	3	3	2	3	3	1	1	-	2	1	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Course Title	SOLAR ENERGY	Semester	VII
Course Code	MVJ20ME741	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3: 0 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs

Course objective is to:

- To learn the various available forms of energy.
- To understand the various methods of harnessing non-conventional energy.
- To study the various applications of solar energy and their economic analysis.
- To learn the fundamental concepts about solar energy systems and devices

Module-1	RBT LEVEL L1, L2	8 Hrs.

Introduction: Energy source, renewable energy sources, renewable energy potential and achievements in India, Sustainable energy: The engine of sustainable development Solar energy: General characteristics of solar energy; the Sun, solar spectrum, spectral solar impedance.

Solar Radiation at the Earth Surface: Solar constant beam, diffuse and global radiation. Solar radiation data of India. Measurement of solar radiation: Pyrometer, pyro-heliometer, sunshine recorder.

Solar radiation geometry: Sun earth angles- latitude, declination, hour angle, zenith, solar altitude angle, surface azimuth angle, solar azimuth angle, Local apparent time, solar time, apparent motion of sun, day length, numerical examples. Flux on a plane surface, Solar radiation on a inclined surface- Beam, defuse, reflected radiation on a tilted surface, expression for flux on a tilted surface, monthly average hourly and daily radiation on inclined surface. Numerical examples.

Laboratory Sessions/ Experiential learning:

- Design of solar panels for street lights in campus
- Build a solar cell sun tracker to track the sun with calibrated panels.

Applications: Solar energy is used for producing heat, electricity.

Video link: https://nptel.ac.in/courses/103/103/103103206/
https://www.youtube.com/watch?v=ucBP1cADTgI
https://www.youtube.com/watch?v=gKSUTAC1lh0
https://nptel.ac.in/courses/115/103/115103123/

Module-2	RBT LEVEL L1, L2	8 Hrs.

Solar thermal radiation devices: Liquid flat plate collectors, solar air heaters, concentrating collectors like cylindrical, parabolic, evacuated tubular collectors. Storage devices: Sensible heat

storage, latent heat storage. Application of solar energy: water heating, space heating, space cooling, active and passive cooling systems. Various power generation methods; Solar furnace, Refrigeration, Distillation, Solar ponds; theory, working principle, operational problems.

Solar photovoltaic system: Introduction, Description, Principles of working of solar cell: Doping, Fermi level, p-n junction, photovoltaic effect. Photovoltaic Material:- Single crystal solar cell, Poly crystal solar cell, thin film solar cell, I-V characteristic, limits to cell efficiency, Cell temperature factors affecting PV cell performance Current status and Future potential of P.V. cells.

Laboratory Sessions/ Experiential learning:

- Schematic of solar pump

Applications: Solar cells are used for heating.

Video link: https://nptel.ac.in/courses/112/105/112105050/
https://www.youtube.com/watch?v=rg1x4jJmSl4
https://www.youtube.com/watch?v=FgjfJGfusdE
https://www.youtube.com/watch?v=ZLgOoMSlS3Y

Module-3	RBT LEVEL L1, L2	8 Hrs.

Performance analysis of liquid flat plate collectors: General description, collector geometry, selective surface, basic energy balance equation, stagnation temperature, transmissivity of the cover system, transmissivity- absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss- coefficient, problems.

Temperature distribution Solar Concentrators: Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency. Effect of various parameters on the collector performance: Collector orientation, selective surface, fluid inlet temperature, number of covers, dust. Solar Concentrators: Introduction, characteristic parameters: Aperture area, Acceptance angle, absorber area, geometric concentration ratio. Local concentration ratio or brightness concentration ratio, intercept factor, optical efficiency, thermal efficiency. Concentration ratio.

Laboratory Sessions/ Experiential learning:

- Studying the performance of Temperature distribution Solar Concentrators.

Applications: Solar collectors will collect the solar radiations.

Video link: https://nptel.ac.in/courses/103/103/103103206/
https://www.youtube.com/watch?v=wvl0QAQCJyc
https://www.youtube.com/watch?v=BZtkHHNoyjA
https://www.youtube.com/watch?v=JbJ7AVHBQfs
https://www.youtube.com/watch?v=EjjZJH_7Di0

Module-4	RBT LEVEL L1, L2, L3	8 Hrs.

Concentrators: Concentration, Non-tracking concentrator. Geometrical optics in concentrators: Ray tracing in a reflecting surface, ray tracing in a refracting surface. Theoretical solar image. Thermal analysis: Cylindrical parabolic concentrator, Hemispherical Bowl Mirror, V- trough. Tracking Methods: Three Dimensional Concentrators, Two dimensional concentrators. Materials for concentrators: - Reflecting and Refracting surfaces, receiver cover and surface coating, working fluids, insulation, Numerical problems

Laboratory Sessions/ Experiential learning:

- Making the model of cylindrical parabolic concentrator, Hemispherical Bowl Mirror.

Applications: Solar Concentrators will improve the efficiency of the solar system.

Video link: https://nptel.ac.in/courses/103/103/103103206/

https://www.youtube.com/watch?v=hVik_I2ONUU

https://www.youtube.com/watch?v=-rYmTp5BW8c

https://www.youtube.com/watch?v=-SsJBobMpAk

Module-5	RBT LEVEL L1, L2, L3	8 Hrs.

Solar power stations in India: Elements of a solar power station, design of solar power system, solar power charging stations, design of solar panels for lighting purposes. Etc., Solar powered house. Repair of solar panels. Wind -Solar hybrid power plant. Installation, commissioning of grid solar power plant, Maintenance of solar power plants, safety considerations of solar power plants.

Laboratory Sessions/ Experiential learning:

- Studying the Repair of Solar panels.

Applications: Solar cells are used for lighting of street lights.

Video link: https://nptel.ac.in/courses/103/103/103103206/

https://www.youtube.com/watch?v=8m0IAy8jjLY

https://nptel.ac.in/courses/115/103/115103123/

https://www.youtube.com/watch?v=r6OnREoqoOM

Course outcomes:

CO1	Gain an understanding of the available solar energy and the current solar energy conversion and utilization processes.
CO2	Illustrate the working principle of solar radiation measuring devices.
CO3	Analyse the effect of various parameters on the performance of liquid flat plate collectors
CO4	Analyse the effect of various parameters on the performance concentrators.
CO5	Understand the manufacturing processes involved, environmental challenges that need to be solved, economic aspects, and future potentials of solar energy utilization.

Text Books:	
1.	**Solar Energy: Fundamentals, Design, Modelling and Applications by G.N. Tiwari, Narosa** Publishing House, 2002 ISBN 81-7319-450-5.
2.	**Solar Engineering of Thermal Processes by Duffie, J.A. and Beckman, W.A., John Wiley and Sons,** New York (1991).
Reference Books:	
1.	**Solar Energy-Principles of Thermal Collection and Storage by S.P. Sukhatme,** Tata McGraw-Hill publishing company limited**,** New Delhi, ISBN 0-07-462453-9.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	1	2	1	-	-	-	-	-
CO2	3	2	2	1	2	-	1	-	-	-	-	-
CO3	3	1	1	-	2	-	-	-	-	-	-	-
CO4	3	1	1	3	3	-	2	-	-	-	-	-
CO5	2	1	3	3	1	2	2	-	-	-	-	1

High-3, Medium-2, Low-1

Course Title	LEAN MANUFACTURING	Semester	7
Course Code	MVJ20ME742	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 3: 0 : 0	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	3	**Exam. Duration**	3

Course objective is to:

- Course aims at providing knowledge about various aspects of Lean Manufacturing.
- Identify how a production line can be run efficiently.
- Reflect upon the critical skills and evaluate their own performance.
- Relate concepts such as 'Just in Time manufacturing' and 'Lean manufacturing to the context of an assembly line.
- Applying concepts of 5S and Six sigma concepts in industries.

