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Recognized by UGC with 2(f) and 12(B) Status.

B.E., MECHANICAL ENGINEERING

2022 BATCH

AUTONOMOUS SYLLABUS

III SEMESTER – VIII SEMESTER

Semester: III		
Mathematics for Mechanical Engineers		
Course Code:	MVJ22ME31	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Use of statistical methods in curve fitting applications.	
2	Understand the concepts of Complex variables and transformation for solving Engineering Problems.	
3	Solve the linear differential equations using Laplace transforms.	
4	Apprehend and apply Fourier Series.	
5	Demonstrate Fourier Transform as a tool for solving Integral equations.	

UNIT-I	
Statistical Methods: Introduction, Correlation and coefficient of correlation, Regression, lines of regression and problems. **Curve fitting:** Curve fitting by the method of least squares. Fitting of the curves of the form $y = ax+b$, $y = ax^2+bx+c$, $y = ae^{bx}$.	8 Hrs
UNIT-II	
Complex Variables: Functions of complex variables, Analytic function, Cauchy-Riemann equations in Cartesian and polar coordinates, Construction of analytic function (Using Milne-Thomson method) Consequences of Cauchy-Riemann equations, Properties of analytic functions. Application to flow problems- complex potential, velocity potential, equipotential lines, stream functions, stream lines.	8 Hrs
UNIT-III	
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, solution of linear differential equations using Laplace transforms.	8 Hrs

UNIT-IV	
Fourier Series: Periodic functions, Dirichlet's condition, Fourier series of periodic functions with period 2π and arbitrary period $2c$. Fourier series of even and odd functions. Half range Fourier Series, Practical harmonic Analysis and Problems.	**8 Hrs**
UNIT-V	
Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse. Fourier sine and cosine transforms, Convolution theorem	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.
CO2	Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
CO3	Use Laplace transform and inverse transforms techniques in solving differential equations.
CO4	Know the use of periodic signals and Fourier series to analyze circuits and system.
CO5	Demonstrate Fourier Transform as a tool for solving Integral equations.

Textbook	
1.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 44th Edition, 2013.
Reference Books	
1.	Fundamentals of Statistics, S C Gupta, Himalaya Publications 2012.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition, 2014.
3.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition
4.	Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006.

Evaluation Method

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: III		
ENGINEERING THERMODYNAMICS		
Course Code:	MVJ22ME32	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To be able to learn and understand basic concepts & definitions of thermodynamics	
2	To be able to use the First and Second Law of Thermodynamics to estimate thermo- mechanical energy conversion and performance parameters	
3	To be able to learn the Concept of Entropy and apply thermodynamics principles to air standard cycles with the help of PV and Ts diagrams	
4	To be able to learn concepts of IC engines, Calculations of BP, IP, Mechanical efficiency, Heat balance sheet	
5	Performance analysis of R.A.C and optimization of compression.	

UNIT-I	
Fundamental Concepts & Definitions: Introduction to Thermodynamics; definitions thermodynamics, concepts of thermodynamics, Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium- Zeroth law of thermodynamics, Temperature; concepts, scales, measurement **Work & Heat:** Definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; 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. **Experiential Learning**: IC Engines, Thermometers, Dynamometer, Compressors etc. **Video Links/Any other special information:** 1. https://www.youtube.com/watch?v=WFMIzS2jQQg&t=48s 2. https://nptel.ac.in/courses/112105123/	8 Hrs
UNIT-II	
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.	8 Hrs

Experimental learning: First law for open system- (Use HMT Lab heat exchanger), Flow of 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 **Video Links/Any other special information:** 1. https://nptel.ac.in/courses/112104113/	
UNIT-III	
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 engine, Carnot cycle, Carnot principles. Thermodynamic temperature scale. **Experiential Learning:** Compressors, Turbines, IC engines, Refrigerator, Heat Pump etc **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=10FlW80XN64 2. https://nptel.ac.in/courses/112104113/ 3. https://www.youtube.com/watch?v=cobFAMZDS0o 4. https://nptel.ac.in/courses/112108148/	8 Hrs
UNIT-IV	
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. **Air Standard and Gas power cycles:** Carnot cycle, Air standard Otto, Diesel, and Dual cycles, efficiency derivation. Ideal Brayton cycle, effect of reheat, regeneration and Intercooling- (Simple numerical problems on Otto, Diesel, Dual and ideal Brayton cycle only.). **Experiential Learning:** Heat engines of all types form a very important and commercially used application based on thermodynamic principles. **Video link / Additional online information:** 1. http://www.youtube.com/watch 2. https://youtu.be/LDXLOCTeJQE, 3. https://youtu.be/b5SPb6NHna4, 4. https://youtu.be/PB7n8Y74890 5. https://youtu.be/4-BI22Wx4Pc,	8 Hrs

UNIT-V	
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. **Experiential learning:** Performance parameters, Morse test and heat balance analysis can be found by conducting the experiments in Energy conversion laboratory **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	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Define the basic concepts of thermodynamics like systems, equilibrium, process etc. Identify different work n heat interactions
CO2	Understand First Law of Thermodynamics and its applications
CO3	Understand Second Law of Thermodynamics and its applications
CO4	Understand the concept of Entropy, Available and unavailable Energy.
CO5	Describe the performance parameters of I.C. Engines and Refrigeration comparison of the parameters to improve the efficiency of the same.

Textbooks	
1.	**P K Nag, Engineering Thermodynamics**, Tata McGraw-Hill Education, 2005
Reference Books	
1.	**B K Venkanna & Swati B V, Basic & Applied Thermodynamics,** PHI Learning, 2011
2.	**R K Rajput, "Engineering Thermodynamics",** Laxmi Publications Pvt. Ltd., Sixth Edition, 2023
3.	**Yunus A Cengel; Michael A Boles,** Thermodynamics: An Engineering Approach (SIE) Paperback – 1 July 2017, McGraw Hill Education, ISBN-13: 978-9339221652

Evaluation Method

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: III		
Material Science and Engineering		
Course Code:	MVJ22ME33	CIE Marks: 50
L:T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total: 100
Hours:	40 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Provide basic background for selection of materials for a wide range of products in engineering applications.
2	Introduce the concept of crystal structure, atomic planes and directions and identify imperfections in solids.
3	Elucidate phase stabilities and phase diagrams and identify the mechanism of phase transformations.
4	Enumerate different metals and alloys and elucidate various heat treatment and power metallurgy techniques.
5	Elucidate the corrosion and failure mechanisms in metals and alloys and introduce composite materials.

UNIT-I	
Introduction: Basics of Engineering Materials, their Classifications and Application, Basics of Advance Engineering Materials, Engineering requirements of materials, Properties of engineering materials, Criteria for selection of materials for engineering Applications. **Crystal Structure:** Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, packing of atoms and packing fraction, Classification and Coordination of voids, Bragg's Law. Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Diffusion-Fick's laws, role of imperfections in diffusion.	8 Hrs
UNIT-II	
Solidification and Theory of Alloys: Solidification of metals and an alloy, Nucleation and Growth during freezing of pure metal and alloy ingot/a casting Resultant macrostructures; Effects of Structure on Mechanical Properties. **Phase and Phase equilibrium:** Unary and Binary equilibrium phase diagrams, Hume- Rothery Rules, Gibbs Phase Rule, Lever Rule, Fe-C equilibrium diagram, Different reactions like eutectic, eutectoid, peritectic and peritectoid; non-equilibrium cooling.	8 Hrs
UNIT-III	
Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology. TTT diagram, microstructural effects brought about by these processes and their influence on mechanical properties.	8 Hrs
UNIT-IV	
Corrosion and surface coating: Introduction to corrosion, types of corrosion,	8 Hrs

mechanism of corrosion, corrosion prevention techniques coating materials, coating technologies, types of coating, advantages, and limitations. **Failure of Materials:** Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb theories, yield locus plots, fatigue failure, SN curve, endurance, and fatigue limits, modified goodman diagram, creep failure, fracture mechanics, Griffith criterion.	
UNIT-V	
Metals and Alloys: Carbon and alloy steels-stainless steel and tool steel, maraging steel, cast iron-grey, white, malleable and spheroidal cast iron; Copper and Copper alloys-Brass, Bronze and Cupro-Nickel alloys; Aluminum Alloys, Magnesium Alloys, Nickel based super alloys and Titanium alloys. **Composite Materials:** Introduction, Classification, Metal Matrix Composites, Ceramic Matrix Composites, Polymer Matrix Composites, Natural fiber reinforced composites, Advantages, Limitations, Properties and Applications.	8 Hrs
LABORATORY EXPERIMENTS	24 Hrs.
1. To determine the hardness values of different metal specimens by Rockwell/Vickers hardness testing machine. 2. To determine the hardness values of different metal specimens by Brinell hardness testing machine. 3. To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of the metal specimen and to observe the necking. 4. To carry out the compression test on universal testing machine and determine the change in length/area and compression strength for the give specimen. 5. Carryout the Bending test/Single Shear/Double Shear test on the given specimens and to plot the stress strain graphs. 6. Determining the impact strength of a given material using Charpy/IZOD tests. 7. Carryout the Torsion test on the given specimen and to tabulate the readings and find the torsion values. 8. Demonstration of pin on disc wear test. 9. Demonstration of any two Nondestructive tests. 10. Preparation of the specimen and microstructure observation for different metals and alloys. 11. Demonstration of Fatigue test for the given specimen.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters.
CO2	Understand the importance of phase diagrams and the phase transformations.
CO3	Know various heat treatment methods for controlling the microstructure.
CO4	Correlate between metals, alloys, material properties with component design and identify various kinds of failure mechanisms.
CO5	Understand the application of the different types of composite materials.

Textbooks	
1.	W. D. Callister, "Materials Science and Engineering-An Introduction", Wiley India, 6th Edition, 2006.
2.	Material Science and Metallurgy, M K Muralidhara, Subhas Stores, 2011.

Reference Books	
1.	Kenneth G. Budinski and Michael K. Budinski, Engineering Materials, Prentice Hall India, 4th Edition, 2002.
2.	V. Raghavan, "Material Science and Engineering", Prentice Hall India, 5th Edition, 2004.
3.	P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.

Web links and Video Lectures (e-Resources):

1. Bhattacharya. B, Materials Selection and Design, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/

2. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department of Materials 27 27 Science and Engineering, Indian Institute of Technology Delhi, http://nptel.ac.in/courses/113102080/

3. Subramaniam, A., Structure of Materials, NPTEL Course Material, Department of Material Science and Engineering, Indian Institute of Technology Kanpur, https://nptel.ac.in/courses/113104014/

4. Schuh, C., 3.40J Physical Metallurgy. Fall 2009. Massachusetts Institute of Technology: MIT Open Course Ware, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.

5. Ghosh, R.N., Principles of Physical Metallurgy, IIT Kharagpur, http://nptel.ac.in/syllabus/113105024/

Evaluation Method for IPCC

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)
Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:

Experiment Conduction with Results: 40 marks

Viva Voce: 10 marks

Total 50 marks (B)
The score for the SEE is A+B of total 100 marks

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

Semester: III		
Mechanics of Materials		
Course Code:	MVJ22ME34	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To study the distribution of various stresses in mechanical elements that deform under various loads.	
2	To know behaviour & properties of engineering materials.	
3	To understand the concepts of Principal stress and strains.	
4	To understand the concepts of calculation of shear force and bending moment for beams with different supports.	
5	To expose the students to concepts of Buckling of columns and strain energy.	

UNIT-I	
Stresses and Strains: Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them. **Experiential Learning:** Load and Deformation Measurement Experiments in UTM **Applications:** Stresses and strains induced in various applications like, chair/bench where the students are sitting, strain in the shoe while jogging, stress and strain induced in the concrete building etc. **Video link:** https://www.mtu.edu/materials/k12/experiments/tensile/.	8 Hrs
UNIT-II	
Analysis of Stress and Strain: Introduction to three dimensional state of stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear tress, Mohr circle for plane stress conditions. **Cylinders:** Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations. **Experiential Learning:** Using strain gauges, students will measure the forces and subsequently calculate the stresses in metrology lab. **Applications:** Strain rosettes, Thick and Thin Cylinders **Video link:** https://www.youtube.com/watch?v=qHi8FPnWP6E	8 Hrs
UNIT-III	
Shear Force and Bending Moment:	8 Hrs

Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads, uniformly distributed constant / varying loads. *Stress in Beams:* Bending and shear stress distribution in rectangular, I and T section beams. **Experiential Learning:** Hand calculation of Shear force and bending moment distribution for bridges and buildings. **Applications:** Shear Force and Bending Moment Distribution of beam members of buildings and structures. **Videolink:** https://www.youtube.com/watch?v=wbkvJmUEKHY	
UNIT-IV	
Theories of Failure: Maximum Principal stress theory, Maximum shear stress theory. *Torsion:* Circular solid and hallow shafts, Torsional moment of resistance, Power transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Thin walled sections. **Experiential Learning:** Torsion Experiment in Material Testing Lab **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=-9DYHrqq51E	8 Hrs
UNIT-V	
Columns: Buckling and stability, Critical load, Columns with pinned ends, Columns with other support conditions, Effective length of columns, Secant formula for columns. *Strain Energy:* Strain energy due to axial, shear, bending, torsion and impact load. Castigliano's theorem I and II and their applications. **Experiential Learning:** Impact test in Material Testing Lab and calculating the strain energy absorbed due to impact loading **Applications:** Buckling and stability estimation in Metro, flyover and building columns **Video link:** https://www.youtube.com/watch?v=cZwg6XYpzRw	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply mathematical knowledge to Calculate the deformation behavior of simple structures.
CO2	Critically analyze problem and solve the problems related to mechanical elements and analyze the deformation behavior for different types of loads.
CO3	Analyze the deflection in beams.
CO4	Analyze buckling and bending phenomenon in columns, struts and beams.
CO5	Analysis of shaft for various cross sections.

Textbooks	
1.	S S Bhavikatti Strength of Materials Paperback – 1 Vikas Publishing House Pvt Ltd. ISBN: 9788125927914, 9788125927914
Reference Books	
1.	Bedi D S, "*Strength of Materials*", S Chand and Co. Ltd., New Delhi, 2019.
2.	Ramamrutham S and Narayan R, "*Strength of Materials*", Dhanpat Rai and Sons, New Delhi, 1997.
3.	Popov E P, "*Mechanics of Materials*", Prentice Hall Inc., Englewood Cliffs, New Jersey, 2015.

