Semester III (Department of 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	MVJ19MAT31	Transforms and Statistical Methods	Mathematics	2	2	0	3	50	50	100	3
2	PCC	MVJ19ME32	Mechanics of Materials	ME	3	2	0	3	50	50	100	4
3	PCC	MVJ19ME33	Thermodynamics	ME	2	2	0	3	50	50	100	3
4	PCC	MVJ19ME34	Materials Engineering	ME	3	0	0	3	50	50	100	3
5	PCC	MVJ19ME35	Manufacturing Process	ME	3	0	0	3	50	50	100	3
6	PCC	MVJ19ME36	Machine Drawing	ME	2	0	2	3	50	50	100	3
7	PCC	MVJ19MEL37	Mechanics and Materials Testing-Lab	ME	0	1	3	3	50	50	100	2
8	PCC	MVJ19MEL38	Foundry, Forging and welding-Lab	ME	0	1	3	3	50	50	100	2
9	HSMC	MVJ19KAN39	Kannada	Humanities	1	0	0	3	50	50	100	1
		MVJ19CPH39	CPH		1	0	0	3	50	50		
10	BSC	MVJ19MATDIP 301	Additional Mathematics-1	Mathematics	1	0	0	3	50	50	100	-
				Total	17	8	8	30	500	500	1000	24

Note: BSC: Basic Science, PCC: Professional Core Course , HSMC: Humanity and Social Science
MVJ19MXXDIP301- Mandatory non-credit course

Course Title	TRANSFORMS AND STATISTICAL METHODS	Semester	III
Course Code	MVJ19MAT31	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/week	05	**Total**	100
Credits	03	**Exam. Duration**	3 hrs

Course objective is to:

- Comprehend and use of analytical and numerical methods in different engineering fields.
- Apprehend and apply Fourier series.
- Realize and use of Fourier transforms and Z-Transforms.
- Use of statistical methods in curve fitting applications.
- Use of numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variation.

Module-1	**RBT Level** L1,L2,L3	12 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:

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

Module-2	**RBT Level** L1,L2,L3	12 Hrs.

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

Web Link and Video Lectures:

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

Module-3	RBT Level L1,L2,L3	12 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:

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

Module-4	RBT Level L1,L2,L3	12 Hrs.

Z-Transforms: Difference Equations, Z-Transforms, Standard Z-transforms, Initial-value and Final-value theorems. Inverse Z-transforms.

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

Web Link and Video Lectures:

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

Module-5	RBT Level L1,L2,L3	12 Hrs.

Curve Fitting: Curve fitting by the method of least squares. Fitting of the curves of the form $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$. Linear Programming problem – Formulation and solution by Simplex method.

Statistical Methods: Introduction, Correlation and coefficient of co relation, Regression, line of regression problems.

Web Link and Video Lectures:

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

Course outcomes:

CO1	Use Laplace transform and inverse transforms techniques in solving differential equations.
CO2	Demonstrate Fourier Transform as a tool for solving Integral equations.

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.

Reference Books:	
1.	**B.S. Grewal, *"Higher Engineering Mathematics*"** Khanna Publishers, 43rd Edition, 2013.
2.	**Erwin Kreyszig, *"Advanced Engineering Mathematics*"**, Wiley-India publishers, 10th edition,2014.
3	**Ramana B. V., *"Higher Engineering Mathematics*"**, Tata Mc Graw-Hill, 2006.
4	**Bali N. P. & Manish Goyal, *"A text book of Engineering Mathematics*"**, Laxmi Publications, 8th Edition.
5	**Jain R. K. & Iyengar S.R.K., *"Advanced Engineering Mathematics"***, Narosa Publishing House, 2002.

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	MVJ19ME32	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 10 : 10	**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	12 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	12 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	12 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	12 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	12 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 able to apply mathematical knowledge to calculate the deformation behavior of simple structures.
CO2	Critically analyse problem and solve the problems related to mechanical elements and analyse the deformation behavior 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.

Reference Books:

1	**Popov E P, "*Mechanics of Materials*"**, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.
2	**Hearn E J, "*Mechanics of Materials*"**, Vol. I, Pergamon Press, 1977.
3	**Bedi D S, "*Strength of Materials*"**, S Chand and Co. Ltd., New Delhi, 1984.
4	**Ramamrutham S and Narayan R, "*Strength of Materials*"**, Dhanpat Rai and Sons, New Delhi, 1997.
5	**Singh D K, "*Strength of Materials*"**, ANE Books, 2007.
6	**Jindal U C, "*Textbook on Strength of Materials*"**, Asian Books Pvt. Ltd., 2007.