Module-1	RBT Level L1,L2, & L3	8 Hrs.

Introduction: Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools,

Toyota Production System: Just in time production system. JIT Logic -Pull system Japanese approach to production elimination of waste - JIT implementation requirements JIT application for job shops, Case studies.

Laboratory Sessions/ Experimental learning:

- Operational availability equals machine run time/machine use time.
- To implement the system, three wastes must be removed from the production system: Design out overburden (muri) Reduce inconsistency (mura) Eliminate waste (muda).

Applications:

- Front line production team creates a daily discipline of seeking improvement through collaboration and focusing on the daily process.
- Toyota's own continuous improvement journey.

Video link / Additional online information:

- Lean manufacturing techniques, IIT Roorkee https://www.youtube.com/watch?v=G_0bl6FHo_c
- Lean manufacturing and Kanban Design and planning. Module 37, Prof. Shantanu Bhattacharya, IIT Kanpur. Video Lecture--https://nptel.ac.in/courses/112/104/112104188/
- Toyota Production system- forklift https://www.toyotaforklift.com/resource-library/material-handling-solutions/products/valuing-the-toyota-production-system-and-lean-manufacturing

- Coursera
  https://www.coursera.org/courses?query=lean%20manufacturing
- Coursera

https://www.coursera.org/lecture/fixing-healthcare-delivery-advanced-lean/what-are-the-fundamental-principles-of-lean-tps-TG2wY

Module-2	RBT Level L1,L2&L3	8 Hrs.

Adaptable Kanban System: Kanban rules, supplier Kanban and sequence schedule used by supplier, Monthly information & daily information.

Kaizen: Introduction, Elements of Kaizen, Kaizen – The Three Pillars

Mass production: The rise & fall of Mass Production, Mass production, work force, organization, tools, product –logical limits of Mass production.

Laboratory Sessions/ Experimental learning:

- Introduce Kanban board apps which can be called on for projects big and small, individual and team efforts, one-time or ongoing work.
- Introduce Kaizen into daily activities.

Applications:

- Kanban being applied in traditional project management contexts such as construction and engineering projects.
- Kaizen is must in Toyota- Automotive manufacturer

Video link / Additional online information:

- Kanban Approach, Prof Rajat Agarwal IIT Roorkee
  https://www.youtube.com/watch?v=Zjx7zCjLjyw
- Lean Manufacturing: The Path to Success with Paul Akers
  https://www.youtube.com/watch?v=oarLDeAFSj4
  https://www.youtube.com/watch?v=UMFNys3Yavo
- Coursera
  https://www.coursera.org/courses?query=kanban
- Coursera
  https://www.coursera.org/lecture/six-sigma-principles/jit-kanban-qlp9X

Module-3	RBT Level L1,L2&L3	8 Hrs.

Reduction of setup times- The Quick-Change over- Concepts and Techniques: Setup Concepts, practical procedures for reducing setup time, Pareto diagram.

Standardization of operations: Elements: Takt time, Work Sequence, Standard inventory, Machine layout, multi-function workers and job rotation. Improvement activities to reduce work force and increase worker morale -foundation for improvements.

Laboratory Sessions/ Experimental learning:

- Implement the quick-change over in industry shopfloor for improving productivity.

Applications:

- In make to stock situations, manufacturers usually opt to produce large quantities or lot sizes in order to minimize setup costs.
- *Standardization* can be applied to any process, any task or procedure that is relevant to the organization: answering the phone, doing payroll, taking down client information, keeping track of tasks/process.

Video link / Additional online information:

- Reduction of setup times and Standardization of operations https://www.creativesafetysupply.com/articles/kanban/
- Single Minute Exchange of Dies (SMED) which is a Lean manufacturing tool to reduce the Change-over time of the machines. https://www.youtube.com/watch?v=9ANXiDt7z6c&t=1s
- Coursera https://www.coursera.org/lecture/theimprovephaseforthesixsigmablackbelt/setup-reduction-6-10-mBSym
- Coursera https://www.coursera.org/lecture/themeasurephaseforthesixsigmablackbelt/lean-terminology-9-22-pAxYI

Module-4	RBT Level L1,L2&L4	8 Hrs.

House of Lean -5S's and Waste Walks, Visual Management, Value Stream Mapping-Understanding the current state and designing the future state.

Managing lean enterprise - Finance, Career ladders, geographic spread and advantages of global enterprise.

Laboratory Sessions/ Experimental learning:

- Apply 5S's in automobile manufacturing industries.
- Apply 5S's in food products production industries.

Applications:

- **5S's** is a highly systematic method (or set of techniques) of organizing and optimizing any warehouse, office, institution (i.e. university, hospital, library etc) or a factory's housekeeping.

Video link / Additional online information:

- Lean Agile mindset and the House of Lean https://www.youtube.com/watch?v=FM8cxTHA3lI
- A Spotlight on Leaders: Re-Thinking the Retail Food Industry https://www.lean.org/Events/WebinarHome.cfm
- Coursera https://www.coursera.org/lecture/lean-manufacturing-services/introduction-to-lean-5jjrs

- Coursera
  https://www.coursera.org/lecture/fundamentals-of-management/1-4-lean-7Serp

Module-5	RBT Level L1,L2&L3	8 Hrs.

Six sigma concepts: History, definitions, Statistical definitions, quality levels, Technical aspects, Six sigma for all: benefits to organizations, customers, suppliers and employers, Design for Six Sigma, DMAIC principles, DMADV principles, merits and demerits.

Brief discussion on following topics: Artificial intelligence (AI) with lean manufacturing, Digital manufacturing, Re-Thinking Production Flow (Lean Technique).

Laboratory Sessions/ Experimental learning:

- Apply six sigma concepts in production industries.
- Introduce artificial intelligence (AI) to increase productivity.