Evaluation Method

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: III		
Computer Aided Machine Drawing		
Course Code:	MVJ22MEL35	CIE Marks: 50
L:T:P:S	0:0:2:0	SEE Marks: 50
Credits:	1	Total: 100
Hours:	24 Hrs. of Practical	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To acquire the knowledge of CAD software and its features. Make the students to understand of the devices, instruments.	
2	To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.	
3	To familiarize the students with Indian Standards on drawing practices.	
4	To impart knowledge of thread forms, fasteners, keys, joints, couplings and	
5	To acquire the knowledge of Assembly Drawings.	

UNIT-I	
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	04 Hrs
UNIT-II	
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	05 Hrs

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	
UNIT-III	
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	**05 Hrs**
UNIT-IV	
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	**05 Hrs**
UNIT-V	
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	**05 Hrs**

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

Textbooks	
1.	K.R. Gopala Krishna, "*Machine Drawing*" Subhas Stores, 2021
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.

CO-PO											
C0/P0	P01	P02	P03	P04	P05	P06	P07	P08	P09	P01O	P011
C01	3	3	1	1	2	-	-	-	-	3	1
C02	3	3	1	1	2	-	-	-	-	1	1
C03	3	3	1	1	2	-	-	-	-	1	2
C04	3	3	3	1	2	-	-	-	-	1	2
C05	3	3	3	2	2	-	-	-	-	1	3

High-3, Medium-2, Low-1

CIE Laboratory (50 Marks)
Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as (A+B) for 50 marks

SEE Laboratory Examination (50 Marks)
The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks
The final score for the course out of 100 is the Sum Total of SEE and CIE.

Semester: III		
Electric and Hybrid Vehicles Technology		
Course Code:	MVJ22ME361	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To be able to learn and understand basic concepts of electric Vehicles
2	To be able to learn and understand basic concepts of hybrid electric Vehicles
3	To be able to understand the concepts of Propulsion unit of vehicles
4	To be able to understand varieties of batteries in automotive vehicles
5	To be able to understand energy storage requirements

UNIT-I	
Introduction to Electric Vehicle: History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.	8 Hrs
UNIT-II	
Induction to Hybrid Electric Vehicle: Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	8 Hrs
UNIT-III	
Propulsion unit: Introduction to transmission components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	8 Hrs
UNIT-IV	
Fuel Cells and Batteries: Fuel Cell based energy storage and its analysis, Battery based energy storage devices and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, selecting the energy storage technology, Calculation for the ratings.	8 Hrs
UNIT-V	
Energy Storage Requirements in Hybrid and Electric Vehicles, Hybridization of different energy storage devices, Sizing the drive system, Energy Management Strategies, Implementation issues of energy management strategies, Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Elucidate the evolution of Hybrid and Electric Vehicles and their technology.
CO2	Compare the different types of drive trains and transmission systems involved in Electric and Hybrid Vehicles.
CO3	Elucidate the use of different energy storage devices for electric and hybrid vehicles.
CO4	Summarize the aspects of energy storage requirements in hybrid and electric vehicles.
CO5	Identify the different implementation issues of energy management strategies from case studies on design of battery and hybrid electric vehicles. .

Textbooks	
1.	Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
Reference Books	
1.	A. K. Babu, Electric and Hybrid Vehicles, Second Edition, 1 January 2022 (Author) Khanna Publishing (1 January 2022); Khanna Book Publishing Company, ISBN-13: 978-8195123155
2.	Seth Leitman, "Build Your Own Electric Vehicle" MC Graw Hill, 1st Edition, 2013.
3.	Electrical Vehicle Technology: The Future Towards Eco-Friendly Technology... Paperback by Prof. Sunil R. Pawar, Publisher : Notion Press; 1st edition (11 September 2021), ISBN-10:1685545610
Web links and Video Lectures (e-Resources): NOC: Fundamentals of Electric vehicles: Technology & Economics, IIT Madras Prof. Ashok Jhunjhunwala Prof. Prabhjot Kaur Prof. Kaushal Kumar Jha Prof. L Kannan https://nptel.ac.in/courses/108106170	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: III		
INTERNET OF THINGS (IOT) FOR SMART FACTORIES		
Course Code:	MVJ22ME362	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To introduce different architectures used for connected smart devices.
2	To study various protocols used in the Internet of Things environment.
3	To Design and Develop Internet of Things based solution for real world problems.
4	To present a problem oriented in depth knowledge of IOT & Smart Manufacturing Factories.
5	To address the underlying concepts and methods behind IOT & Smart Manufacturing Factories.

UNIT-I	
The Internet of Things: An overview, Design Principles for Connected Devices, Internet Principles. Thinking about Prototyping – Costs versus ease of prototyping, prototyping and Production, open source versus Closed Source. **Prototyping Embedded Devices**: Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, Beagle Bone Black, etc., Electric Imp and other notable platforms Prototyping of Physical Design. Prototyping online Components – Getting Started with an API, Writing a New API. **Real Time Reactions:** Other Protocols, Techniques for Writing Embedded Code – Memory Management, Performance and Battery Life, Libraries and debugging. **Experiential Learning**: Sketch the architecture of IoT Toolkit and explain each entity in brief and Sensors, Gateway and Cloud interface. **Video Links/Any other special information:** 1. https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLJ5C_6qdAvBG7SHg5mLOQq6bzF-sOPu3k 2. https://www.youtube.com/watch?v=hdZzNOQV5vU 3. https://www.tutorialspoint.com/internet_of_things/internet_of_things_overvie w.htm 4. https://www.youtube.com/watch?v=2v6M5DOzTfc&list=PLdguAlzSoZpqd2nYaFMeSrjQRG7_5Yd3K	08 Hrs
UNIT-II	
Automatic Storage Management in a Cloud World: Introduction to Cloud, Relational Databases in the Cloud, Automatic Storage Management in the Cloud. Smart Connected System Design Case Study. **Internet of Things Privacy, Security and Governance:** Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smarties Approach. Data Aggregation for the IoT in Smart Cities, Security. **Experiential Learning**: Configuring cloud database management and accessing and Data analysis from cloud and reporting.	08 Hrs

Video Links/Any other special information: 1. https://www.youtube.com/watch?v=hHvMan9HWYI 2. https://www.youtube.com/watch?v=g-JuCEvkq9I 3. https://www.scribd.com/document/339463370/Unit-3-IoT-Privacy- Security-Governance 4. https://www.youtube.com/watch?v=foJ8rh-3T_Y	
UNIT-III	
Introduction to Smart Manufacturing: What is "smart manufacturing" really and how does it differ from conventional/legacy Manufacturing-Smart Manufacturing Processes – Three Dimensions: (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 and reduction of GHG). **Experiential Learning**: Introduction to Smart Manufacturing, distinguish its signification in comparison to conventional manufacturing. **Video Links/Any other special information:** 1. https://www.youtube.com/watch?v=sdgI072DJNM 2. https://www.youtube.com/watch?v=h9t06cyC7Es 3. https://www.thalesgroup.com/en/markets/digital-identity-and- security/iot/inspired/smart-manufacturing	08 Hrs
UNIT-IV	
Smart Design/Fabrication: Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor networks and Devices. **Experiential Learning**: To Study about tools for Smart Manufacturing. **Video Links/Any other special information:** https://www.youtube.com/watch?v=WCfwEYaPuDQ https://www.youtube.com/watch?v=y8CJPBty9mI https://www.youtube.com/watch?v=IMPbKVb8y8s	08 Hrs
UNIT-V	
Smart Applications: Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes, Smart Energy Management of manufacturing processes and facilities. **Smart and Empowered Workers**: Eliminating Errors and Omissions, Deskilling Operations, Improving Speed/Agility, Improving Information Capture/Traceability, Improving Intelligent, Decision Making under uncertainty Assisted/Augmented Production, Assisted/Augmented, Assembly, Assisted/Augmented Quality, Assisted/Augmented Maintenance, Assisted/Augmented, Warehouse Operations and Assisted Training. **Experiential Learning**: To study about Smart Application and to study about Smart and Empowered working. **Video Links/Any other special information:** https://www.youtube.com/watch?v=N_z4OaSuoAA	08 Hrs

https://www.youtube.com/watch?v=Bv7PXrvpLNs https://www.youtube.com/watch?v=xn32a320sv4 https://www.youtube.com/watch?v=Qxe68ExM148	

Course Outcomes: After completing the course, the students will be able to	
CO1	Able to understand the basic architecture of Internet of Things based Devices.
CO2	Able to analyze light weight protocols implemented for connected devices.
CO3	Able to develop firmware for controlling wireless devices and Able to design and develop Smart Devices using IoT.
CO4	The student can identify different areas of IOT and Smart Manufacturing Factories.
CO5	Can find the applications of all the areas in day to day life in Factories.

Textbooks	
1.	Dr. Santosh Rane Dr. Bhaveshkumar N. Pasi ,Dr. Subhash K. Mahajan, Development of Smart Manufacturing System: An Industry 4.0 Perspective, Book Rivers; 1st edition, 2024.
2.	Arsheep Bahga, Vijay Madisetti, INTERNET OF THINGS - A HANDS-ON APPROACH, Orient Blackswan Private Limited - New Delhi, 2015.
Reference Books	
1.	A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013, ISBN-10: 111843062X.
2.	N. Vengurlekar and P. Bagal, Database Cloud Storage: The Essential Guide to Oracle Automatic Storage Management, 1st edition, McGraw-Hill Education, 2013, ISBN-10: 0071790152.
3.	M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992.
4.	Raj Kamal, "Internet of Things: Architecture and Design Principles", First Edition, McGraw Hill Education, 2017.

Continuous Internal Evaluation (CIE):

Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)
Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

High-3, Medium-2, Low-1

Semester: III		
SMART MATERIALS AND SYSTEMS		
Course Code:	MVJ22ME363	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives:	
1	To develop the student's ability to learn emerging materials and technologies.
2	To make students to learn prefabricated building components
3	To make students learn the concepts of piezoelectricity and smart composites for real time applications.
4	To be able to appreciate the principles of shape memory alloys and magneto and electrorheological fluids.
5	To be able to implement the concepts of 3D printing in building prototypes and models.

UNIT-I	
Introduction to Smart Materials: Smart Materials – Definition, Types, Emerging Materials, Honey comb structure (Carbon composites), Nano-materials, engineered polymers, emerging sustainable by products (Fly ash and GGBS) and construction chemicals. **Experiential Learning**: Synthesis of Honeycomb structure and composites **Video Links/Any other special information:** https://www.youtube.com/watch?v=yXHlIowQntk https://nptel.ac.in/courses/112104173	8 h
UNIT-II	
Prefabricated/ Manufactured building components Definition, types of prefabricated/ manufactured building components and infrastructure, modular coordination, standardization, materials, systems, production, transportation and installation. Wood, Engineered Wood and Bamboo as construction materials. **Experiential Learning:** Fabrication of prefabricated concrete slabs **Video link / Additional online information:** https://www.youtube.com/watch?v=FdbHC4sfqBo https://archive.nptel.ac.in/courses/124/105/124105013/	8 h

UNIT-III	
Piezo-electric materials and Smart Composites: Definition, Principles of Piezo-electricity, materials (Polymers and Ceramics), sensors (Piezo-electric sensor, strain gauge, shear sensor, in-plane and out of plane sensor, accelerometer), smart composites **Experiential Learning**: Demonstration of the concept of piezoelectricity through simple models and prototypes **Video Links/Any other special information:** https://www.youtube.com/watch?v=_XABS0dR15o https://nptel.ac.in/courses/112104173 https://www.youtube.com/watch?v=N1ALRmT4s9I https://www.youtube.com/watch?v=3oVf0r51Fzw	8 h
UNIT-IV	
Shape Memory Alloys: Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, NiTiNOL actuators. **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). **Experiential Learning:** Demonstration of Shape Memory Effect. **Video link / Additional online information:** https://www.youtube.com/watch?v=Pn-6bGORy0U https://www.sciencedirect.com/topics/materials-science/shape-memory-effect	8 h
UNIT-V	
3-D Printing Importance, Historic development, advantages, common terminologies, classification, Process chain, 3–D modelling, Data conversion and transmission, checking and preparation, Building, Post processing, Applications **Video link / Additional online information:** https://www.youtube.com/watch?v=m12bX1eEVDM https://archive.nptel.ac.in/courses/112/103/112103306/	8 h

Course Outcomes: After completing the course, the students will be able to	
CO1	Make use of the emerging materials for construction
CO2	Decide the proper prefabricated building component in construction of smart structures
CO3	Use smart materials and methods in building construction
CO4	Apply the concepts of Shape memory alloys and ER and MR fluids in real time.
CO5	Prepare 3-D models and prototypes from 3D printing process

Textbooks	
1.	"Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107)

Reference Books	
1.	Donald R. Askeland and Pradeep P. Fulay, Essentials of Materials Science and Engineering, 2009, Cengage Laerning.
2.	"Smart Structures–Analysis and Design", A.V.Srinivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).

Continuous Internal Evaluation (CIE):

Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)
Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

Semester: III		
Instrumentation and Controls		
Course Code:	MVJ22ME364	CIE Marks: 50
L:T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total: 100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To provide a basic knowledge about measurement systems and their components
2	To learn about various sensors used for measurement of mechanical quantities.
3	To learn about system stability and control and integrate the measurement systems with the process for process monitoring and Control.
4	To develop competence in sensors, transducers and terminating devises with associated parameters and illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
5	Illustrate the use of various plots for stability analysis.