7	**Don H Morris, William F Riley and Leroy D Sturges, *"Mechanics of Materials*"**, John Wiley and Sons Inc., Fifth Edition, 2001.
8	**Lord Chilver and John Case, *"Strength of Materials and Structures*"**, Arnold, Fourth Edition, 1999.
	WebLinks:
1	https://nptel.ac.in/courses/112107146/
2	https://www.brcmcet.edu.in/strength-of-materials-lab.html
3	https://web.mit.edu/course/3/3.225/book.pdf

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	MVJ19ME33	**CIE**	50
Total No. of Contact Hours	60 L: T : P :: 40 : 10 : 10	**SEE**	50
No. of Contact Hours/week	05	**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	14 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 / Additional online information:

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

Module-2	**RBT Level** L1,L2,L3	10 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 / Additional online information:

1. https://www.youtube.com/watch?v=1OFlW8OXN64
2. https://nptel.ac.in/courses/112104113/

Module-3	**RBT Level** L1,L2,L3	12 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 . Clasius's statement of Second law of Thermodynamic; Equivalence of the two statements; Reversible and irreversible processes; factors that make a process .irreversible, reversible heat engines, Carnot cycle, Carnot principles. Thermodynamic temperature scale.

Applications: Refrigerator, Heat Pump, Heat Engines etc

Video link / Additional online information:

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

Module-4	**RBT Level** L1,L2,L3	12 hrs

Entropy: Clasius 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 / Additional online information:

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	12 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 / Additional online information:
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

Reference Books:	
1	**T R Sitaraman**, " ***Basic Thermodynamics***", Interline Publishing
2	**Nag P.K. "*Basic & Applied Thermodynamics*".** Tata McGraw Hill Pub. Co, 2nd edition
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

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	MVJ19ME34	**CIE**	50
Total No. of Contact Hours	60 L : T : P :: 40 : 10 : 10	**SEE**	50
No. of Contact Hours/week	05	**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	12 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	12 Hrs.

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

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 nondestructive testing (NDT)

Laboratory Sessions/ Experimental learning:

- Demonstrate non-destructive tests, like Dye penterant 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	12 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 microstrctural 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	12 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_ME0p0Ag

Module-5	**RBT Level** L1,L2,L3	12 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.

Reference 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.
3.	**V. Raghavan**, ***"Material Science and Engineering"***, Prentice Hall India, 5th Edition, 2004

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	MVJ19ME35	**CIE**	50
Total No. of Contact Hours	60 L: T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/week	05	**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	12 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	12 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 / 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	12 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:

1) 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	12 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-Glk*

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/4fee7b45-917b-4911-bc5d-bd8dac26e153
3. EPMA : Powder Metallurgy Component Production Cycle : https://youtu.be/_eM49JlmFp0

Module-5	**RBT Level** L1,L2,L3	12 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=NOiXh80_jXU
   d) Water Jet Machining Process : https://www.youtube.com/watch?v=4Begp-_zJ70

Course Outcomes:	
CO1	Identify and explain all the steps involved in basic casting processes.
CO2	Identify and explain the principle behind metal forming process and detail all the forging and rolling process.
CO3	Categorise and explain all the special casting processes and Press and Die punch assembly
CO4	Understand the process of Powder Metallurgy and Polymer product manufacturing process

	along with micro and Nano machining.
CO5	Categorise and explain the non-conventional Machining Process and its applications.

Reference 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".***
4.	**Degarmo, Black & Kohser, *"Materials and Processes in Manufacturing"***
5.	**P N Rao**, "***Manufacturing Technology: Foundry, Forming and Welding***", 2nd Edition Tata Mc Graw-Hill Publication.
6	**O.P Khanna**, "***Foundry Technology***", Dhanpat rai publications-2003 reprint.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 202.1	2	2	2	-	-	-	-	-	-	-	-	-
CO 202.2	2	2	2	-	-	-	-	-	-	-	-	-
CO 202.3	2	2	2	-	-	-	-	-	-	-	-	-
CO 202.4	2	2	2	-	-	-	-	-	-	-	-	-
CO 202.5	2	2	2	-	-	-	-	-	-	-	-	-
Avg	2	2	2	-	-	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Course Title	COMPUTER AIDED MACHINE DRAWING	Semester	III
Course Code	MVJ19ME36	**CIE**	50
Total No. of Contact Hours	60 L: T : P :: 40 : 0 : 20	**SEE**	50
No. of Contact Hours/week	06	**Total**	100
Credits	03	**Exam. Duration**	03 Hr

Course objective is to:

- 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	10 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	10 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	10 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 But 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	10 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	20 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=4hhJ0OSKVYg&list=PLQL-DlNb9_TXAbUK_H4JyZnhv9MW3nhG
2. https://www.youtube.com/watch?v=boyN1l3fA6g&list=PLQL-DlNb9_TVqG1Zrw-9F-S0LItg3T5fD
3. https://www.youtube.com/watch?v=-9AKKLoUICw&list=PLQL-DlNb9_TXW68eA3yVkXQXWDUaYcw0X
4. https://www.youtube.com/watch?v=yKl_FiUdAu4&list=PLQL-DlNb9_TUHs8CUXYw-Lna-Gp4rTu9g
5. 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.