Applications:

- Production industries for taking help of artificial intelligence (AI)

Video link / Additional online information:

- Six sigma -NPTEL Prof. Vinod Gupta, School of management, IIT Kharagpur. https://nptel.ac.in/courses/110/105/110105039/
- From Lean Production to the Lean Enterprise
  https://hbr.org/1994/03/from-lean-production-to-the-lean-enterprise
- Coursera
  https://www.coursera.org/lecture/six-sigma-principles/six-sigma-methodology-zykLE
- Coursera
  https://www.coursera.org/learn/introduction-to-ai

Course outcomes:

CO1	To understand issues & challenges in implementing & developing lean manufacturing techniques from TPS & its contribution for improving organizational performance
CO2	Apply lean techniques like Kanban rules, Kaizen to bring competitive business culture for improving organization performance
CO3	Applying reduction of setup times and Standardization of operations analyze how lean techniques can be applied to manufacturing & service industry
CO4	Implementing 5S's and global enterprise to present industries
CO5	Analyzing six sigma and artificial intelligence in supporting production

Text Books:

1.	Productions and Operations Management - ChaselAquilino - Dreamtechlatestedition.

2.	Toyoto Production System -An integrated approach to Just in Time - Yasuhiro Monden - Engineering and Management Press -Institute of Industrial Engineers Norcross Georgia - 1983.
3.	Lean Thinking - James P. Womack and Daniel T. Jones- Simon & Schuster, Inc, 2003.
Reference Books:	
1.	Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - Richard Schourberger - ASQC Press1991.
2.	Quality Function Development - James Bossert - ASQC Press1991
3.	Lean and Six Sigma - Six Sigma Black Belt (2007 BOK): Enterprise-Wide Deployment Paper Back by Suvabrata Mitra.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	1	2	3	2	2	3	3
CO2	3	2	3	1	3	3	2	3	2	2	3	3
CO3	3	1	3	1	3	1	2	3	2	2	3	3
CO4	3	1	3	1	3	3	2	3	2	2	3	3
CO5	3	3	3	3	3	3	2	3	2	2	3	3

High-3, Medium-2, Low-1

Course Title	CONTROL ENGINEERING	Semester	7
Course Code	MVJ20ME743	**CIE**	50
Total No. of Contact Hours	40 L: T : P :: 3: 0 : 0	**SEE**	50
No. of Contact Hours/week	3	**Total**	100
Credits	3	**Exam. Duration**	3

Course objective is to:

- Mathematical modelling of the mechanical systems using differential equations
- Deduction of Transfer functions using block Diagrams and signal flow graphs
- Emphasize on transient characteristics and response of the systems and Routh - Hurwitz stability criteria
- Analysis of frequency response characteristics of control systems.
- Construction of root locus plots and to ascertain the stability of the control systems

Module-1	RBT Level L1,L2&L3	8 Hrs.

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers-Proportional, Integral, Differential, Proportional & Integral, Proportional Differential and Proportional Integral Differential controllers.

Laboratory Sessions/ Experimental learning:

1. Basics and heated tank: PID standard temperature control of heated tank, No control heated tank

Applications:

2. Traffic light control system
3. Fan with controller

Video link / Additional online information:

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/
3. https://nptel.ac.in/courses/108/101/108101037/
4. https://nptel.ac.in/courses/108/106/108106098/

Module-2	RBT Level L1,L2&L3	8 Hrs.

Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block dia. to obtain closed loop transfer function. Signal flow graphs: Mason's gain formula

Laboratory Sessions/ Experimental learning:

1. Feed forward liquid level control in double tank.

Applications:

2. Liquid level control

Video link / Additional online information:

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/
3. https://nptel.ac.in/courses/108/101/108101037/
4. https://nptel.ac.in/courses/108/106/108106098/

Module-3	RBT Level L1,L2&L4	8 Hrs.

Steady State Response and Transient Response: Transient response and steady state analysis of unit, step input, steady state characteristics, equilibrium in a system Routh's stability criterion for a control system.

Root Locus Plots: Root locus method: Significance of Root locus, angle and magnitude conditions, breakaway points, angles of departure and arrival, construction of Root locus using general rules and steps, Lead and Lag compensation.

Laboratory Sessions/ Experimental learning:

- Step test, Set point weighing

Applications:

- Speed control of DC motor

Video link / Additional online information:

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/
3. https://nptel.ac.in/courses/108/101/108101037/
4. https://nptel.ac.in/courses/108/106/108106098/

Module-4	RBT Level L1,L2&L3	8 Hrs.

Frequency Domain Analysis: Relationship between time and frequency response, Polar plot, Bode's Plot, Nyquist plot and Nyquist stability criterion, Relative Stability, Phase and Gain Margins.

Laboratory Sessions/ Experimental learning:

- . PD control for desired pole placement

Applications:

- Magnetic levitation

Video link / Additional online information:

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/
3. https://nptel.ac.in/courses/108/101/108101037/
4. https://nptel.ac.in/courses/108/106/108106098/

Module-5	RBT Level L1,L2&L3	8 Hrs.

Module - 5 System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system.

Laboratory Sessions/ Experimental learning:

1. Develop motors speed controls as required in industries.

Applications:

2. To analyse the control action on the liquid levels in tanks.

Video link / Additional online information:

1. https://nptel.ac.in/courses/108/106/108106098/
2. https://nptel.ac.in/courses/108/102/108102043/
3. https://nptel.ac.in/courses/108/101/108101037/
4. https://nptel.ac.in/courses/108/106/108106098/

Course outcomes:

CO1	Mathematical modeling of the mechanical systems using differential equations
CO2	Deduction of Transfer functions using block Diagrams and signal flow graphs
CO3	Emphasize on transient characteristics and response of the systems and Routh - Hurwitz stability criteria
CO4	Analysis of frequency response characteristics of control systems.
CO5	Construction of root locus plots and to ascertain the stability of the control systems

Text Books:

1.	"Modern Control Engineering" by K Ogata.
2.	"Automatic Control Systems" by B C Kuo.

Reference Books:

1.	"Modern Control Systems" by R C Dorf and R H Bishop
2.	"Control Systems Engineering" by N S Nise.
3.	"Discrete-time Control Systems" by K Ogata.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	2	1	1	1	1	3
CO2	3	3	2	1	1	1	2	1	1	1	1	2
CO3	3	3	2	1	1	1	2	1	1	1	1	2
CO4	3	3	3	2	1	1	2	1	1	1	1	3
CO5	3	3	3	2	1	1	2	1	1	1	1	3

High-3, Medium-2, Low-1

Course Title	TRIBOLOGY	Semester	VII
Course Code	MVJ20ME744	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3:0:0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	03	Exam. Duration	3hrs

Course objective is to:

- Describe the Lubrication principle and mechanisms.
- Finding the load carrying capacity in light and heavy loaded journal bearings.
- Friction force and power loss Analysis in hydrodynamic and hydrostatic lubrication.
- Identify the appropriate material for bearings based on the application.
- Study the different wear mechanism in tribological components.

Module-1	RBT Level: L1, L2	8 Hrs.

Introduction to Tribology:
Properties of oils and equation of flow: Viscosity, Newton's Law of viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, classification of lubricants.

Laboratory Sessions/ Experimental learning: Finding out the viscosity of different liquids (oils).

Applications: It can be used in bearings, brakes, seals and cams.

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/112102014/

https://www.nptel.ac.in/courses/112102015/

http://www.nptelvideos.in/2012/12/tribology.html

Module-2	RBT Level: L2, L3	8 Hrs.

Hydrodynamic Lubrication:
Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, idealized full journal bearings.

Mechanism of Pressure Development in an Oil Film:
Reynold's investigations, Reynold's equation in two dimensions, Partial journal bearings, end leakages in journal bearing, Numerical problems.

Laboratory Sessions/ Experimental learning: Finding the Friction loss and power loss in journal bearings

Applications: These concepts are used for lubrication purpose for automobile vehicles.