UNIT-I	
Basic Concepts of Measurement and Metrology: Definition and significance of measurement, generalized measurement system, Performance characteristics of measuring instruments, Inaccuracy of Measurements, Definition and objectives of metrology, Introduction to standards, Types of standards, slip gauges. **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. **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	8 Hrs
UNIT-II	
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. **Screw thread and Gear measurements, Surface Roughness measurements.** **Sensors and Transducers:** Introduction, Transfer efficiency, Loading effect, Primary and Secondary transducers, classification of Sensors and transducers with examples. Advantages and limitations of each type of sensors and transducers. **Signal Conditioning:** Mechanical systems, Electrical intermediate modifying devices, Input circuitry simple current sensitive circuit, electronic amplifiers,	8 Hrs

Filters, Types of filters, telemetry, Cathode ray oscilloscope, Oscillographs. **Video link / Additional online information:** **https://archive.nptel.ac.in/courses/108/106/108106098/**	
UNIT-III	
Strain and Force Measurement: Methods of strain measurement, Strain gauges, Preparation and mounting of strain gauges, Gauge factor, 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. **Introduction to Coordinate Measuring Machine**. **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/**	**8 Hrs**
UNIT-IV	
Introduction: Components of a control system, Open loop and closed loop systems, Types of controllers, Mathematical Models of Mechanical systems **Time domain performance of control systems:** Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants. **Block diagram algebra,** Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations. **Laboratory Sessions/ Experimental learning:** Study of On-Off Controller for Flow/ Temperature. **Applications:** Automation and control of Electronic circuits, wireless communication and broadcasting. **Video link / Additional online information:** **https://archive.nptel.ac.in/courses/108/106/108106098/**	**8 Hrs**
UNIT-V	
Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain margin using root locus. Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot. **Laboratory Sessions/ Experimental learning:** Study of Control Modes like P, PD, PI, PID for Pressure / Temperature / Flow. **Video link / Additional online information :** **https://archive.nptel.ac.in/courses/108/106/108106098/**	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
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 comparators, dial indicator, LVDT, pressure gauges, comparator and measuring devices.
CO5	Understand the concepts of stability of control systems.

Textbooks:	
1. Dr. T Chandrashekar, Textbook of Mechanical Measurements & Metrology, Subhas Stores, 2015.	
Reference Books :	
1.	E.O. Doebelin, "Measurement Systems (Applications and Design)", 5th ed.- - McGrawHill. 2004, 9780072438864, 007243886X.
2.	Beckwith Marangoni and Lienhard, "Mechanical Measurements" Pearson Education, 6th Ed., 2006. ISBN-13 - 978-0201847659
3.	Control Systems Engineering S Palani Tata McGraw Hill Publishing Co Ltd ISBN-13 9780070671935
4.	Control Systems Engineering I.J. Nagrath, M Gopal New Age International (P) Ltd. 2018

Continuous Internal Evaluation (CIE):
Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)
Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):
The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

High-3, Medium-2, Low-1

Semester: III		
Social Connect & Responsibility		
Course Code:	MVJ22SCR37	CIE Marks: 100
L: T:P:S	0:0:2:1	SEE Marks: -
Credits:	1	Total :100
Hours:	24 Hrs. of Practical	SEE Duration: -

Course objectives: The course will enable the students to:

1. Provide a formal platform for students to communicate and connect to the surroundings.
2. create a responsible connection with society.
3. Understand the community in general in which they work.
4. Identify the needs and problems of the community and involve them in problem –solving.
5. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
6. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.

General Instructions - Pedagogy:

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied social and cultural skills.
2. State the need for activities and its present relevance in society and provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

Contents :

The course is mainly activity-based that will offer a set of activities for the students that enables them to connect with fellow human beings, nature, society, and the world at large.

The course will engage students for interactive sessions, open mic, reading group, storytelling sessions, and semester-long activities conducted by faculty mentors.

In the following a set of activities planned for the course have been listed:

Social Connect & Responsibility - Contents

MODULE I — 4 Hours

Plantation and adoption of a tree:

Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONE TREE) They will also make an excerpt either as a documentary or a photo blog describing the plant's origin, its usage in daily life, its appearance in folklore and literature - – Objectives, Visit, case study, report, outcomes.

MODULE II — 5 Hours

Heritage walk and crafts corner:

Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives,Visit, case study, report, outcomes.

MODULE III — 5 Hours

Organic farming and waste management:

Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus – Objectives, Visit, case study, report, outcomes.

MODULE IV — 5 Hours

Water conservation:

Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photoblog presenting the current practices – Objectives, Visit, case study, report, outcomes.

MODULE V — 5 Hours

Food walk:

City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, case study, report, outcomes.

Course outcomes (Course Skill Set):

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

CO1: Communicate and connect to the surroundings.

CO2: Create a responsible connection with society.

CO3: Involve in the community in general in which they work.

CO4: Notice the needs and problems of the community and involve them in problem –solving.

CO5: Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.

CO6: Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.

Activities:

Jamming session, open mic, and poetry: Platform to connect to others. Share the stories with others. Share the experience of Social Connect. Exhibit the talent like playing instruments, singing, one-act play, art-painting, and fine art.

PEDAGOGY:

The pedagogy will include interactive lectures, inspiring guest talks, field visits, social immersion, and a course project. Applying and synthesizing information from these sources to define the social problem to address and take up the solution as the course project, with your group. Social immersion with NGOs/social sections will be a key part of the course. Will all lead to the course project that will address the needs of the social sector?

COURSE TOPICS:

The course will introduce social context and various players in the social space, and present approaches to discovering and understanding social needs. Social immersion and inspiring conversional will culminate in developing an actual idea for problem-based intervention, based on an in-depth understanding of a key social problem.

Duration:

A total of 40 - 50 hrs engagement per semester is required for the 3rd semester of the B.E. /B.Tech. program. The students will be divided into groups. Each group will be handled by faculty mentors. Faculty mentor will design the activities (particularly Jamming sessions open mic, and poetry) Faculty mentors has to design the evaluation system as per VTU guidelines of scheme & syllabus.

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE):

After completion of the course, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period. The report should be signed by the mentor. The report shall

be evaluated on the basis of the following criteria and/or other relevant criteria pertaining to the activity completed. Marks allotted for the diary are out of 50. Planning and scheduling the social connect Information/Data collected during the social connect Analysis of the information/data and report writing Considering all above points allotting the marks as mentioned below

Excellent : 80 to 100
Good : 60 to 79
Satisfactory : 40 to 59
Unsatisfactory and fail: <39

Special Note:

NO SEE – Semester End Exam – Completely Practical and activities-based evaluation

Pedagogy – Guidelines:

It may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

Sl No	Topic	Group size	Location	Activity execution	Reporting	Evaluation Of the Topic
1.	**Plantation and adoption of a tree:**	May be individual or team	Farmers land/ parks / Villages / roadside/ community area / College campus etc.	Site selection /Proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by Faculty
2.	**Heritage walks and crafts corner:**	May be individual or team	Temples / monumental places / Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.	Site selection /Proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by Faculty
3.	**Organic farming and waste management:**	May be individual or team	Farmers land / parks / Villages visits / roadside/ community area / College campus etc.	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by Faculty
4.	**Water conservation** : & conservation techniques	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers / campus etc.	site selection / proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by Faculty
5.	**Food walk: Practices in society**	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by Faculty

Plan of Action (Execution of Activities)

Sl.NO	Practice Session Description
1	Lecture session in field to start activities
2	Students' Presentation on Ideas
3	Commencement of activity and its progress
4	Execution of Activity
5	Execution of Activity
6	Execution of Activity
7	Execution of Activity
8	Case study-based Assessment, Individual performance
9	Sector/ Team wise study and its consolidation
10	Video based seminar for 10 minutes by each student at the end of semester with Report.

- Each student should do activities according to the scheme and syllabus.
- At the end of semester student performance has to be evaluated by the faculty for the assigned activity progress and its completion.
- At last consolidated report of all activities from 1st to 5th, the compiled report should be submitted as per the instructions and scheme.

Assessment Details for CIE (both CIE and SEE, no SEE)

Weightage CIE – 100% Implementation strategies of the project (NSS work). The last report should be signed by NSS officer of the institute / Department SCR Faculty, the HOD and Principal. At last report should be evaluated by the NSS officer of the institute / Department SCR Faculty. Finally, the consolidated marks sheet should be sent to the Controller of Examination office.

Rubrics to be followed:

Field Visit, Plan, Discussion - **10 Marks**

Commencement of activities and its progress weekly - **20 Marks**

Case study-based Assessment Individual performance with report - **20 Marks**

Sector wise study & its consolidation 5*5 = 25 **25 Marks**

Seminar for 10 minutes by each student at the end of semester with Report. Activities 1 to 5, 5*5 = 25 **25 Marks**

Total marks for the course in each semester - **100 Marks**

For each activity, 20 marks CIE will be evaluated for IA marks at the end of semester, Report and assessment copy should be made available in the department.

Students should present the progress of the activities as per the schedule in the prescribed practical session in the field. There should be positive progress in the vertical order for the benefit of society in general through activities.

Semester: III		
IDEA BOX (Level 1)		
Course Code:	MVJ22A3011	CIE Marks: 50
L: T:P:S	1:0:2:0	SEE Marks: 50
Credits:	2	Total :100
Hours:	12 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course objectives: This course will enable students,

- To develop conceptual thinking skills to generate ideas and content to solve problems or createopportunities.
- To develop a research and workspace practice through inquiry and iteration.
- To develop critical thinking skills that will allow them to analyze and position their work in a team or group actively and effectively.

UNIT – 1	4 h and 8 h
Introduction to Innovation: Definition of Innovation, Importance of Innovations and Inventions, What to Innovate, Types of Innovations, Innovation and Design Thinking, Concepts in Design Thinking- concept of empathy, concept of ethnography, concept of divergent thinking, concept of convergent thinking, concept of visual thinking, concept of assumption testing and concept of prototyping within the context of innovation and design thinking.	
UNIT – 2	4 h and 8 h
Stages of thinking: The Design Process: Stage 1 – Define, Stage 2 – Research, Stage 3 – Ideate, Stage 4 – Prototype, Stage 5 – Select, Stage 6 – Implement, Stage 7 – Learn, Idea generation Basic design directions, Themes of thinking, Inspiration and references, Brainstorming, Value, Inclusion, Sketching, Presenting ideas.	

UNIT – 3	4 h and 8 h
Activity on Perspective, Activity on Empathy (Where, who and what), Identifying a market need, Targeting the right audience, carrying out competitor and SWOT analyses, Defining the problem statement, Perform Research. Activities on Idea Generation	

Course outcomes: Students will be able to

CO1	Understand the need of innovations and aspects of innovations
CO2	Design appropriate innovative solution.
CO3	Demonstrate practical idea generation and work effectively in a team.

Textbooks:

1. Sam Harrison "Idea Spotting: How to Find Your Next Great Idea", Cincinnati, Ohio: HOW Books, 2006.

Reference Books

1.	Michael Michalko "Cracking Creativity", Ten Speed Press; Revised edition ,13 April 2011.
2.	Austin Kleon "Steal like an Artist", Workman Publishing; 1st edition, 15 April 2014.

Semester: III		
TINKERING LAB (Level 1)		
Course Code:	MVJ22A3031	CIE Marks: 50
L: T:P:S	1:0:2:0	SEE Marks: 50
Credits:	2	Total :100
Hours:	12 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course objective is to:

To create workspaces that are suitable for young minds to learn innovation skills, develop ideas via hands-on activities, work and learn in a flexible environment.

UNIT 1. Introduction to Tinkering Lab	4 h and 8 h
Orientation program about safety and health issues	
UNIT 2. Training program	**4 h and 8 h**
To provide hands on session on various tools of different departments	
UNIT 3. Project work	**4 h and 8 h**
Project work: Submitting the report on idea generation and design work on Level1	

Course outcomes:

COs	1) Understand the ethics in handling the equipment and its safety precautions 2) Work with hand tools and equipment for designing new components in the tinkering lab.

Textbooks:

1. S K Haldar, Industrial and Occupational Health, CBS Publishers and Distributors Pvt. Ltd, 2nd Edition, 2023.

Reference Books:

1.	"Professional Ethics" R Subramanian, Oxford University Press, 2nd Edition 2017.
2.	"Fundamental principles of occupational health and safety" Benjamin O. Alli; International Labour Office – Geneva: ILO, 2008

Semester: III		
CNC LAB (Level 1)		
Course Code:	MVJ22A3111	CIE Marks: 50
L: T:P:S	1:0:2:0	SEE Marks: 50
Credits:	2	Total :100
Hours:	12 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course objectives: -

This course will enable students to,

- Understand the working principle of the CNC Machines.
- Understand the driving characteristics of the driving system, feedback devices and the application of CNC Machines.

UNIT 1. INTRODUCTION TO CNC MACHINE TOOLS:	4 h and 8 h

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning center, machining center, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection.

UNIT 2. STRUCTURE OF CNC MACHINE TOOL	4 h and 8 h

CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings.

UNIT 3. Activities and Project work	4 h and 8 h

1. To develop a program involving step turning and taper turning
2. Identify at least 2 different products in the market and prepare a report on requirements to manufacture /develop the product using Computer numerical control technology.
3. To start literature survey regarding the project identified.

Course outcomes:	
	1. Understand the fundamentals of CNC Machines, initialization of coordinate system. 2. Develop the dimension system and structure of the CNC Part Program for parts.
Textbooks: 1. Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, 4th Edition, 2016.	
Reference Books:	
1.	Mechatronics HMT Tata McGraw-Hill Publishing Company Limited, New Delhi 2005
2.	Koren Y, Computer Control of Manufacturing systems McGraw Hill 1986.

Semester: 3/4/5/6		
NATIONAL SERVICE SCHEME(NSS)		
Course Code:	MVJ22NSS 39/49/59/69	CIE Marks: 50
L: T:P:S	0:0:2:0	SEE Marks: -------
Credits:	0	Total :100
Hours:	24 Hrs. of Practical	SEE Duration: ----------

Course Objectives: National Service Scheme (NSS) will enable the students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem–solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

General Instructions - Pedagogy

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes:

1. Use innovative teaching methods along with lectures to help students build both theoretical and practical social and cultural skills.
2. Explain the importance of NSS activities today with real-life examples like cleanliness drives or blood donation camps.
3. Motivate and guide students to plan and carry out their own activities.
4. Give homework, grade assignments and quizzes, and keep records of students' progress in real-life field activities.
5. Encourage students to work in groups to improve their creativity and problem-solving skills.

National Service Scheme (NSS) – Contents

1. Organic farming, Indian Agriculture (Past, Present and Future), Connectivity for marketing.
2. Waste management – Public, Private and Govt organization, 5R's.
3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4. Water conservation techniques – Role of different stakeholders – Implementation.
5. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
6. Helping local schools to achieve good results and enhance their enrolment in Higher/technical/vocational education.
7. Developing Sustainable Water management system for rural areas and implementation approaches.
8. Contribution to any national level initiative of Government of India. For e.g. Digital India, Skill India, Swatch Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.
9. Spreading public awareness under rural outreach programs. (Minimum 5 programs).
10. Plantation and adoption of plants. Know your plants.
11. Organize National integration and social harmony events/workshops/seminars. (Minimum 02 programs).
12. Govt. school rejuvenation and helping them to achieve good infrastructure.