Reference 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.
3.	**S. Trymbakaa Murthy, "*A Text Book of Computer Aided Machine Drawing*"** CBS Publishers, New Delhi, 2007.
4	**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

Course Title	MECHANICS AND MATERIAL TESTING LAB	Semester	III
Course Code	MVJ19MEL37	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 00: 10: 30	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	3 hrs

Course objective is to:

- To learn the concept of the preparation of samples to perform characterization such as microstructure, volume fraction of phases and grain size.
- To understand mechanical behaviour of various engineering materials by conducting standard tests.
- To learn material failure modes and the different loads causing failure.
- To learn the concepts of improving the mechanical properties of materials by different methods like heat treatment, surface treatment etc.

	EXPERIMENTS
	PART-A
1.	Preparation of specimen for Metallographic examination of different engineering materials. To report microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze &composites.
2.	Heat treatment: Annealing, normalizing, hardening and tempering of steel. Metallographic specimens of heat treated components to be supplied and students should report microstructures of furnace cooled, water cooled, and air cooled, tempered steel. Students should be able to distinguish the phase changes in a heat treated specimen compared to untreated specimen.
3.	Brinell, Rockwell and Vickers's Hardness tests on untreated and heat treated specimens.
4.	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing.
	PART-B
5.	Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine

6.	Torsion Test on steel bar.
7.	Bending Test on steel and wood specimens.
8.	Izod and Charpy Tests on Mild steel and C.I Specimen.
9.	To study the wear characteristics of ferrous and non-ferrous materials under different parameters.
10.	Tensile, shear and compression tests of steel, aluminum and cast iron specimens using Universal Testing Machine.
11.	Fatigue Test (demonstration only).
Course outcomes:	
CO1	Acquire experimentation skills in the field of material testing
CO2	Develop theoretical understanding of the mechanical properties of materials by performing experiments.
CO3	Apply the knowledge to analyse a material failure and determine the failure inducing agent/s.
CO4	Apply the knowledge of testing methods in related areas.
CO5	Understand how to improve structure/behaviour of materials for various industrial applications.

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

Course Title	FOUNDRY, FORGING AND WELDING LAB	Semester	III
Course Code	MVJ19MEL38	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 00: 10: 30	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	3 hrs

Course objective is to:

- To provide an insight into different sand preparation and foundry equipment.
- To provide an insight into different forging tools and equipment and arc welding tools and equipment.
- To provide training to students to enhance their practical skills in welding, forging and hand moulding.
- To practically demonstrate precautions to be taken during casting, hot working and welding operations.

EXPERIMENTS

PART-A

Testing of Moulding sand and Core sand.

Preparation of sand specimens and conduction of the following tests:

1. Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. Permeability test
3. Sieve Analysis to find Grain Fineness Number (GFN) of Base Sand
4. Clay content determination on Base Sand.

Welding Practice:

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

PART-B

Foundry Practice:

Use of foundry tools and other equipment for Preparation of moulding sand mixture.

Preparation of green sand moulds kept ready for pouring in the following cases:

1. Using two moulding boxes (hand cut moulds).
2. Using patterns (Single piece pattern and Split pattern).

3. Incorporating core in the mould. (Core boxes). 4. 4. Preparation of one casting (Aluminium or cast iron-Demonstration only)
PART-C
Forging Operations: Use of forging tools and other forging equipment. • Calculation of length of the raw material required to prepare the model considering scale loss. • Preparing minimum three forged models involving upsetting, drawing and bending operations.
Course outcomes:

CO1	Demonstrate various skills in preparation of molding sand for conducting tensile, shear and compression tests using Universal sand testing machine.
CO2	Demonstrate skills in determining permeability, clay content and Grain Fineness Number of base sands.
CO3	Demonstrate skills in preparation of forging models involving upsetting, drawing and bending operations.
CO4	Demonstrate skills in preparation of various welding joints on M.S flats using Arc welding equipment

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:	
1	One question is to be set from Part-A : 20 marks (10 marks for sand testing + 10 Marks for welding)
2	One question is to be set from either Part-B or Part-C: 20 Marks
3	Viva – Voce: 10 marks