Video link / Additional online information (related to module if any):

https://www.nptel.ac.in/courses/112102015/

https://nptel.ac.in/courses/112/102/112102014/

Module-3	RBT Level : L2, L3	8 Hrs.

Slider / Pad Bearing with a Fixed and Pivoted Shoe:

Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, influence of end leakage, numerical examples.

Laboratory Sessions/ Experimental learning: Study of load carrying capacity in bearings.

Applications: These concepts are used for lubrication purpose for automobile vehicles.

Video link / Additional online information (related to module if any):

http://www.nptelvideos.in/2012/12/tribology.html

https://www.youtube.com/watch?v=hNfgnX2lA18

Module-4	RBT Level : L2, L3,L4	8 Hrs.

Hydrostatic Lubrication:

Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing.

Bearing Materials:

Commonly used bearings materials, properties of typical bearing materials.

Laboratory Sessions/ Experimental learning: Selection of proper of bearing materials according to applications.

Applications: Applied for Nano materials, composite materials.

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/112102014/

https://www.youtube.com/watch?v=HTIzwP8BKC8

Module-5	RBT Level: L2, L4,L5	8 Hrs.

Wear: Introduction, Types of Wear Mechanism: Adhesive Wear- Quantitative Equations-Experimental Evidence- Role of Metallurgical Compatibility-Structural Effects-Grain Boundary Effects, Abrasive Wear(by Plastic Deformation and Fracture)-Abrasive Wear by Plastic Deformation-Quantitative Equation-Effect of Relative Hardness of Abrasive Medium to Workpiece , Fatigue Wear-Rolling Contact.

Fatigue-Static Fatigue, Impact Wear-Solid Particle Erosion- Quantitative Equations- Cavitation Erosion- Percussion, Chemical (Corrosive) Wear- Tribochemical Wear, Fretting and Fretting Corrosion.

Laboratory Sessions/ Experimental learning: Study of Abrasive Wear (by Plastic Deformation and Fracture) and safety measurements

Applications: Applies for wear and tear of different materials, fatigue strength. **Video link / Additional online information (related to module if any):** http://www.nptelvideos.in/2012/12/tribology.html https://ocw.mit.edu/courses/mechanical-engineering/2-800-tribology-fall-2004/lecture-notes/

Course outcomes:	
CO1	Realize and describe the Lubrication principle and mechanisms.
CO2	Compute load carrying capacity in light and heavy loaded journal bearings.
CO3	Analyse the friction force and power loss in hydrodynamic and hydrostatic lubrication.
CO4	Identify the appropriate material for bearings based on the application.
CO5	Recognize the different wear mechanism in tribological components

Text Books:	
1.	Lubrication of Bearings – Theoretical Principles and Design by Redzimovskay E I., Oxford press company 2000
2.	Principles and Applications of Tribology by Moore, Pergamaon press 1998
Reference Books:	
1	Fundamentals of Tribology by Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006 .
2	Introduction to Tribology Bearings by Mujumdar B. C., S. Chand company pvt. Ltd 2008

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	-	-	-	-	-	-	-	1
CO2	3	3	3	2	2	-	-	-	2	-	-	1
CO3	3	3	3	3	3	-	-	-	2	-	-	1
CO4	3	2	2	-	3	-	-	-	2	-	-	1
CO5	3	3	3	-	-	-	-	-	1	-	-	1

High-3, Medium-2, Low-1

Course Title	ENERGY ENGINEERING	Semester	VII
Course Code	MVJ20ME751	**CIE**	50
Total No. of Contact Hours	40 L : T : P : 3:0:0	**SEE**	50
No. of Contact Hours/week	04	**Total**	100
Credits	03	**Exam. Duration**	3 Hours

Course objective is to:

- Understand energy scenario, energy sources and their utilization
- Learn about energy conversion methods
- Study the principles of renewable energy conversion systems

Module-1	RBT LEVEL L1, L2	08 Hrs

Steam Generators: Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, LaMount, Benson, Velox, Loeffer, Schmidt steam generators, Cooling towers and Ponds, Accessories such as Superheaters, De-superheater, Economizers, Air preheaters.

Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.

Laboratory Sessions/ Experiential learning:

- Making the model of La Mount, Benson, Velvox, Loeffer steam generators.

Applications: Electricity can be produced from Steam and Geothermal energy.

Video link: https://nptel.ac.in/courses/112/107/112107291/
https://www.youtube.com/watch?v=ZTKCSjIAZyo
https://www.youtube.com/watch?v=txoEqwSxUrQ
https://www.youtube.com/watch?v=mCRDf7QxjDk

Module-2	RBT LEVEL L1, L2, L3	08 Hrs

Solar Radiation: Extra-terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam and global radiation, solar radiation data

Solar Radiation Measurement: Pyranometer, shading ring, Pyrheliometer, sunshine recorder, schematic diagrams and principles of working. (no numericals)

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent motion of sun, day length and numerical examples

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid), sensible heat storage, latent heat storage, application of solar energy water heating. Solar heating and cooling, active and passive systems, power generation, refrigeration. Distillation, solar pond, principle of working, operational problems, Solar cells and its applications

Laboratory Sessions/ Experiential learning:

- Studying of Solar collectors.

Applications: Solar cells are used for heating the water.

Video link: https://nptel.ac.in/courses/103/103/103103206/
https://nptel.ac.in/courses/112/105/112105050/
https://www.youtube.com/watch?v=ucBP1cADTgI
https://www.youtube.com/watch?v=rg1x4jJmSl4

Module-3	RBT LEVEL L1, L2, L3	08 Hrs

Tidal Energy: Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy.

Wind Energy: Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.

Biomass Energy: Photosynthesis, photosynthetic oxygen production, energy plantation. Bio Chemical Route: Biogas production from organic wastes by anaerobic fermentation, Bio gas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft gasifiers.

Laboratory Sessions/ Experiential learning:

- Making the model of Tidal energy, Wind energy and Biomass energy plant.

Applications: Electricity can be produced from Tidal energy, Wind energy and Biomass energy.

Video link: https://nptel.ac.in/courses/103/103/103103206/
https://www.youtube.com/watch?v=qSWm_nprfqE
https://www.youtube.com/watch?v=m7ImT4CdcPo
https://www.youtube.com/watch?v=7AlxnCIyHG4

Module-4	RBT LEVEL L1, L2, L3	08 Hrs

Hydroelectric plants: Advantages & disadvantages of water power, Hydrographs and flow duration curves, numericals, Storage and pondage, General layout of hydel power plants-components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer.

Ocean Thermal Energy: Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems associated with OTEC.

Laboratory Sessions/ Experiential learning:

- Making the model of Hydroelectric and Ocean Power plant.

Applications: Electricity can be produced from Hydroelectric and Ocean Thermal energy.

Video link: https://nptel.ac.in/courses/112/107/112107291/

https://www.youtube.com/watch?v=OC8Lbyeyh-E

https://www.youtube.com/watch?v=_c9tBOjny28

https://www.youtube.com/watch?v=IASV8IH-ytE

Module-5	RBT LEVEL L1, L2, L3	08 Hrs

Nuclear Energy Principles of release of nuclear energy-Fusion and fission reactions. Nuclear fuels used in the reactors, Chain reaction, Moderation, breeding, Multiplication and thermal utilization factors. General components of a nuclear reactor and materials,

Hydrogen Energy: properties of Hydrogen with respect to its utilization as a renewable form of energy sources, production of hydrogen, electrolysis of water, thermal decomposition of water, thermos chemical production and bio-chemical production.