NOTE:

- Student/s in individual or in a group should select any one activity at the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of the semester, an activity report should be submitted for evaluation.

Distribution of Activities

Sem	Topics/Activities to be Covered
25 Marks	1. Organic farming, Indian Agriculture (Past, Present and Future), Connectivity for marketing. 2. Waste management – Public, Private and Govt organization, 5R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.
25 Marks	1. Water conservation techniques – Role of different stakeholders – Implementation. 2. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 3. Helping local schools to achieve good results and enhance their enrolment in Higher/technical/vocational education.
25 Marks	1. Developing Sustainable Water management system for rural areas and implementation approaches. 2. Contribution to any national level initiative of Government of India. For e.g. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc. 3. Spreading public awareness under rural outreach programs. (Minimum 5 programs). 4. Plantation and adoption of plants. Know your plants
25 Marks	1. Organize National integration and social harmony events/workshops/seminars. (Minimum 02 programs). 2. Govt. school rejuvenation and helping them to achieve good infrastructure.

Pedagogy–Guidelines, it may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

Sl No	Topic	Group size	Location	Activity execution	Reporting	Evaluation of the Topic
1.	Organic farming, Indian Agriculture(Past, Present and Future) Connectivity for marketing.	May be individual or team	Farmers land/Villages/roadside / Community area/ College campus etc.	Site selection /Proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govt organization, 5 R's.	May be individual or team	Villages/City Areas/ Grama panchayat/public associations/Govem ment t Schemes officers/ campus etc.	Site selection /Proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
3.	Setting of the information imparting club for women leading to contribution in social and economic issues.	May be individual or team	Women empowerment groups/ Consulting NGO's & Govt. Teams/ College campuses etc.	Group selection/proper consultation/Continuous monitoring/ information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stake holders– Implementation.	May be individual or team	Villages/city Areas/ Grama panchayat/public associations/Govem ment t Schemes officers/ campuses etc.	site selection / proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages/city Areas/ Grama panchayat/public associations/Govem ment t Schemes officers/ campuses.	Group selection/proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

6.	Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	May be individual or team	Local government/ private/ aided schools/Government Schemes officers/ etc....	School selection/proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
7.	Developing Sustainable Water management system for rural areas and implementation approaches.	May be individual alorteam	Villages/City Areas/ Grama panchayat/public associations/Govern ment Schemes officers/ campusetc....	Site selection/proper consultation/Continuous monitoring/ Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
8.	Contribution to any national level initiative of Government of India. For e.g. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.	May be individual alorteam	Villages/City Areas/ Grama panchayat/public associations/Govemment Schemes officers/ campus etc.	Group selection/pro per consultation/Continu ous monitoring / Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
9.	Spreading public awareness under rural outreach programs. (minimum5programs). Socials connect and responsibilities.	May be individual alorteam	Villages /CityAreas / Grama panchayat/public associations/Govern ment Schemes officers/ campusetc....	Group selection/pro per consultation/ Continu ous monitoring / Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
10.	Plantation and adoption of plants. Know your plants.	May be individual alorteam	Villages/CityAreas / Grama panchayat/public associations/Govern ment nt Schemes officers/ campusetc....	Place selection/proper consultation/Continu ous monitoring / Information board	Report should be submitted by individualsto the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer
11.	Organize National integration and social harmonyevents /Workshops /Seminars.(Minimum 02 programs).	May be individual alorteam	Villages/CityAreas / Grama panchayat/public associations/Govern ment Schemes officers/ campusetc....	Place selection/proper consultation/Continu ous monitoring / Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be individua l alorteam	Villages/CityAreas / Grama panchayat/public associations/Gov ern ment nt Schemes officers/ campusetc....	Place selection/proper consultation/Con tinu ous monitoring / Information board	Report should be submitted by individuals to the concerned evaluation authority	Evaluation as per the rubrics of scheme and syllabus by NSS officer

Plan of Action (Execution of Activities)

Sl.NO	Practice Session Description
1	Lecture session by NSS Officer
2	Students' Presentation Topics
3	Presentation-1, Selection of topic, PHASE-1
4	Commencement of activity and its progress-PHASE-2
5	Execution of Activity
6	Execution of Activity
7	Execution of Activity
8	Execution of Activity
9	Execution of Activity
10	Case study-based Assessment, Individual performance
11	Sector wise study and its consolidation
12	Video based seminar for 10minutes by each student at the end of semester with Report.

- In semester end, each student should do activities according to the scheme and syllabus.
- At the end of the semester, student performance must be evaluated by the NSS officer for the assigned activity progress and its completion.
- Finally, at the end of the semester, a consolidated report of activities should be compiled and submitted as per the instructions.

Course Outcomes (Course Skill Set)
At the end of the course, the student will be able to:
CO1: Understand the importance of his/her responsibilities towards society.
CO2: Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO3: Evaluate the existing system and propose practical solutions for the same for sustainable development.
CO4: Implement government or self-driven projects effectively in the field.
CO5: Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general

Assessment Details for CIE(both CIE and SEE)

Weightage	**CIE–100%**	• Implementation strategies of the project(NSS work). • The last report should be signed by NSSOfficer,the HOD and principal. • Finally, the report should be evaluated bythe NSS officer of the institute. • Finally,the consolidated marks sheet should be sent to the university and to be made available at LIC visit.
Presentation-1 Selection of topic, PHASE-1	10 Marks	
Commencement of activity and its progress- PHASE-2	10 Marks	
Case study-based Assessment Individual performance	10 Marks	
Sector wise study and its consolidation	10 Marks	
Video based seminar for 10minutes by each Student at the end of semester with Report.	10 Marks	
Total marks for the course in end semester	**50Marks**	

Marks scored for 50 by the students should be Scale down to 25 Marks in end semester

For CIE entry in the VTU portal.

CIE (50 Marks)

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for each activity. Marks of each evaluation includes Weekly Attendance & activities performed by students. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks.(A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as (A+B) for 50 marks

Suggested Learning Resources:

Books:

1. **NSS Course Manual,** Published by NSS Cell, VTU Belagavi.
2. Government of Karnataka, NSS cell, activities reports and its manual.
3. Government of India, NSS cell, Activities reports and its manual.

CourseOutcomes(COs)	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CO1: Understand the importance of social responsibility and civic engagement	2	2	-	-	-	3	3	2	2	2	-
CO2: Develop leadership qualities and democratic attitudes	-	2	-	-	-	2	2	3	3	2	-
CO3: Work effectively as an individual and as a team in diverse fields of community	2	-	-	-	-	3	2	3	3	2	-
CO4: Acquire skills in mobilizing community participation and local resources	-	-	2	-	1	3	3	2	2	2	2
CO5: Understand and apply health, hygiene, and environmental conservation knowledge	-	-	1	-	1	3	3	2	-	-	-
CO6: Demonstrate ethical values, empathy, and compassion in social work	-	-	-	-	-	3	3	3	2	-	-

Semester: III		
Additional Mathematics-I (Common to all branches)		
Course Code:	MVJ22MATDIP-1	CIE Marks:100
L:T:P :S :	2:0:0:0	SEE Marks: 0
Credits:	0	Total:100
Hours:	25 Hours of Theory	
Course Learning Objectives: The students will be able		
To familiarize the important and introductory concepts of Differential calculus, Integral calculus, Vector differentiation, Probability, ordinary differential equations of first order, and analyze the engineering problems.		

UNIT 1	
Differential calculus: Recapitulation of successive differentiation -nth derivative -Leibnitz theorem (without proof) and Problems,Polar curves - angle between the radius vector and tangent, angle between two curves, pedal equation, Taylor's and Maclaurin's series expansions- Illustrative examples. Self study: Radius of curvature. **Video link :** https://www.khanacademy.org/ https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11	5 Hrs.
UNIT 2	
Integral Calculus: Statement of reduction formulae for the integrals of sinn (x) , cosn (x) , sinn (x) cosn (n) and evaluation of these integrals with standard limits-problems. Double and triple integrals-Simple examples. Self study: Volume revolution, Surface area of revolution. **Video link :** https://www.youtube.com/watch?v=rCWOdfQ3cwQ https://www.khanacademy.org/math/ap-calculus-ab/ab-integration-new/ab-6-1/v/introduction-to-integral- calculus	5 Hrs.
UNIT 3	
Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. **Vector identities** - $div(\phi \vec{A})$, $curl(\phi \vec{A})$, $curl(grad(\phi))$, $div(curl \vec{A})$. Self study: Line integrals, Green's theorem, Gauss and stokes theorem. Video link : https://www.whitman.edu/mathematics/calculus_online/chapter16.html	5 Hrs.

https://www.math.ust.hk/~machas/vector-calculus-for-engineers.pdf https://www.youtube.com/watch?v=sO9Z2RSeH4s	
UNIT 4	
Probability: Basic terminology, Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples. Bayes theorem-examples. Self study: Applications of Bayes' Theorem. Video link : https://www.khanacademy.org/math/statistics-probability/probability-library https://nptel.ac.in/courses/111/105/111105041/	5 Hrs.
UNIT 5	
Ordinary Differential Equations of First Order: Introduction – Formation of differential equation, solutions of first order and first degree differential equations: variable separable form, homogeneous, exact, linear differential equations. Some special first order equations: Bernoulli equation, Clairaut's equation Self study: Applications of differential equations(ODE): Newton's law cooling. Video link : https://www.mathsisfun.com/calculus/differential-equations.html	5 Hrs.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge of calculus to solve problems related to polar curves and its applications
CO2	Apply the concept of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes.
CO3	Illustrate the applications of multivariate calculus to understand the solenoidal and irrotational vectors and also exhibit the inter dependence of line, surface and volume integrals.
CO4	Understand the basic Concepts of Probability
CO5	Recognize and solve first-order ordinary differential equations occurring in different branches of engineering.

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
3.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014.

Continuous Internal Evaluation (CIE):

- Two CIE Will be conducted for 50 marks each and average of two will be taken (A)
- Two Quizzes will be conducted along with CIE for 10 Marks Each and scaled to 15 marks each. Sum of two quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C) for 100 marks

CO-PO Mapping											
CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	3	3		2						1	1
CO2	3	3		2						1	1
CO3	3	3		3							1
CO4	2	2		3						1	1
CO5	2	2		2							1

Semester: IV		
Manufacturing Process		
Course Code:	MVJ22ME41	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	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.
2	Describe moulding, patterns and moulding furnaces. Determine the appropriate parameters for different manufacturing processes. Justify the most appropriate manufacturing process for a given product.
3	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.
4	Provide methods of analysis allowing a mathematical/physical description of polymer processing and powder metallurgy techniques in manufacturing.
5	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.

UNIT-I	
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, Simpleproblems 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.	8 Hrs

Casting – Types of Casting, Advantages, Limitations, and Applications, Casting defects. **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 **Video link / Additional online information:** Sand Casting Process: https://www.youtube.com/watch?v=mx1qteRUYwI	

UNIT-II	
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:** https://www.youtube.com/watch?v=g7MkIBdl06c&list=PLwdnzlV3ogoUQnGO8eFFygVBTjF0xyYMq https://www.youtube.com/watch?v=mmKy5PbndQI&list=PLyqSpQzTE6M-KwjFQByBvRx464XpCgOEC	8 Hrs

UNIT-III	
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 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/	8 Hrs

UNIT-IV	
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 • Comtec Mfg., Inc - Powder Metallurgy Specialist *https://www.youtube.com/watch?v=azGg68B-GlA* Video link / Additional online information:	8 Hrs

1. EPMA : Powder Metallurgy Component Production Cycle https://youtu.be/_eM49JlmFp0	

UNIT-V	
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. 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:* • 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	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
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	Categorize 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	Categorize and explain the non-conventional Machining Process and its applications.

Textbooks	
1.	O.P Khanna, "Foundry Technology", Dhanpat rai publications-2003 reprint.
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.

Continuous Internal Evaluation (CIE):
•Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
•Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
•Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)
Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks
Semester End Examination (SEE):
The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

High-3, Medium-2, Low-1

Semester: IV		
Machining Science and Operations		
Course Code:	MVJ22ME42	CIE Marks: 50
L: T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	40 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	This course will highlight topics related to metal cutting.
2	Appreciate the working of different types of turning machines.
3	The course will deal with milling shaping and drilling of materials using single and multipoint cutting tool.
4	Appreciate the Gear cutting methodology, finishing operation, and different non-traditional machining processes.

UNIT-I	
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. **Desired properties and types of cutting tool materials** – HSS, carbides coated carbides, ceramics. Cutting fluids. Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and work piece and chip. Measurement of tool tip temperature. **Laboratory Sessions/ Experimental learning:** • Drawing of Merchant circle diagram 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	8 Hrs
UNIT-II	
Turning Machine: Classification of Lathe, Driving mechanisms of lathe, constructional features of different types of lathe, different operations on lathe, Tool Layout. Shaping Machine, Planing Machine, driving mechanism, different operations	8 Hrs

on shaping machine and planing machine, Simple problems on machining time calculations. **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	
UNIT-III	
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. **Grinding**: Types of Abrasives and bonding, grinding wheel nomenclature, mounting, truing and dressing of grinding wheels, different types of grinding machines. **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	8 Hrs
UNIT-IV	
Gear Cutting Technology **Gear Milling**: Gear milling machine, worm gear milling, bevel gear milling, milling cutters. **Indexing**: Simple, compound, differential and angular indexing calculations. Simple numerical on indexing. **Gear Hobbing**: Principle of Hobbing process, advantages and limitations of Hobbing process. Hobbing techniques, Hobbing cycles, Hobbing of Worm Wheels.	8 Hrs

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**: https://www.youtube.com/watch?v=B8w-0Oi0Yf4	
UNIT-V	
Non-Conventional Machining Processes: Need for non traditional machining, Principle, equipment & operation of Laser Beam, Plasma Arc Machining, Electro Chemical Machining, Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, Electron Beam Machining, Electron Discharge Machining and Plasma Arc Machining. **Applications**: An ultrasonic tool essentially creates many small vibrations that, over time, remove material from the workpiece with which it's used https://www.engineeringchoice.com/what-is-ultrasonic-machining/ **Video link / Additional online information**: Introduction to Non-Traditional Machining by Dr. A k Sharma Department of Mechanical Engineering, IIT Kanpur. https://www.bing.com/videos/search?q=NPTEL+Ultrasonic+machining&docid=603500698202029147&mid=E2D0437D56F63E9FCA93E2D0437D56F63E9FCA93&view=detail&FORM=VIRE **Applications**: Automobile industry, Aerospace Industry, all type of sheet metal industry. **Video link / Additional online information**: https://www.youtube.com/watch?v=JgNaSll8Obo	8 Hrs
Practical Experiments – Lab Sessions	**24 Hrs.**
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. 2. Cutting of V Groove/ dovetail / Rectangular groove using a shaper. 3. Cutting of Gear Teeth using Milling Machine. 4. 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.