Laboratory Sessions/ Experiential learning:

- Making Model of Nuclear power plant

Applications: Nuclear power plants are used for producing the Electricity.

Video link: https://nptel.ac.in/courses/112/101/112101007/

https://youtu.be/_BbUOAjGpzw

https://www.youtube.com/watch?v=_UwexvaCMWA&t=86s

https://www.youtube.com/watch?v=a4pXAmljdUA

Course outcomes:

CO1	Understand the construction and working of steam generators and their accessories and Discuss characteristics of geothermal energy
CO2	Analyse solar energy with the help of solar radiation measuring instruments and Explain the angles related to solar radiation geometry and design solar collectors for harnessing solar energy.
CO3	Explain different types of wind mills and their design principles. Compute coefficient of performance of wind mill. Discuss characteristics of tidal energy, Bio mass energy.
CO4	Discuss characteristics of Hydro electric plants, ocean thermal energy
CO5	Discuss characteristics of Nuclear energy and Describe the methods of production of hydrogen for utilization as a renewable form of source of energy.

Text Books:	
1.	**Power Plant Engineering by P. K. Nag** Tata McGraw Hill Education Private Limited, New Delhi, Third Edition, 2012
2.	**Power Plant Engineering Arora and Domkundwar ,Dhanpat Rai & Co**. (P) Ltd. Sixth Edition, 2012.
3.	**Non-conventional Sources of Energy, G.D. Rai, Khanna** Publishers, New Delhi, Fifth Edition, 2015
Reference Books:	
1.	**Non-conventional energy resources, B H Khan**, McGraw Hill Education 3rd Edition
2.	**Principles of Energy conversion,A. W. Culp Jr** McGraw Hill 1996
3.	**Power Plant Technology M.M. EL-Wakil** McGraw Hill International 1994
4.	**Subhas P.Sukhatme, J K Nayak, "Solar energy",** Tata Mc Graw Hill,India 3rd Edition. 2009, ISBN: 9780070142961
5.	**John W.Twidell, Tony Weir, "Renewable energy resources" , Routledge**, 4th edition, 2014, ISBN:9780415633581

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	1	2	1	-	-	-	-	-
CO2	3	3	2	-	-	-	1	-	-	-	-	2
CO3	3	1	-	-	-	-	1	-	-	3	-	2
CO4	3	1	-	-	-	-	1	-	-	3	-	2
CO5	-	-	-	-	-	-	2	-	-	3	-	2

High-3, Medium-2, Low-1

Course Title	SMART MATERIALS AND MEMS	Semester	VII
Course Code	MVJ20ME752	CIE	50
Total No. of Contact Hours	40 L: T : P :: 3 : 0 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	3 Hrs

Course objective is to:

- This course provides a detailed overview to smart materials, piezoelectric materials structures and its characteristics.
- The study of Smart structures and Modelling helps in Vibration control using smart materials in various applications. Helps to understand the principles and concepts of using MEMS, ER& MR Fluids for various applications.

Module-1	RBT Level L1,L2	08 Hrs.

Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect- Application, Processing and characteristics.

Shape Memory Alloys: Introduction, Phenomenology, and Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators.

Laboratory Sessions/ Experimental learning:

- Fabrication Inchworm motors, Different shape memory alloys materials test in different temperature.

Applications: Dental Implants,

Video link / Additional online information:

https://www.youtube.com/watch?v=YJ0WWW0AoUk

Module-2	RBT Level L1,L2	08 Hrs.

Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).

Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements. –

Laboratory Sessions/ Experimental learning:

- ER and MR fluid test and Optical fiber testing.

Applications: Communication industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=KK_h3-BucR0
2. https://www.youtube.com/watch?v=VS5xy9-av1c
3. https://www.youtube.com/watch?v=-ap00IUJm7k&list=PLFW6lRTa1g83YaqmM9r2MAAiJVY93bOP7

Module-3	RBT Level L1,L2	08 Hrs.

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers.

Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations.

Biomimetics: Characteristics of Natural structures. Fibre reinforced: organic matrix natural composites, Natural creamers, Mollusks. Biomimetic sensing, Challenges and opportunities.

Laboratory Sessions/ Experimental learning:

- Parallel damping test, Vibration analysis using gyroscope. Identification of biomimetic structure in our surroundings.

Applications: Civil Construction industry.

Video link / Additional online information:

1. https://www.youtube.com/watch?v=WopxFu1jwpM
2. https://www.youtube.com/watch?v=AEWqAcSeQm4

Module-4	RBT Level L2,L3,L4	08 Hrs.

MEMS: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Micro fabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow, Silicon based, Process selection and design.

Piezoelectric Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications.

Magnetic Actuation: Concepts and Principles, Magnetization and Nomenclatures, Fabrication and case studies, Comparison of major sensing and actuation methods

Laboratory Sessions/ Experimental learning:

- Different models to be created using piezoelectric materials.

Applications: All type of Sensors manufacturing industry,

Video link / Additional online information:

https://www.youtube.com/watch?v=j9y0gfN9WMg&list=PLWzzOF0m-O4isgM-VSVm-73wyLHaB49bB

Module-5	RBT Level L2,L3	08 Hrs.

Polymer MEM S& Microfluidics: Introduction, Polymers in MEMS (Polyimide, SU-8, LCP, PDMS, PMMA, Parylene, Others) Applications (Acceleration, Pressure, Flow, Tactile sensors). Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves.

Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition.

Laboratory Sessions/ Experimental learning:

- Different Sensors Assembly or fabrication.

Applications: Automotive industry, Robotics, Health care industry.

Video link / Additional online information:

https://www.youtube.com/watch?v=nE1C4ghfvac&list=PLgMDNELGJ1CbufZjqWa8uoSlQWKqVwPN7

Course outcomes:	
CO1	Describe the methods of controlling vibration using smart systems and fabrication methods of MEMS.
CO2	Explain the principle concepts of Smart materials, structures, Fibre optics, ER & MR Fluids, Biomimetics and MEMS with principles of working.
CO3	Analyze the properties of smart structures, MEMS, with the applications and select suitable procedure for fabrication.
CO4	Summarize the methods and uses of Micro fabrications, Biomimetics, types of polymers used in MEMS, Fibre optics, piezoelectric sensing and actuation.

Text Books:	
1.	A.V.Srinivasan, "*Smart Structures –Analysis and Design*", Cambridge University Press, New York, 2001, (ISBN: 0521650267).
2.	M.V.Gandhi and B.S.Thompson, "*Smart Materials and Structures*", Chapmen & Hall, London, 1992 (ISBN:0412370107)
Reference Books:	
1.	Chang Liu, "*Foundation of MEMS*", Pearson Education. (ISBN:9788131764756)

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	1	-	-	-	1	1	-	2
CO2	3	3	1	2	2	-	-	-	1	1	-	2
CO3	3	3	1	2	3	-	-	-	1	1	-	2
CO4	3	3	1	2	3	-	-	-	1	1	-	2

High-3, Medium-2, Low-1

Course Title	OPERATIONS RESEARCH	Semester	VII
Course Code	MVJ20ME753	CIE	50
Total No. of Contact Hours	40 L: T : P :: 3: 0 : 0	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	03	Exam. Duration	03 hrs

Course objective is to:

- To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
- To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and Machinery.

Module-1	RBT Level L1, L2, L3	8 Hrs.

Introduction:

Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Laboratory Sessions/ Experimental learning: Case Studies for formulation of LLP to know the statistics for daily marketing of newspaper, banking sector, different firms.

Applications: Formulation can be used in agriculture, financial sector, marketing.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/111107128/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-2	RBT Level L2, L4	8 Hrs.

Linear Programming Problems:

Simplex method, Canonical and Standard form of LPP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Laboratory Sessions/ Experimental learning: Case Studies for formulation of LLP to utilize minimum resources available to achieve the target for different sectors like supply chain management, marketing.

Applications: LPP can be used in defense, industries sectors and hospitals.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/112106134/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-3	RBT Level L2, L3, L4	8 Hrs.

Transportation Problem:

Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem.

Assignment Problem:

Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems

Laboratory Sessions/ Experimental learning: Case Studies for different transportation system to obtain best optimal distance to reach the target.

Applications: These methods can be used in transportation of goods and any other services.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/111107128/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-4	RBT Level L1, L2, L4	8 Hrs.

Network analysis:

Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Numerical Problems.

Queuing Theory:

Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

Laboratory Sessions/ Experimental learning: Building a different network activity for financial and marketing projects management.

Applications: Network and Queuing methods can be adopted in completing various projects within the given deadline to earn the profit and minimize the loss.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/110106062/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Module-5	RBT Level L2, L3,L5	08 Hrs.

Game Theory:

Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2xN and Mx2 games by graphical method. Formulation of games.

Sequencing:

Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.

Laboratory Sessions/ Experimental learning: Collecting the statistical data to develop the project using Game theory and Sequencing.

Applications: These methods give the perfect results of any production of machines.

Video link / Additional online information (related to module if any):

http://nptel.ac.in/courses/112106131/

https://nptel.ac.in/courses/112/106/112106134/

https://nptel.ac.in/courses/111/107/111107128/

https://nptel.ac.in/courses/110/104/110104063/

Course Outcomes:	
CO1	Understand the meaning, definitions, scope, need, phases and techniques of operations research.
CO2	Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.

CO3	Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.
CO4	Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks. Solve waiting line problems for M/M/1 and M/M/K queuing models.
CO5	Solve problems on game theory for pure and mixed strategy under competitive environment. Determine minimum processing times for sequencing for different n jobs and m machines using Johnson's algorithm.

Text Books:	
1.	Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications Pvt. Ltd. 2016.
2.	Operations Research, P K Gupta and D S Hira, S. Chand and Company LTD. Publications, New Delhi – 2007.
Reference Books:	
1	Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006
2	Operations Research, Paneerselvan, PHI

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	-	-	-	2	-	1	-	1
CO2	3	3	3	1	-	-	-	2	-	1	-	2
CO3	3	3	3	1	-	-	-	2	-	1	-	2
CO4	3	3	3	1	-	-	-	2	-	2	-	2
CO5	2	3	3	2	-	-	-	2	-	1	-	2

High-3, Medium-2, Low-1

Course Title	DESIGN LAB	Semester	7
Course Code	MVJ20MEL76	**CIE**	50
Total No. of Contact Hours	20 L: T: P: 0: 1: 3	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	03

Course Learning Objectives:

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.

Sl. No	Experiments
	PART A
1	Experimental studies of Single Degree of Freedom Vibrating systems.
2	Experiment on Governors – Porter/Proell/Hartnell to find the equilibrium speed, sensitiveness, power and effort.
3	Experiment on the balancing of rotating masses.
4	Experiment on rotating shafts to find the critical speed.
5	Demonstration of writing of codes in MATLAB/PYTHON to find the natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems.
	PART B
6	Experiment on Photo-elastic materials for the determination of the fringe constant using. a) Circular disc subjected to diametral compression. b) Pure bending specimen.
7	Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook
8	Experiment on Journal bearing to find the pressure distribution.
9	Determination of Principal Stresses and strains in a member subjected to combined loading using Strain

10	Determination of stresses in Curved beam using strain gauge.
11	Static structural analysis of a curved beam in ANSYS Workbench to determine the deformation, stresses and strains. (Von mises/Principal Stresses/Strains and total deformation)
Course outcomes:	
CO1	Determine the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.
CO2	Carry out balancing of rotating masses.
CO3	Characterize the performance of governors.
CO4	Determine stresses in disk, beams, plates and hook using photo elastic bench.
CO5	Determination of Pressure distribution in Journal bearing
CO6	Analyse the stress and strains using strain gauges and write the programs.

Reference Books:	
1.	Shigley's Mechanical Engineering Design, Richard G. Budynas, and J.Keith Nisbett, McGraw-Hill Education, 10th edition, 2015.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 20 marks
2.	One question is to be set from Part-B: 20 Marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	1	1	2	1	1	1	1
CO2	3	3	3	1	1	1	1	2	1	1	2	2
CO3	3	3	3	1	1	1	1	2	1	1	2	2
CO4	3	3	3	1	1	2	2	2	2	2	2	2
CO5	2	3	3	2	1	1	1	2	1	1	2	2

High-3, Medium-2, Low-1

Course Title	CIM LAB	Semester	7
Course Code	MVJ20MEL77	**CIE**	50
Total No. of Contact Hours	20 L: T: P: 0: 1: 3	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	03

Course Learning Objectives:

- To introduce students to the concepts of computer integrated manufacturing.
- To expose students to CNC part programming.
- To make the students understand the importance of automation in industries.
- To expose students to FMS, Robotics, and Hydraulics and Pneumatics.
- To introduce students to modelling and design for manufacturing using Autodesk Fusion 360.

Sl. No	Experiments
	PART A
1	Introduction to G Codes, M Codes and CNC Turning and Milling Machines.
2	CNC manual Part programming for turning operations.
3	Simulation of Turning operations using CAM Software.
4	Demonstration of turning operations using CNC part programs on MTAB NC Turn Machine.
	PART B
5	CNC manual Part programming for milling operations.
6	Simulation of Milling operations using CAM Software packages
7	Demonstration of Milling operations using CNC part programs on MTAB NC Mill Machine.
8	Robot Programming – Pick and Place and Stacking programming – Demonstration.
	PART C (OPTIONAL)
9	Modelling and Design for Mechanical Engineers using the modelling software available.
10	Basic Study of Pneumatics, Hydraulics and Electro pneumatics.

Course outcomes:

CO1	Write the CNC Programs for turning and milling.
CO2	Carry out machining of the components using CNC programs.
CO3	Program the robots for simple operations.
CO4	Carryout the post processing of CNC programs on control systems.
CO5	Carryout the modelling and design for new age manufacturing systems.