Course Outcomes: After completing the course,	
CO1	Students will be able to understand Merchants circle diagram.
CO2	Students will be able to understand the theory of metal cutting.
CO3	Students will be able to understand removal of metal using a cutting tool.
CO4	Students will be able to understand about milling drilling and grinding machines.
CO5	Students will be able to Analyse and understand Gear cutting technology.

Textbooks	
1. 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.

Evaluation Method

Continuous Internal Evaluation (CIE):

Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks
Weekly Evaluation 30 Marks
Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks (B)

The score for the SEE is A+B of total 100 marks

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

High-3, Medium-2, Low-1

Semester: IV		
Fluid Mechanics		
Course Code:	MVJ22ME43	CIE Marks: 50
L: T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	40 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand the properties of fluids and concept of control volume are studied.
2	Enumerate the applications of the conservation laws to flow through pipe.
3	Enumerate the applications of the conservation laws to flow through pipe.
4	Elucidate the importance of various types of flow in pumps.
5	Elucidate the importance of various types of flow in turbine.

UNIT-I	
Fluid Properties and Flow Characteristics: Dimensions and units: physical properties of fluids- specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric gauge and vacuum pressure –measurement of pressure. Manometers Piezometer, U-tube, inverted and differential manometers. Pascal's law, hydrostatic law. **Buoyancy and floatation**: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.	08 h
UNIT-II	
Fluid Dynamics: Forces acting on fluid in motion, Linear momentum equation, Impact of jets, Moment of momentum equation, Euler's equation of motion along a streamline, Bernoulli's equation – assumptions and limitations. Introduction to Navier-Stokes equation, Venturi-meters, orifice meters, rectangular and triangular notches, pitot tubes, Rota-meter, electromagnetic flow meter **Boundary Layer Theory**: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles	08 h
UNIT-III	
Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Streamline, path line and streak lines and stream tube. Stream function and velocity potential function, differences, and relation between them. Condition for irrotational flow, flow net, source and sink, doublet, and vortex flow. **Dimensional Analysis**: Similitude and modelling – Dimensionless numbers **Closed conduit flow**: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line- hydraulic gradient line.	08 h
UNIT-IV	
Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes,	08 h

Centrifugal pumps: classification, working, work done – manometric head-losses and efficiencies- specific speed- pumps in series and parallel- performance characteristic curves, cavitation & NPSH, reciprocating pumps: Working, Discharge, slip, indicator diagrams.	
UNIT-V	
Hydraulic Turbines: Classification of turbines, Impulse and reaction turbines, Pelton wheel, Francis's turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube- theory functions and efficiency. Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors, and oscillators. Advantages, limitations, and applications.	08 h
LABORATORY EXPERIMENTS	
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. 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: After completing the course, the students will be able to	
CO1	Acquire the knowledge of the basic principles of fluid mechanics and fluid kinematics.
CO2	Acquire the basic knowledge of fluid dynamics and flow measuring instruments.
CO3	Acquire the knowledge on the nature of flow and flow over bodies and the dimensionless analysis.
CO4	Elucidate the concepts of the turbomachinery and their applications.
CO5	Conduct basic experiments of fluid mechanics and hydraulic machinery and understand the working principles.

Textbooks	
1	Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2013. ISBN 13: 9788189401269

Reference Books	
1.	Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi, 2016. ISBN 13: 9788121901000
2.	A textbook of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers. ISBN 13: 9788131808153
3.	P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008. ISBN : 9788120332812

EVALUATION METHOD

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks (B)

The score for the SEE is A+B of total 100 marks

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: IV		
Mechanical Measurements and Metrology Lab		
Course Code:	MVJ22MEL44	CIE Marks: 50
L: T:P:S	0:0:2:0	SEE Marks: 50
Credits:	1	Total :100
Hours:	24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course objectives:

- 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 Pressure Gauge
2.	Calibration of Thermocouple
3.	Calibration of LVDT
4.	Calibration of Load cell
5.	Determination of modulus of elasticity of a mild steel specimen using strain gauges.
PART-B	
6	Measurements using Optical Projector / Toolmakers' Microscope
7	Measurement of angle using Sine Centre / Sine bar / bevel protractor
8	Measurement of alignment using Autocollimator / Roller set
9	Measurements of surface roughness using Tally Surf/Mechanical Comparator
10	Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer
11	Calibration of Micrometer using slip gauges
12	Measurements of Screw thread parameters using two wire or three-wire methods.

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.
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.

Textbooks: 1. Dr. T Chandrashekar, Textbook of Mechanical Measurements & Metrology, Subhas Stores, 2015.	
Reference Books:	
1.	Beckwith Marangoni and Lienhard *"Mechanical Measurements"* Pearson Education 6th Ed., 2006.

CIE Laboratory (50 Marks)
Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as (A+B) for 50 marks

SEE Laboratory Examination (50 Marks)
The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks
The final score for the course out of 100 is the SumTotal of SEE and CIE.

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

Semester: IV		
Python for Mechanical Engineers		
Course Code:	MVJ22ME451	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course objective is to:

- To understand the basics of algorithmic and flow chart for problem solving
- To learn to solve problems using Python basics of Data expression and Statements
- To learn to solve problems using Python conditionals
- To learn to solve problems using Python loops
- To use Python data structures – lists, tuples, dictionaries to represent complex data.

UNIT – 1	08Hrs.

Introduction to Programming: Meaning of problem solving, Definition of programming, Software bug, Programming errors, Natural language v/s Formal language, Programming Paradigm, interpreted v/s compiled, typed v/s type-less programming language. Algorithms: Definition, characteristics, Building blocks of Algorithms, Pseudo-code, flowcharts, Algorithmic problem solving, Simple strategies for developing algorithms, Mechanical Engineering Solved examples .

Video link / Additional online information:
Programming, Data Structures and Algorithms using Python By Madhavan Mukund
https://nptel.ac.in/courses/106106145

Programming in Python by Dr.Rizzwan Rehman

https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

UNIT – 2	08Hrs.

Introduction to Python: History, Salient features, Working with IDLE. Data expression and Statements: Variable and assignment, python data types, operators in python. Mechanical Engineering Applications (Flowchart, algorithm and program)

Video link / Additional online information:

Programming, Data Structures and Algorithms using Python By Madhavan Mukund https://nptel.ac.in/courses/106106145

Programming in Python by Dr.Rizzwan Rehman

https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

UNIT – 3	08Hrs.

Boolean values and Operators, Decision making: if statement syntax, simple Programs (including algorithm and flow chart) If-else syntax, flow chart, simple Programs (including algorithm and flow chart) If-elif-else, syntax, flowchart, Mechanical Engineering Applications (Flowchart, algorithm and program)

Video link / Additional online information:
Programming, Data Structures and Algorithms using Python By Madhavan Mukund
https://nptel.ac.in/courses/106106145

Programming in Python by Dr.Rizzwan Rehman

https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

UNIT – 4	08Hrs.

Iteration : state, while loop: syntax, flowchart, simple Programs (including algorithm and flow chart) for loop: syntax, flow chart. Mechanical Engineering Applications (Flowchart, algorithm and program)

Video link / Additional online information:
Programming, Data Structures and Algorithms using Python By Madhavan Mukund
https://nptel.ac.in/courses/106106145

Programming in Python by Dr.Rizzwan Rehman

https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

UNIT – 5	08Hrs.

Lists and Tuples : List methods, Processing lists, nested lists, tuples. Programs on lists and tuples. Introductions to functions, syntax, simple programs on functions, Sharing python code using modules.

Video link / Additional online information:
Programming, Data Structures and Algorithms using Python By Madhavan Mukund
https://nptel.ac.in/courses/106106145

Programming in Python by Dr.Rizzwan Rehman

https://onlinecourses.swayam2.ac.in/cec22_cs20/preview

Course Outcomes:	
CO1	Develops algorithms and flowcharts for problem solving.
CO2	Develop programs by using Data expression and Statements, loops

CO3	Demonstrate proficiency in handling python conditionals and identify the methods to create and manipulate lists, tuples.

Text Books:	
1	Al Sweigart, "Automate the Boring Stuff with Python",1stEdition, No Starch Press, 2015. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)
2	S.A. Kulkarni, "Problem solving and python programming", 2nd edition Yesdee publishing pvt. Ltd. 2019
Reference Books	
1	Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Green Tea Press, 2015.

Continuous Internal Evaluation (CIE):
Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The theory exam consists of a written paper structured into two parts:

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

High-3, Medium-2, Low-1

Semester: IV		
Precision Engineering and Nano Fabrication		
Course Code:	MVJ22ME452	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Learn and understand basic concepts & definitions of precision engineering
2	Make selection of the type of microfabrication technique required for any specific product
3	Know about the special microfabrication and gauging when their use is warranted.

UNIT-I	
Introduction – Precision, Accuracy & Smoothness – Need – Development of overall machining precision Classes of achievable machining Accuracy- Precision machining-High precision Machining-Ultra precision Machining- application of precision machining- Materials for tools and machine elements – carbides – ceramic, CBN & diamond-Tool and work material compatibility. **Experiential Learning**: High precision machining of components in machine shop lab **Video Links/Any other special information**: https://nptel.ac.in/courses/112105231	8 Hrs
UNIT-II	
Precision machine element Introduction – Guide ways – Drive systems – Spindle drive – preferred numbers – Rolling elements– hydrodynamic & hydrostatic bearings – Hybrid fluid bearings- Aero static and aero dynamic bearings-Hybrid gas bearings-materials for bearings. **Experiential Learning**: High precision machining of components in machine shop lab **Video link / Additional online information**: https://nptel.ac.in/courses/112105231	8 Hrs
UNIT-III	
Error Control: Error – Sources – Static stiffness – Variation of the cutting force – total compliance – Different machining methods – Thermal effects – heat source – heat dissipation – Stabilization – decreasing thermal effects – forced vibration on accuracy – clamping & setting errors – Control errors due to locations – principle of constant location surfaces. **Experiential Learning**: High precision machining of components in machine shop lab **Video link / Additional online information**: https://nptel.ac.in/courses/112105231	8 Hrs
UNIT-IV	
Micro and Nano fabrication Micro and Nano machining processes-diamond machining - micro engraving — Micro replication techniques — forming — casting — injection	8 Hrs

moulding - micro embossing - Energy assisted processes LBM, EBM, FIB, Micro electro discharge machining-photolithography-LIGA process-Silicon micro machining-Wet and dry etching-thin film deposition. **Experiential Learning**: Micro manufacturing of silicon wafer based components in chemistry lab. **Video link / Additional online information**: **https://nptel.ac.in/courses/112105231**	
UNIT-V	
Nano Machining: Laser Optics, Laser Ablation, Heat Affected Zone and Laser Polymerization, Micro and Nano welding: Micro and Nano welding in similar and dissimilar materials; welding processes like ultrasonic, EB, LB; applications. Micro and Nano casting: Casting processes like vacuum, semi-solid state; applications. Processing of Integrated Circuits, Clean rooms, crystal growing and shaping of wafers, Etching, Photo and other lithography techniques, Impurity introduction, Thermal oxidation, CVD, Metallization etc. IC packaging **Experiential learning**: • Etching of the different substrate materials in clean room **Video link / Additional online information**: **https://nptel.ac.in/courses/112105231**	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Appreciate the meaning of precision machining and the importance of it.
CO2	Get familiarized with the requirements of machine network elements to achieve precision in the components.
CO3	Appraise the principles of various precision engineering processes and apply them in actual field.
CO4	Appreciate the various method of micro and nanomachining using LASER and other processes.
CO5	Appraise the Application of ultra-precision manufacturing for producing precise components

Textbooks	
1.	Venkatesh V.C. and Izman S., Precision Engineering, Tata McGraw Hill, 2007.
Reference Books	
2.	Murthy R.L., Precision Engineering, New Age International, 2009.
3.	Nakazawa H., Principles of Precision Engineering, Oxford University Press, 1994.

Continuous Internal Evaluation (CIE):
Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

CO-PO Mapping											
CO/P O	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO1 0	PO11
CO1	3	3	3	3							1
CO2	3	3	2	3							
CO3	2	3	3	3							1
CO4	3	3	2	3							
CO5	3	3	3	2							

Semester: IV		
Micro Electro Mechanical Systems		
Course Code:	MVJ22ME453	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Give an insight into the history and latest developments regarding MEMS
2	Appreciate piezoelectric and magnetic sensing and actuation.
3	Elucidate the importance of measurement, signal processing, drive and control techniques
4	Elucidate the concept of Signal Processing, Drive and Control Techniques.
5	Explicate the concepts of MEMS and Microfabrication.