Reference Books:	
1.	Mikell P Groover, Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Learning, 4th edition, 2015.
Scheme of Examination: As per the MVJCE Autonomous Regulations, Semester End Examination (SEE) is to be conducted and evaluated for 100 marks which will be proportionately reduced and considered for 50 marks by the Grading authority.	
1.	One question is to be set from Part-A: 20 Marks
2.	One question is to be set from Part-B: 20 Marks
3.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	2	1	1	1	1	3
CO2	3	3	2	1	1	1	2	1	1	1	1	2
CO3	3	3	2	1	1	1	2	1	1	1	1	2
CO4	3	3	3	2	1	1	2	1	1	1	1	3
CO5	3	3	3	2	1	1	2	1	1	1	1	3

High-3, Medium-2, Low-1

Photoelastic apparatus in Design Lab for Experimental Stress Analysis

MTAB XLTURN – Turning Centre and XLMILL – Milling Centre in CIM Lab

Course Title	PROJECT PHASE-1	**Semester**	VII
Course Code	MVJ20MEP78	**CIE**	50
Total No. of Contact Hours	-	**SEE**	-
No. of Contact Hours/week	-	**Total**	50
Credits	02	**Exam. Duration**	-

Course Learning Objectives:

- To facilitate the students learn and apply an engineering design process in mechanical engineering, including project resource management.
- To test their learned theory knowledge in an actual working situation.
- To provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem

Sl. No	PHASES FOR PROJECT WORK
1	Introduction to the project area.
2	Extensive literature survey.
3	List of proposed objectives.
4	Proposed Methodology.
5	Time estimation for completing the project.
Course outcomes:	
CO1	Literature gap determination and definition of the problem.
CO2	Evaluate the various validation and verification methods.
CO3	Scientific Design / Numerical Analysis / Analytical model and interpret them.
CO4	Apply tools / techniques for problem solving and prepare project work.

Reference Books:	
1.	**C. R. Kothari,** "***Research Methodology: Methods and Techniques***", New Age International (P) Limited, Second Edition, 2004.
2.	**Ranjit Kumar,** "***Research Methodology: A step-by step guide for beginners***", SAGE Publications Ltd, Third Edition, 2011
Scheme of Examination:	
1.	Introduction and Problem Definition: 10 marks
2.	Literature survey: 10 marks
3.	Project objectives and methodology: 10 marks
4.	Presentation: 10 marks
5.	Viva – Voce: 10 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	2	1	1	1	1	3
CO2	3	3	2	1	1	1	2	1	1	1	1	2
CO3	3	3	2	1	1	1	2	1	1	1	1	2
CO4	3	3	3	2	1	1	2	1	1	1	1	3
CO5	3	3	3	2	1	1	2	1	1	1	1	3

High-3, Medium-2, Low-1

Course Title	BIG DATA ANALYTICS	Semester	VII
Course Code	CERTIFICATE COURSE	CIE	--
Total No. of Contact Hours	30	SEE	--
No. of Contact Hours/week	03	Total	--
Credits	02	Exam. Duration	--

Course objective is to:

- Introduce the concepts of Big Data Analytics and perform basic Hadoop Administration.
- Expose the students to Data warehousing and Visualization in decision making.
- Introduce the concepts of core data mining techniques for data analytics.

Module-1	RBT Level L1,L2,L3	6 Hrs.

Introduction

Introduction to big data, data & Information, Challenges, Technologies, Application, Future Scope, Need for storing the data.

Hadoop – Introduction, Distributed file system, Map reduce programming model, Hadoop ecosystem, HDFS commands

Laboratory Sessions/ Experimental learning: Students will be exposed to Hadoop ecosystem and HDFS commands through hands on experience.

Applications: Data analytics and big data

Video links: https://www.youtube.com/watch?v=iANBytZ26MI

Module-2	RBT Level L1,L2,L3	6 Hrs.

HBase

Introduction, Model, Operations, HBase vs RDBMS, Command, Examples.

Map reduce

Introduction, Simple map, Map function, Reduce function, Grouping, Mapper, Reducer, Example

Laboratory Sessions/ Experimental learning: Students will be exposed to HBase, Commands and examples and will be exposed to Map reduce functions.

Applications: HBase is used for storing the data and running the map functions.

Video links: https://nptel.ac.in/courses/112105123/4

Module-3	RBT Level L1,L2,L3	6 Hrs.

Apache MapReduce

Components, Programming model, Configuring and MapReduce Jobs in IDE

Hive

Introduction, Data types, File formats, Views, Indexes

Laboratory Sessions/ Experimental learning: Students will be exposed to Apache MapReduce and MapReduce Jobs in IDE and Hive through real time examples. **Applications:** Process the vast amount of data. **Video links:** https://www.youtube.com/watch?v=mafw2-CVYnA		
Module-4	**RBT Level L1,L2,L4**	**6 Hrs.**
Pig Latin – Introduction, Grunt shell, Command, Data model **Sqoop** – Introduction, Import data, Query import, Export data **Laboratory Sessions/ Experimental learning:** Students will be exposed to data modeling and export of data through real time examples. **Applications:** Data modeling and exporting the data. **Video links:** https://www.youtube.com/watch?v=_nmYqkk-n9A		
Module-5	**RBT Level L3,L4,L5**	**6 Hrs.**
Oozie – Introduction, Oozie architecture, Oozie action nodes **NoSQL** – Introduction, Storage architecture, Operation, Modifying Data stores, Indexing, Transaction, Parallel processing **Laboratory Sessions/ Experimental learning:** Students will be exposed to data indexing, transaction and parallel processing through hands on sessions. **Applications:** Data indexing, transaction and parallel processing. **Video links:** https://www.youtube.com/watch?v=0buKQHokLK8		

Course outcomes:	
CO1	Explain the concepts of HDFS and MapReduce framework.
CO2	Recognize the role of basic data tools for big data analytics.
CO3	Infer the importance of core data mining techniques for data analytics
CO4	Recognize the role of Business Intelligence, Data warehousing and Visualization in decision making
CO5	Compare and contrast different Text Mining Techniques

Reference Books:	
1.	Anil Maheshwari, "Data Analytics", 1st Edition, McGraw Hill Education, 2017. ISBN-13: 978-9352604180.
2.	Douglas Eadline,"Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1stEdition, Pearson Education, 2016. ISBN-13: 978-9332570351.
3.	Eric Sammer,"Hadoop Operations: A Guide for Developers and Administrators",1stEdition, O'Reilly Media, 2012.ISBN-13: 978-9350239261.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	2	-	-	-	2	1	1	1
CO2	3	3	1	2	2	1	-	-	2	1	1	1
CO3	3	3	2	3	3	1	-	-	2	1	2	1
CO4	3	3	2	3	3	1	1	-	2	1	2	2
CO5	3	3	3	3	2	2	2	-	3	2	3	3

High-3, Medium-2, Low-1

Scheme for VIII Semester B.E. (Mechanical Engineering)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1.	Proj	MVJ20MEP81	Project Phase-2	ME				3	50	50	100	8
2.	Int	MVJ20MEI82	Internship	ME				3	50	50	100	3
3.	Sem	MVJ20MES83	Seminar	ME				3	50	50	100	1
4.	CRT	MVJ20MEC84	Certification	Industry/Institute								2
				Total	-	-	-	9	150	150	300	14

Note: 1. PCC: Professional Core Course , PE: Professional Elective, OE: Open Elective, Proj: Project Work, Int.: Internship, Sem : Seminar, CRT: Certification Course (Can be carried out during the program period but same will reflect in the final semester grade card).

2. The certification course of a minimum duration of 30 hours completed by the students will be considered for 2 credits, and reflected in VIII semester.

Course Title	PROJECT PHASE-2	Semester	VIII
Course Code	MVJ20MEP81	CIE	50
Total No. of Contact Hours	-	SEE	50
No. of Contact Hours/week	-	Total	100
Credits	8	Exam. Duration	03 Hrs

Course Learning Objectives:

- To provide an opportunity and atmosphere in which students may test theory learned in the classroom in an actual working situation and discover the value of work and the rewards of accomplishment.
- As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills.
- To provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

Sl. No	PHASES FOR PROJECT WORK
1	Introduction and Problem Definition
2	Summary of literature survey
3	Formulation of revised project objectives
4	Proposed Methodology and implementation
5	Results and discussion
6	Project report documentation
7	Oral presentation

Course outcomes:	
CO1	Perform literature review on par with international journal standards
CO2	Identify literature gap and define the problem.
CO3	Design experiments scientifically/perform numerical analysis/develop analytical models and interpret the results and apply advanced tools/techniques for solving the problem.
CO4	Compile the results, discuss the findings and draw the conclusions for the project.
CO5	Prepare quality document of project work.

Reference Books:

1. J. P. Holman, "*Experimental Methods For Engineers*", McGraw-Hill Companies, Eighth edition, 2012.
2. Prasanna Chandra, "*Projects- Appraisal, Preparation, Budgeting and Implementation*", McGraw-Hill Companies, 1987.

Scheme of Examination:

1.	Relevance of the topic: 10 marks
2.	Report: 20 marks
3.	Evaluation by Guide: 25 marks
4.	Presentation: 30 marks
5.	Viva – Voce: 15 marks

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	2	1	1	1	2	2	2
CO2	2	2	2	2	3	2	1	1	1	2	2	2
CO3	2	2	2	3	3	2	1	1	1	2	2	2
CO4	2	2	2	3	3	2	2	1	1	2	2	2
CO5	2	2	3	3	3	2	2	1	1	2	2	2

High-3, Medium-2, Low-1

Course Title	INTERNSHIP	Semester	08
Course Code	MVJ20MEI82	CIE	50
Total No. of Contact Hours	-	SEE	50
No. of Contact Hours/week	-	Total	100
Credits	03	Exam. Duration	3hrs

Course objective is to:

- Get an inside view of an industry and organization/company
- Gain valuable skills and knowledge
- Make professional connections and enhance student's network
- Get experience in a field to allow the student to make a career transit

Guidelines

1. Students have to undergo this training for a period of 6 weeks (minimum) during the vacation between even and odd semesters of II and III year or III and IV year.
2. Those students who are unable to complete during these periods will have to undergo the internship after VIII semester and VIII semester grade card will be issued only after the successful completion of internship by that student
3. The department shall nominate a faculty as a mentor for a group of students to prepare and monitor the progress of the students
4. The students shall report the progress of the internship to the mentor/guide at regular intervals and may seek his/her advice.
5. After completion of Internship, students shall submit a report to the department with the approval of both internal and external guides/mentors.
6. Evaluation of Internship shall be conducted during VIII semester by internal and external examiners for 100 marks.
7. The external examiner shall be from the industry where the student carried out the internship. In case of non-availability of external examiner, the concerned head of the department shall appoint an external examiner from the nearby college or a senior faculty member from outside the department in consultation with respective BOE and approved by Principal
8. The internship carries three credits. A student has to get a minimum of 40% marks for a pass. If the student fails to complete the same then internship has to be repeated in its entirely
9. The breakup of marks for the evaluation of training is as in table.

Evaluation by the supervisor under whom the training was carried out	25 marks
Evaluation by DSEC	
i. Relevance of the Field training/Industrial Internship	10 marks
ii. Report	25 marks
iii. Evaluation	40 marks
Total	100 marks

Course outcomes:

CO1	To experience a 30 days' internship training, enabling the student for onsite visits, study projects and practical training.
CO2	To develop a skill for handling multiple situations, practical problems, analysing team work and communication abilities
CO3	To integrate theory with practice and carry out performance objectives on strong work ethics, persistence, adaptability and critical
CO4	To analyse work environment and create solution to problems.
CO5	To build a record of work experience and construct a good relationship with the employers.

Reference Books:

1.	T1.Pamela Myers Kiser, "Human Services Internship: Getting the Most From Your Experience", Cengage Learning, 4th Edition, 2016. (ISBN13: 978-1305087347)
2.	T3.H. Frederick Sweitzer, "Successful Internship", Brooks/Cole Publishing Co., 5th Edition, 2019.
3.	R1. Bill Hobbs, Zach Schleien, "Hacking the Internship Process (Work)", La Plata Press, Paperback, 2017.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	3	2	1	1	1	2	2	2
CO2	2	2	2	2	3	2	1	1	1	2	2	2
CO3	2	2	2	3	3	2	1	1	1	2	2	2
CO4	2	2	2	3	3	2	2	1	1	2	2	2
CO5	2	2	3	3	3	2	2	1	1	2	2	2

High-3, Medium-2, Low-1

Course Title	SEMINAR	Semester	VI
Course Code	MVJ20MES83	**CIE**	50
Total No. of Contact Hours	-	**SEE**	50
No. of Contact Hours/week	-	**Total**	100
Credits	01	**Exam. Duration**	03 hrs

Course Objectives is to:

1. To equip students for making a technical presentation based on a thorough research review on any contemporary area of Engineering and Management fields.
2. Offering the student an opportunity to interact with faculty and peer group and to build the ability to making independent presentation.

STAGES OF SUBJECT SEMINAR

i) Identification of seminar topic related to area of interest in the field of advanced Mechanical Engineering.

ii) Case studies related to selected topics.

iii) Final seminar will start from 6th week of the semester in the department before the Departmental Evaluation Committee constituted by HOD.

iv) The seminar marks are to be awarded by the committee.

v) Students shall submit the seminar report in the prescribed standard format.

COURSE OUTCOMES: On completion of the course, student should be able to:

CO1: Conduct literature survey on a current topic based on peer reviewed literature and identify research gap in the literature

CO2: Develop methodologies to resolve the identified problem(s)

CO3: Develop presentation slides / report arranging the material coherently and discuss the topic with clarity and confidence.

CO4: Summarize the presentation, submit the report and identify scope for further work.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	3	3	2	3	3	3	3	3
CO2	3	3	2	3	3	3	2	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	2	1	3	3	3	3	3	3	3	3

High-3, Medium-2, Low-1

SCHEME OF EVALUATION				
	MARKS ALLOTED			
PARTICULARS	MAX MARKS	EVALUATOR 1	EVALUATOR 2	AVERAGE
Report	15			
Relevance of topic with the program	10			
Oral presentation & Etiquette	15			
Viva Voce	10			
TOTAL	50			

Note: All the students are required to be present for the presentations given by individual students.