UNIT-I	
MEMS: History of MEMS, Intrinsic Characteristics, and 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. **Experiential Learning**: Demonstration of functioning of sensors and actuators in MEMS devices **Video Links/Any other special information:** 1. https://nptel.ac.in/courses/117105082 2. https://archive.nptel.ac.in/courses/108/108/108108113/	8 Hrs
UNIT-II	
Piezoelectric and Magnetic Sensing and Actuation: Introduction, Cantilever Piezoelectric actuator model, Properties of Piezoelectric materials, Applications. Magnetic Actuation: Concepts and Principles. **Experiential Learning**: Demonstration of the concepts of piezoelectric and mangetic sensing and actuation. **Video Links/Any other special information:** 1. https://nptel.ac.in/courses/117105082 2. https://archive.nptel.ac.in/courses/108/108/108108113/	8 Hrs
UNIT-III	
Measurement, Signal Processing, Drive and Control Techniques: Quasi -static and Dynamic Measurement Methods; Signal conditioning devices; Constant voltage, Constant-current and Pulse drive methods; Calibration methods; Structural dynamics and Identification techniques; Passive, Semi - active and Active control; Feedback and feed forward/control strategies. **Experiential Learning**: Demonstration of measurement, signal process drive and control techniques **Video Links/Any other special information:** 1. https://nptel.ac.in/courses/117105082 2. https://archive.nptel.ac.in/courses/108/108/108108113/	8 Hrs
UNIT-IV	
Data Acquisition and Processing – Signal Processing and Control for	8 Hrs

Smart Structures – Sensors as Geometrical Processors – Signal Processing – Control System – Linear and Non-Linear. **Experiential Learning**: Data acquisition and signal processing using NI-LAB VIEW Software **Video Links/Any other special information**: 1. https://nptel.ac.in/courses/117105082 2. https://archive.nptel.ac.in/courses/108/108/108108113/	
UNIT-V	
Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyroscopes. **MEMS Micro manufacturing and Product development**: Bulk and Surface Micromachining, The LIGA Process, MEMS product development-Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition. **Experiential Learning**: Preparation of product development plan for MEMS devices considering all the concepts of product development. **Video Links/Any other special information**: 1. https://nptel.ac.in/courses/117105082 2. https://archive.nptel.ac.in/courses/108/108/108108113/	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Define the basic concepts of MEMS and latest developments in the domain
CO2	Understand Design, Analysis, Manufacturing and Applications of MEMS Products
CO3	Appreciate the application of MEMS devices in real time.
CO4	Apply the principle of Measurement, Signal Processing, Drive and Control Techniques in their projects.
CO5	Apply the knowledge of MEMS and MEMS fabrication techniques in real time.

Textbooks	
1. V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", John Wiley and Sons, England, 2006.	
Reference Books	
1.	Manouchehr E. Motamedi, "MOEMS: Micro-Opto-Electro-Mechanical Systems" New Age International Publishers, 2010 (ISBN-13 : 978-8122428339)
2.	Chang Liu, "Foundation of MEMS", Pearson Education. (ISBN:9788131764756)

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: IV		
Robotics and Automation		
Course Code:	MVJ22ME454	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To Familiarize with anatomy, specifications and types of Robots
2	Obtain forward and inverse kinematic models of robotic manipulators
3	Develop dynamic model and design the controller for robotic manipulators
4	Choose appropriate Robotic configuration and list the technical specifications for robots used in different applications
5	Familiarize with different types of mobile robots, kinematic models, motion control and sensors for mobile robots

UNIT-I	
Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot configurations- PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots; Classification of robots based on motion control methods and drive technologies; 3R concurrent wrist; Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot.	8 Hrs
UNIT-II	
Robot Kinematics Direct Kinematics- Rotations-Fundamental and composite Rotations, Homogeneous coordinates, Translations and rotations, Composite homogeneous transformations, Screw transformations, Kinematic parameters, The Denavit-Hartenberg (D-H) representation, The arm equation, direct kinematics problems (upto 3DOF) Inverse kinematics- general properties of solutions, Problems (upto 3DOF) Inverse kinematics of 3DOF manipulator with concurrent wrist (demo/assignment only)	8 Hrs
UNIT-III	
Trajectory planning Tasks, Path planning, Trajectory Planning. Joint space trajectory planning- cubic polynomial, linear trajectory with parabolic blends, trajectory planning with via points; Cartesian space planning, Point to point vs continuous path planning. Obstacle avoidance methods- Artificial Potential field, A* algorithms.	8 Hrs
UNIT-IV	
Manipulator Dynamics Lagrange's formulation – Kinetic Energy expression, velocity Jacobian and Potential Energy expression, Generalized force, Euler-Lagrange equation, Dynamic model of planar and spatial serial robots upto 2 DOF, modelling including motor and gearbox. Robot Control The control problem, Single axis PID control-its disadvantages, PD gravity control, computed torque control.	8 Hrs

UNIT-V	
Industrial Applications-Material handling, welding, Spray painting, Machining. Case study for robotic applications including robot selection considerations for a typical industrial Robotics & Automation. Application- number of axes, work volume, capacity & speed, stroke &reach, Repeatability, Precision and Accuracy, Operating environment. For e.g. – the robotic configuration for pick and place robot, spot welding robot in a car manufacturing industry, peg in hole assembly. Applications in the medical, mining, space, defence, security, domestic, entertainment.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Differentiate between open and closed kinematic chain with the help of examples.
CO2	Differentiate between reachable and dexterous workspace.
CO3	Differentiate between path and trajectory of a robotic manipulator
CO4	Understand the Dynamic model of robotic manipulators
CO5	Understand the Characteristics of a spray-painting robot.

Text Books	
1. Introduction to Robotics by S K Saha, Mc Graw Hill Education	
Reference Books	
1.	Robert. J. Schilling , "Fundamentals of robotics – Analysis and control", Prentice Hall of India 1996.
2.	Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
4.	Robotics Technology and Flexible Automation, Second Edition, S. R. Deb
Web links and Video Lectures (e-Resources): https://archive.nptel.ac.in/courses/112/105/112105249/ https://onlinecourses.nptel.ac.in/noc21_me76/preview	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50

Semester IV			
IDEA BOX (Level 2)			
Course Code	MVJ22A4012	**CIE Marks**	50
L:T:P:S	1 : 0 : 2	**SEE Marks**	50
Credits	02	**Total Marks**	100
Hours	12 Hrs. of Theory and 24 Hrs. of Practical	**Exam. Duration**	2 hours

Course objectives: This course will enable students,

- To develop innovation mindset and understand levels of innovation, manufacturing and Investments.
- To understand different types of prototypes and their benefits .
- To develop critical thinking skills by developing the prototypes and testing.

UNIT - 1	**4 and 8**
Technology Readiness Levels of the Innovation, Manufacturing Readiness Levels of innovations, Investment Readiness levels for Innovation	
UNIT - 2	**4 and 8**
Prototyping and experimentation : Initial Design, Developing designs, Types of prototypes: Sketches and diagrams, 3D printing or rapid model, Physical model, Wireframe, Role-play through virtual or augmented reality, Feasibility, Working model, Video prototype, Horizontal, Vertical, Experimental Prototyping.	
UNIT - 3	**4 and 8**
Activity on realization of the TRL, MRL and IRL, To design and develop the proof of concepts for the ideas/problem statements defined in 3rd semester, To develop strategies to make the project work flawlessly.	

Course outcomes: Students will be able to

CO1	Understand the Concepts of TRL,MRL and IRL
CO2	Design develop Protypes
CO3	Demonstrate practical aspects of design and development of the proposed idea.

	TextBooks:
1.	Michael Michalko "Cracking Creativity", Ten Speed Press; Revised edition ,13 April 2011.
	Reference Books:
1.	Austin Kleon "Steal like an Artist", Workman Publishing; 1st edition, 15 April 2014.
2.	Sam Harrison "Idea Spotting: How to Find Your Next Great Idea", Cincinnati, Ohio: HOW Books, 2006.

Semester IV			
Tinkering Lab (Level 2)			
Course Code	MVJ22A4032	CIE	50 Marks
L:T:P:S	1 : 0 : 2	SEE Marks	50
Credits	02	Total Marks	100
Hours	12 Hrs. of Theory and 24 Hrs. of Practical	Exam. Duration	2 hours

Course objective is to:	
To empower students with skills of creativity, innovation, critical thinking, design thinking, social and cross-cultural collaboration and ethical leadership.	
UNIT - 1	4 and 8
Introduction to Modelling and analysis: A overview of modelling and analysis software, explaining the orthographic projection principles, different planes, different views of the drawing, different analysis tools and their significance in project work	
UNIT - 2	4 and 8
Hands on experience on Modelling and analysis tool: Giving hands on training on modelling tool (solid Edge 3D modelling) and analysis on Ansys software	
UNIT - 3	4 and 8
Project work: Submitting the CAD model of the idea generated in the level 1, along the analysis carried out in the Ansys software.	
Course outcomes:	
COs	1. Promote innovative skill set among the young minds.
	2. Develop CAD models for 3D printing
Text/Reference Books:	
1.	'Machine Drawing with Auto CAD', Goutam Rohit & Goutham Ghosh, 1st Indian print Pearson, Education, 2005
2.	"Finite Element Analysis" Bhavighati, Pearson Publication, 4th Edition 2016

Semester IV			
CNC Lab (Level 2)			
Course Code	MVJ22A4112	**CIE**	50Marks
L:T:P:S	1 : 0 : 2	**SEE Marks**	50
Credits	02	**Total Marks**	100
Hours	12 Hrs. of Theory and 24 Hrs. of Practical	**Exam. Duration**	2 hours

Course objectives: -

This course will enable students to,

- Understand the different drives and controllers in CNC.
- Understand the CNC Part Program terminologies

UNIT - 1	**4 and 8**

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer.

UNIT - 2	**4 and 8**

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, manual part programming for machining center and turning center.

UNIT - 3	**4 and 8**

To develop a program for the project identified
To develop the design and mechanism involved in the project and initiate the fabrication of the project.

Course outcomes:	
	1. Understand the fundamentals of CNC drivers and controllers 2. Develop the part programs for various operations.
Text/Reference Books:	
1.	Mechatronics HMT Tata McGraw-Hill Publishing Company Limited, New Delhi 2005
2.	Computer Control of Manufacturing systems Koren Y McGraw Hill 1986
3.	Automation, Production Systems, and Computer –Integrated Manufacturing by Mikell P. Groover

Semester: IV		
BIOLOGY FOR ENGINEERS		
Course Code:	MVJ22BI47	CIE Marks: 50
L: T:P:S	2:0:0:0	SEE Marks: 50
Credits:	2	Total :100
Hours:	24 Hrs. of Theory	SEE Duration: 2 Hrs.

Course objectives:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To enable the students with an understanding of biodesign principles to create novel devices and structures.
- To provide the students with an appreciation of how biological systems can be re-designed as substitute products for natural systems.
- To motivate the students to develop interdisciplinary vision of biological engineering.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
2. Instructions with interactions in classroom lectures (physical/hybrid).
3. Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
4. Flipped classroom sessions (~10% of the classes).
5. Industrial visits, Guests talks and competitions for learning beyond the syllabus.
6. Students' participation through audio-video based content creation for the syllabus (as assignments).
7. Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.

8. Students' seminars (in solo or group) oral presentations.

Module-1	(4 Hours)

CELL BASIC UNIT OF LIFE

Introduction. Structure and functions of a cell. Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules: Properties and functions of enzymes, vitamins and hormones.

Module-2	(5 Hours)

APPLICATION OF BIOMOLECULES

Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication, food processing, detergent formulation and textile processing.

Module-3	(5 Hours)

ADAPTATION OF ANATOMICAL PRINCIPLES FOR BIOENGINEERING DESIGN

Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as purification system. Kidney as a filtration system.

Module-4	(5 Hours)

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS:

Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluoro carbons (PFCs).

Module-5	(5 Hours)

TRENDS IN BIOENGINEERING:

Muscular and Skeletal Systems as scaffolds, scaffolds and tissue engineering, Bioprinting techniques and materials. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Bioconcrete. Bioremediation. Biomining.

Course outcome (Course Skill Set)

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

1. Elucidate the basic biological concepts via relevant industrial applications and case studies.
2. Evaluate the principles of design and development, for exploring novel bioengineering projects.
3. Corroborate the concepts of biomimetics for specific requirements.
4. Think critically towards exploring innovative biobased solutions for socially relevant problems.

Continuous Internal Evaluation (CIE) – 50 Marks

The CIE for the mandatory credit courses common across all disciplines comprises of two components as follows:

Internal Assessment Tests (30 Marks):

Two Internal Assessment tests will be conducted, each comprising 50 multiple choice questions for a total of 50 marks. The average of the two test scores will be scaled down to 30 marks.

Assignments (20 Marks):

Students are required to complete two assignments, each carrying 10 marks. These assignments may include projects*, poster presentations*, seminars*, or similar academic activities. The marks of the two assignments are added to get 20 marks.

*Each assignment will undergo two rounds of evaluation to assess progress and quality

At the beginning of the semester, the instructor/faculty teaching the course has to announce the methods of Assignment for the course.

Together, these two components are added to get the Final CIE marks of 50.

Semester End Examination (SEE) – 50 Marks

A Semester End Examination is conducted for 50 marks comprising of multiple-choice questions (MCQ) type each of one mark.

The final score for the course out of 100 is the Sum Total of SEE and CIE.

Suggested Learning Resources:

Books

- Biology for Engineers, Rajendra Singh C and Ratnakar Rao N, Rajendra Singh C and Ratnakar Rao N Publishing, Bengaluru, 2023.
- Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
- Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
- Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
- Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
- Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.

  Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
- Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
- Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C

  Udayashankar Lambert Academic Publishing, 2019.
- 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.

  Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016

Web links and Video Lectures (e-Resources):
• https://nptel.ac.in/courses/121106008 • https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists • https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009 • https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006 • https://www.coursera.org/courses?query=biology • https://onlinecourses.nptel.ac.in/noc19_ge31/preview • https://www.classcentral.com/subject/biology • https://www.futurelearn.com/courses/biology-basic-concepts
Activity Based Learning (Suggested Activities in Class)/ Practical Based Learning • Group Discussion of Case studies • Model Making and seminar/poster presentations • Design of novel device/equipment like Cellulose-based water filters, Filtration system

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

Semester: IV		
Universal human values course		
Course Code:	MVJUHV48	CIE Marks: 50
L: T:P:S	1:0:0:0	SEE Marks: 50
Credits:	1	Total :100
Hours:	15 Hrs. of Theory	SEE Duration: 2 Hrs.

Course Learning Objectives: The students will be able to	
1	Appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2	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.
3	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.

UNIT-I	
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: • https://www.youtube.com/watch?v=85XCw8SU084 • https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3p Z3yA7g_OAQz • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	3 Hrs
UNIT-II	
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.	3 Hrs

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: • https://www.youtube.com/watch?v=GpuZo495F24 • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	
UNIT-III	
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: • https://www.youtube.com/watch?v=F2KVW4WNnS • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	3 Hrs
UNIT-IV	
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: • https://www.youtube.com/watch?v=1HR-QB2mCF0 • https://www.youtube.com/watch?v=lfN8q0xUSpw • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	3 Hrs
UNIT-V	
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	3 Hrs

Humanistic Models in Education (Tutorial 13) Exploring Steps of Transition towards Universal Human Order (Tutorial 14) Video link: • https://www.youtube.com/watch?v=BikdYub6RY0 • https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw	

Course Outcomes: After completing the course, the students will be able to	
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

Textbooks	
1.	AICTE SIP UHV-I Teaching Material, https://fdp-si.aicte india.org/ AicteSipUHV _download.php
2.	A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
3.	Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2
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)
5.	The Story of My Experiments with Truth – by Mohandas Karamchand Gandhi

Continuous Internal Evaluation (CIE) – 50 Marks

The CIE for the mandatory credit courses common across all disciplines comprises of two components as follows:

Internal Assessment Tests (30 Marks):

Two Internal Assessment tests will be conducted, each comprising 50 multiple choice questions for a total of 50 marks. The average of the two test scores will be scaled down to 30 marks.

Assignments (20 Marks):

Students are required to complete two assignments, each carrying 10 marks. These assignments may include projects*, poster presentations*, seminars*, or similar academic activities. The marks of the two assignments are added to get 20 marks.

*Each assignment will undergo two rounds of evaluation to assess progress and quality

At the beginning of the semester, the instructor/faculty teaching the course has to announce the methods of Assignment for the course.

Together, these two components are added to get the Final CIE marks of 50.

Semester End Examination (SEE) – 50 Marks

A Semester End Examination is conducted for 50 marks comprising of multiple-choice questions (MCQ) type each of one mark.

The final score for the course out of 100 is the SumTotal of SEE and CIE.

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

SEMESTER 3/4/5/6		
PHYSICAL EDUCATION (SPORTS & ATHLETICS)		
Course Code:	MVJ22PE39/49/59/69	CIE Marks: 100
L: T:P:S	0:0:2:0	SEE Marks: -
Credits:	0	Total :100
Hours:	24	SEE Duration: -

Course Objectives: the student will be able to

1	Understand the meaning and importance of the fitness and the benefits of fitness
2	Types of fitness and fitness tips.
3	Importance of Sports, and Yoga in a day-to-day life.
4	Understand the importance of aerobics and other activities for healthy lifestyle.
5	Know about the different roles of organization and administration in sports events.

Topics / Activities to be Covered (100Marks)

Module I **4 Hours**

Orientation

- Lifestyle
- Fitness
- Food & Nutrition: Sports diet.
- Stress Management

Module II **4 Hours**

General Fitness & Components of Fitness

- Warming up (Free Hand Exercises).
- Strength—Push-up/Pull-ups
- Speed—30MtrDash.
- Agility—Shuttle Run
- Flexibility—Sit and Reach

Module III **6 Hours**

Specific Games (Anyone to be selected by the student)

- Volleyball— Attack, Block, Service, Upper Hand Pass and Lower Hand and Pass.
- Throw ball—Service, Receive, Spin attack, Net Drop & Jump throw.
- Kabaddi— Hand touch, Toe Touch, Thigh Hold, Ankle hold and Bonus.
- Basketball-dribbling, passing, shooting etc.
- Table Tennis—Service (Fore Hand & Back Hand)
- Receive (Fore Hand & Back Hand)
- Smash, Athletics (Track / Field Events) -Running, Jumping, Throwing.

Module IV	6 Hours

Role of Organization and administration

- Planning.
- Organizing.
- Staffing.
- Directing.
- Coordinating & controlling.
- Reporting & Recording.
- Budgeting.

Module V	4 Hours

Aerobics

- Dance Aerobics
- Sport Aerobics
- Warm up Aerobics
- Cardiovascular Aerobics

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness.
CO2	Familiarization of health-related Exercises, Sports for overall growth and development.
CO3	Create a foundation for the professionals in physical Education and Sports.
CO4	Participate in the competition at regional / state / national / international levels.
CO5	Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.

Assessment Details for CIE (both CIE and SEE)

Weight age	CIE – 100%	
Participation of student in all the modules	50 Marks	• Implementation strategies of the project (PE work). • The last report should be signed by PED, the HOD and principal. • At last report should be evaluated by the PED of the institute. • Finally, the consolidated marks sheet should be sent to the Controller of Examinations office.
Final presentation / exhibition / Participation In competitions / practical on specific tasks Assigned to the students	50 Marks	
Total marks for the course in eachsemester	**100 Marks**	

Marks scored for 100 by the students should be Scale to 50 marks in each semester.

Students should present the progress of the activities as per the schedule in the prescribed practical session in the field.There should be positive progress in the vertical order for the benefit of society in general.

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CO/PO Mapping											
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1	-	-	-	-	-	-	-	2	2	-	-
CO 2	-	-	-	-	-	-	-	2	2	-	-
CO 3	-	-	-	-	-	-	-	2	2	-	-
CO 4	-	-	-	-	-	-	-	2	2	-	-
CO 5	-	-	-	-	-	-	-	3	3	-	-

Semester: IV		
Additional Mathematics-II (Common to all branches)		
Course Code:	MVJ22MATDIP2	CIE Marks:100
L:T:P :S :	2:0:0:0	SEE Marks: 0
Credits:	0	Total:100
Hours:	25	
Course Learning Objectives: The students will be able to		
	To familiarize the important tools Linear Algebra, differential Calculus, Beta and Gamma functions, Three-dimentional Geometry and higher order ODE's and PDE's for analyzing the engineering problems.	

UNIT 1	
Linear Algebra: Introduction - Rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Diagonalization of a square matrix of order two. Self study: Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix- Examples. Video Links : https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdf https://nptel.ac.in/content/storage2/courses/122104018/node18.htmlhttps://www.youtube.com/watch?v=Pq- tUQzeSRw	5 Hrs.
UNIT 2	
Differential calculus: Indeterminate forms: L-Hospital rule (without proof), Total derivatives, Composite functions. Maxima and minima for a function of two variables. Jacobians- simple examples. **Beta and Gamma functions:** Beta and Gamma functions, Relation between Beta and Gamma function-	5 Hrs.

simple problems. Self study: Asymptotes, Curve tracing. Video Links : https://www.youtube.com/watch?v=6RwOoPN2zqE https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11	
UNIT 3	
Analytical solid geometry : Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- differentforms, 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/	5 Hrs.
UNIT 4	
Differential Equations of higher order: Linear differential equations of second and higher order equations with constant coefficients. Inverse Differential operator, Operators methods for finding particular integrals, Method of variation of parameters, and Euler – Cauchy equation. Self study: Undetermined coefficients Video link: https://www.slideshare.net/ayeshajavednoori/application-of-higher-order-differential-equations	5 Hrs.
UNIT 5	
Partial differential equation: Introduction- Classification of partial differential equations, formation of partial differential equations. Method of elimination of arbitrary constants and functions. Solutions of non-homogeneous partial differential equations by direct integration. Solution of Lagrange's linear PDE. Self study: One dimensional heat and wave equations and solutions by the method of separable of variable Video Link : https://www.khanacademy.org/PDE	5 Hrs.

http://www.nptelvideos.in/	

Course Outcomes: After completing the course, the students will be able to	
CO1	Make use of matrix theory for solving system of linear equations and compute eigenvalues and eigen vectors required for matrix diagonalization process.
CO2	Learn the notion of partial differentiation to calculate rates of change of multivariate functions and solve problems related to composite functions and Jacobians.
CO3	Understand the Three-Dimensional geometry basic, Equation of line in space-different forms, Angle between two line and studying the shortest distance .
CO4	Demonstrate various physical models through higher order differential equations and solve such linear ordinary differential equations.
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
3.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014.

Continuous Internal Evaluation (CIE):

- Two CIE Will be conducted for 50 marks each and average of two will be taken (A)
- Two Quizzes will be conducted along with CIE for 10 Marks Each and scaled to 15 marks each. Sum of two quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

  Final CIE Marks will be calculated as (A+B+C) for 100 marks

CO/ PO	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
CO1	3	3	-	2	-	-	-	-	-	-	1
CO2	3	3	-	2	-	-	-	-	-	-	1
CO3	3	3	-	3	-	-	-	-	-	-	-
CO4	2	2	-	3	-	-	-	-	-	-	1
CO5	2	2	-	2	-	-	-	-	-	-	-

Semester: V		
Industrial Management		
CourseCode:	MVJ22ME51	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Understand the fundamental concepts and principles of management and to help the students gain understanding of the functions and responsibilities of managers.	
2	Understand the concepts of project management and collaborative project teams.	
3	Understand the Traditional Project Management and launch and execute to TPM.	
4	Understand the process of Workplace and Organizational vision	
5	knowledge, with respect to concepts, principles and practical applications of statistical process control	

UNIT-I	
Industrial 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 - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans. **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. Directing & controlling: Meaning and nature of directing - Leadership styles, Motivation Theories.	8 Hrs
UNIT-II	
Understanding the Project Management Landscape : Defining a Project, Defining a Program, Defining a Portfolio,Challenges to Effective Project Management, Managing the Creeps, Introducing Project Management Life Cycles, Agile Project Management Approaches, Extreme Project Management Approach, Hybrid Project Management Approach, Choosing the Best-Fit PMLC Model, Definition of Strategic Project Management, The Business Environment: Business Climate, Market Opportunities , Enterprise Capacity, SWOT, Value Chain Analysis. **Collaborative Project Team and PM Process Groups :** The Complex Project Team, Project Executive, Core Team, Using the Co-Manager Model, Establishing Meaningful Client Involvement, The Challenges to Meaningful Client Involvement, Project Management Process Groups : Project Integration Management, Project Scope Management, Project Schedule Management, Project Cost Management, Project Quality Management.	8 Hrs
UNIT-III	
Traditional Project Management (TPM): Using Tools, Templates, and Processes to Scope a Project, Managing Client Expectations, The Project Scoping Meeting, Project Scoping Meeting Deliverable. How to Plan a TPM Project: Using Tools, Templates, and Processes to Plan a Project, The Importance of Planning, Using Application Software Packages to Plan a Project.	8 Hrs

Launch and Execute a TPM Project: Using the Tools, Templates, and Processes to Launch a Project, Recruiting the Project Team, Developing a Team Deployment Strategy, Conducting the Project Kick-Off Meeting, Establishing Team Operating Rules, Managing Scope Changes, Managing Team Communications, Assigning Resources, Resource Leveling Strategies, Finalizing the Project Schedule, Writing Work Packages. Execute a TPM Project	
UNIT-IV	
Understanding the Workplace: Defining Organizational Behaviour, Perception, Personality, and Emotions, Values, Attitudes, and Diversity in the Workplace, Groups and Teamwork: From Individual to Team Member, Stages of Group and Team Development, Creating Effective Teams, Interacting Effectively, The Communication Process, Barriers to Effective Communication, Organizational Communication, Power and Politics at the workplace, Conflict and Negotiation at workplace. **Sharing the Organizational Vision:** Organizational Culture: Definition of Organizational Culture, Creating and Sustaining an Organization's Culture, Changing Organizational Culture, Leadership: Leadership as Supervision, Inspirational Leadership, Contemporary Leadership Roles, Contemporary Issues in Leadership, Decision Making.	**8 Hrs**
UNIT-V	
Process and Technology Management : Definition of process management. Major process decisions-process choice, vertical integration, resource flexibility, customer involvement, capital intensity, relationships between decisions, service operation, economics of scoop and gaining focus. Designing process-process rearranging and process improvement. Management of technology and its role in improving business performance. Creating and applying technology-R and D stages and technology fusion. Technology strategy. Implementation guidelines. Statistical Process Control: Check sheets; Graphs (Trend Analysis); Histograms; Pareto charts; Cause-and-effect diagrams; Scatter diagrams; Control charts, Statistical Basis of the Control Charts -basic principles, choices of control limits, significance of control limits, control limits, analysis of pattern on Variable attribute control charts.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss Decision making, Organizing, Staffing, Directing and Controlling.
CO2	Correlate concepts of Traditional Project Management and launch and execute TPM projects.
CO3	Plan and reframe the project management Landscape and Process Groups
CO4	Design and modify the organizational vision and workplace culture.
CO5	Plan and collaborate the concepts of statistical process control.

Textbooks	
1.	Principles of Management Tripathy and Reddy Tata McGraw Hill 3rd edition 2006.
Reference Books	
1.	Organisational Behaviour by - Stephen Robbins - Pearson Education/PHI - 17th Edition, 2003

2.	Statistical Quality Control: E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher
3.	Statistical Process Control by John S Oakland , 6th Edition, Routledge, ISBN:978-0750669627

Web links and Video Lectures (e-Resources):

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

https://archive.nptel.ac.in/courses/110/107/110107094/

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

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
Turbo Machines		
Course Code:	MVJ22ME52	CIE Marks: 50
L: T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	40 and 24	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved	
2	Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.	
3	Analyse various designs of steam turbine and their working principle.	
4	Study the various designs of hydraulic turbine based on the working principle.	
5	Understand the various aspects in design of power absorbing machine.	

UNIT-I	
Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies. **Thermodynamics of fluid flow:** Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, Incompressible fluids and perfect gases, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process	08 Hrs
UNIT-II	
Energy exchange in Turbo machines: 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, Problems. **General Analysis of Turbo machines:** Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity relationship, General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Problems.	08 Hrs
UNIT-III	
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. **Reaction turbine** – Parsons's turbine, condition for maximum utilization factor, reaction staging. Problems.	08 Hrs
UNIT-IV	
Hydraulic Turbines: Classification, various efficiencies. **Pelton turbine –** velocity triangles, design parameters, 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.	08 Hrs

UNIT-V	
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. 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.	08 Hrs

LABORATORY EXPERIMENTS

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. 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. Measurements of Exhaust Emissions of Petrol engine.
8. Measurements of Exhaust Emissions of Diesel engine.
9. Demonstration of measurements of P-θ, PV plots using IC Engine test rig.

Course Outcomes: After completing the course, the students will be able to	
CO1	Able to give precise definition of turbomachinery
CO2	Apply the Euler's equation for turbomachinery to analyse energy transfer in turbomachines
CO3	Understand the principle of operation of pumps, fans, compressors and turbines
CO4	Perform the preliminary design of turbomachines (pumps, rotary compressors and turbines)
CO5	Analyze the performance of turbo machinery.

Textbooks:	
1. A Textbook of Hydraulic Machines, RK Rajput, S. Chand Publishing	
Reference Books	
1.	An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers, reprint 2008.
2.	Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002
3.	Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964).

Web links and Video Lectures (e-Resources):

1. http://acl.digimat.in/nptel/courses/video/112104305/L01.html
2. http://acl.digimat.in/nptel/courses/video/112106303/L08.html
3. http://acl.digimat.in/nptel/courses/video/112106303/L09.html
4. http://acl.digimat.in/nptel/courses/video/112106303/L13.html

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks (B)

The score for the SEE is A+B of total 100 marks

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
Theory of Machines		
Course Code:	MVJ22ME53	CIE Marks: 50
L: T:P:S	3:2:0:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	50	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Explain the types of relative motion to differentiate between Machine, Mechanism, and Structure	
2	Draw velocity and acceleration diagrams of linkages.	
3	Determine gear parameters and determine train value & fixing torque in gear trains.	
4	Design Cam profile for the desired follower motion.	

UNIT-I	
Fundamentals and types of Mechanisms Introduction: Definition of link, pari, kinematic chain, mechanism, machine, inversion, structure- Types of motion, Grashof's criterion, Inversions of 4 bar chian, single slider crank chain and double slider crank chain, Degrees of freedom, Grubler's criterion for mobililty of mechanims. Mechanisms: Drag link and toggle mechanism - straight line mechanisms, condition for exact straight line motion, Peaucillier and Hart mechanisms- intermittent motion mechanism, Ratchet and Pawl and Geneva wheel- Pantograph, condition for perfect steering, steering gear mechanisms, Ackermann - Hooke's joint, Oldhams couplin.	10 Hrs
UNIT-II	
Velocity and Accelerations in Mechanisms Concept of relative velocity and relative acceleration of a point on a link, angular acceleration, inter-relation between linear and angular velocity and acceleration. Draw velocity and acceleration diagram for 4 bar and slider crank mechanisms. Instantaneous centre- Kennedy's Theorem - To determine linear velocity and angular velocity of simple mechanisms by IC method. Klein's construction for velocity and acceleration of slider crank mechanism.	10 Hrs
UNIT-III	
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 in-volute gears, methods of avoiding interference-minimum number of teeth to avoid interference on pinion meshing with gear and pinion meshing with rack. Numerical Problems.	10 Hrs

UNIT-IV	
Gear Trains - Velocity ratio and train value, types of gear trains-simple, compound, reverted and epicyclic gear trains. Algebraic/Tabular method of finding train value of epicyclic gear trains. Numerical Problems	10 Hrs
UNIT-V	
Cams : Types of cams, Types of followers and types of follower motion. Displacement, velocity and acceleration curves for simple harmonic motion, uniform velocity, uniform acceleration and retardation motion and cycloidal motion. Draw cam profile for disc cam with reciprocating follower(knife edge, roller and flat faced) - to find maximum velocity and acceleration in each case	10 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Define the basic mechanisms for developing a machine.
CO2	Construct velocity and acceleration diagram for mechanism.
CO3	Design of simple gears.
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 , ISBN 007-059120-2

Reference Books	
1.	SADHU SINGH : "Theory of Machines", 2nd Edition, Pearson Education Publications, 2007, ISBN-13 : 978-8177581270
2.	GHOSH A. AND MALLICK A.K : "Theory of Mechanisms and Machines", Affiliated East-West Pvt. Ltd, New Delhi, 1988. ISBN-13:978-8185938936
3.	R S KHURMI, J K GUPTA " A text book of Theory of Machines", S CHAND publication, ISBN-13:978-8121910019

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/112105268/
2. https://swayam.gov.in/nd1-noc20-me21/
3. https://nptel.ac.in/courses/1121/104/112104121/
4. https://nptel.ac.in/courses/1121/104/112104121/
5. https: //nptel.ac.in/courses/1121/104/112104121/

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V SEM		
CNC Programming and 3-D Printing lab		
Course Code:	MVJ22MEL54	CIE Marks: 50
L: T:P:S	0:0:2:0	SEE Marks: 50
Credits:	1	Total :100
Hours:	24	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes
2	To understand the operation of various machining process
3	To educate the students on the usage of CAM packages.
4	To expose the students on the usage of 3D Printing Technology
5	To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

PART A EXPERIMENTS
1) Write a manual part program for Simple Facing Operation 2) Write a manual part program for Simple Turning Operation 3) Write a manual part program for Linear and Circular Contour Operation 4) Write a manual part program for Step Turning Operation 5) Write a manual part program for Taper Turning Operation 6) Write a manual part program for Drilling operation 7) Write a manual part program for External Threading operation 8) Write a manual part program for Boring operation 9) Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software 10) CNC part programming using CAM packages : Simulation of Turning simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM 11) CNC part programming using CAM packages : Simulation of Drilling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM 12) CNC part programming using CAM packages : Simulation of Milling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM
PART B EXPERIMENTS
1) Part Model-1: Creating a 3D CAD model, in suitable CAD Software and Check the design for manufacturing. 2) Assembly Model-2: Creating a 3D CAD assembly model containing four or more parts in CAD Software and Check the assembly 3) Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs) 4) Simple 3D Printing Model : Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)

Course Outcomes: After completing the course, the students will be able to	
CO1	Students will have knowledge of G-code and M-code for machining operations.
CO2	Students will able to perform CNC programming for turning, drilling, milling and threading operation
CO3	Students will able to visualize the 3D models using CAD software's

CO4	Students will able to use 3D printing technology
CO5	Students are able to understand robotic programming and FMS

Reference Books	
1	P.M. Agarwal, V.J. Patel, CNC Fundamentals and Programming
2	P.N. Rao, "CAD/CAM Principles and Application",3rd Edition, Tata McGraw-Hill, New Delhi, 2012
3	Mikell P. Groover, "Automation, Production systems and computer integrated manufacturing", Prentice Hallof India Private Ltd., New Delhi, 2008
4	Kunwoo Lee, Principles of CAD/CAM/CAE systems, Addison Wesley, 1999
5	NPTEL – Mechanical – Mechatronics and Manufacturing Automation

CIE Laboratory (50 Marks)

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as (A+B) for 50 marks

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks
The final score for the course out of 100 is the SumTotal of SEE and CIE.

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

Semester: V		
Mechatronics and Microprocessors		
Course Code:	MVJ22ME551	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Understand the various components of Mechatronics systems, including mechanical, electrical, and computer elements, and how they interact in integrated systems.	
2	Evaluate and compare different control systems used in automation, considering factors such as precision, response time, and energy efficiency.	
3	Design and conduct experiments to assess the performance of Mechatronics systems or components, analyzing data to determine compliance with specifications and identifying areas for improvement.	
4	Apply Mechatronics design principles to product development, considering functionality, manufacturability, and cost-effectiveness.	
5	Collaborate effectively as members of multidisciplinary teams, leveraging diverse expertise to solve complex problems and innovate in Mechatronics applications.	

UNIT-I	
Introduction: Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine. Transducers and Sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.	8 Hrs
UNIT-II	
Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods. Electro-Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.	8 Hrs
UNIT-III	
Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.	8 Hrs
UNIT-IV	
Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram,	8 Hrs

ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application. Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor.	
UNIT-V	
Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Machine Elements: Different types of guideways, Linear Motion guideways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Illustrate various components of Mechatronics systems.
CO2	Assess various control systems used in automation.
CO3	Design and conduct experiments to evaluate the performance of a mechatronics system or component with respect to specifications, as well as to analyse and interpret data.
CO4	Apply the principles of Mechatronics design to product design.
CO5	Function effectively as members of multidisciplinary teams.

Reference Books	
1.	Mechatronics HMT Ltd Tata Mc Graw Hill 1st Edition, 2000 ISBN:978007 4636435.
2.	Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi 2008.
3.	Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histand McGraw-Hill Inc USA 2003.
4.	Introduction to Robotics: Analysis, Systems, Applications. Saeed B. Niku, Person Education 2006.
5.	Mechatronics System Design Devdas Shetty, Richard A. kolk Cengage publishers. Second Edition.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112107298

https://archive.nptel.ac.in/courses/112/107/112107298/

https://onlinecourses.nptel.ac.in/noc22_me128/preview

https://gpbhubaneswar.org/public/uploads/dept-study-material/63db66fb76ba6.pdf

https://onlinecourses.nptel.ac.in/noc24_ee46/preview

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)

- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
Automation in Manufacturing		
Course Code:	MVJ22ME552	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To Understand the basic introduction about the manufacturing operations
2	To Describe the Automated Manufacturing Systems and industrail control systems
3	To Describe the part families and machine cells for flexible manufacturing systems.
4	To study the various Inspection Technologies technique and quality control systems
5	To gain the knowledge of computer aided process planning and several inspection techniques

UNIT-I	
Introduction: Production System Facilities, Manufacturing Support systems, Automation in Production systems, Automation principles & Strategies. **Manufacturing Operations:** Manufacturing Operations, Product/Production Relationship, Production concepts and Mathematical Models & Costs of Manufacturing Operations.	8 Hrs
UNIT-II	
Automated Manufacturing Systems: Components of a Manufacturing systems, Classification of Manufacturing Systems, overview of Classification Scheme, Single Station Manned Workstations and Single Station Automated Cells. **Industrial Control System**: Basic Elements of an Automated System, Advanced Automation Functions & Levels of Automation, Continuous versus Discrete control, Computer Process control, Forms of Computer Process Control.	8 Hrs
UNIT-III	
Group Technology & Flexible Manufacturing Systems: Part Families, Parts Classification and coding, Production Flow Analysis, Cellular Manufacturing, Flexible Manufacturing Systems: What is an FMS, FMS Components, FMS Applications & Benefits, and FMS Planning & Implementation Issues.	8 Hrs
UNIT-IV	
Quality Control Systems: Traditional and Modern Quality Control Methods, Taguchi Methods in Quality Engineering. Introduction to SQC Tools. Inspection Technologies: Automated Inspection, Coordinate Measuring Machines Construction, operation & Programming, Software, Application & Benefits, Flexible Inspection System, Inspection Probes on Machine Tools, Machine Vision, Optical Inspection Techniques & Non-contact Non-optical Inspection Technologies.	8 Hrs
UNIT-V	
Manufacturing Support System: Process Planning, Computer Aided Process Planning, Concurrent Engineering & Design for Manufacturing, Advanced Manufacturing Planning, Just-in Time Production System, Basic concepts of lean and Agile manufacturing. Basic Concepts of Lean and Agile manufacturing, Comparisons of Lean & Agile Manufacturing.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the basic introduction about the manufacturing operations
CO2	Describe the Automated Manufacturing Systems and industrail control systems
CO3	Explain FMS planning and applications of Automated guided vehicle systems.
CO4	Summarize the various Inspection Technologies technique and quality control systems
CO5	Associate the knowledge of computer aided process planning and several inspection techniques

Text Books	
1.	Automation, Production Systems and Computer Integrated Manufacturing, M. P. Groover, Pearson education. Third Edition, 2008

Reference Books	
1.	Principles of CIM, Vajpayee, PHI.
2.	Anatomy of Automation, Amber G.H & P. S. Amber, Prentice Hall.
3.	Performance Modeling of Automated Manufacturing Systems, Viswanandham, PHI
Web links and Video Lectures (e-Resources): https://elearn.nptel.ac.in/shop/nptel/automation-in-manufacturing/?v=c86ee0d9d7ed	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):
The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
Supply chain management & Introduction to SAP		
Course Code:	MVJ22ME553	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Get an Introduction to Supply Chain Management.
2	Appreciate the design and network in supply chain management.
3	Understand the role of coordination in supply chain management
4	Understand the current trends of Supply Chain Management.
5	Get an overview of SAP MM module

UNIT-I	
Introduction to Supply Chain Management- Supply chain – objectives – importance – decision phases – process view – competitive and supply chain strategies – achieving strategic fit – supply chain drivers – obstacles – framework – facilities – inventory – transportation – information – sourcing – pricing.	8 Hrs
UNIT-II	
Designing the Supply Chain Network- Designing the distribution network – role of distribution – factors influencing distribution – design options – e-business and its impact –distribution networks in practice – network design in the supply chain – role of network –factors affecting the network design decisions – modeling for supply chain.	8 Hrs
UNIT-III	
Transportation Networks and Sourcing- Role of transportation – modes and their performance – transportation infrastructure and policies - design options and their trade-offs –Tailored transportation. Sourcing – In-house or Outsource – 3rd and 4th PLs – supplier scoring and assessment.	8 Hrs
UNIT-IV	
Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains - Reverse Supply chain. Future of IT in supply chain- E Business in supply chain.	8 Hrs
UNIT-V	
SAP Overview-SAP R/3 Basics, Business Framework Architecture, SAP MM Overview, Organization Structure of an Enterprise, Procurement Process, Purchase Order, Goods Receipt, Invoice Verification, Purchase Requisition	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the framework and scope of supply chain management.
CO2	Build and manage a competitive supply chain using strategies, models, techniques and information technology.
CO3	Plan the demand, inventory and supply and optimize supply chain network.
CO4	Understand the emerging trends and impact of IT on Supply chain.
CO5	Understand the importance of SAP in materials management for an enterprise.

Text Books	
1.	Sunil Chopra and Peter Meindl, Dharam Vir Kalra SUPPLY CHAIN MANAGEMENT, Pearson, 7th Edition, 2018.

Reference Books	
1.	David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Ravi Shankar, Designing & Managing the Supply Chain, Tata McGraw-Hill, 4th Edition, 2022.
2.	Agrawal P. K. SAP MM INVENTORY MANAGEMENT : TECHNICAL REFERENCE AND LEARNING GUIDE, PHI, 2014.
Web links and Video Lectures (e-Resources): https://onlinecourses.nptel.ac.in/noc23_mg71/preview https://archive.nptel.ac.in/courses/110/108/110108056/ https://nptel.ac.in/courses/110107074	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):
The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
PROCESS EQUIPMENT DESIGN		
Course Code:	MVJ22ME554	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Identify the preliminary design of various processes
2	Identify various stresses acting on the walls of pressure vessels
3	Estimate the overall heat transfer coefficient for heat ex-changers
4	Choose the appropriate reactor for the desired process

UNIT-I	
INTRODUCTION TO PLANT DESIGN. PROCESS DESIGN DEVELOPMENT: Design project procedure, design information from the literature, flow diagrams, preliminary design, comparison of different processes, equipment design, scale-up in design. Materials of construction, selection of materials, fabrication of equipment.	8 Hrs
UNIT-II	
MECHANICAL DESIGN OF PROCESS EQUIPMENT: Pressure vessels – calculation of thickness of cylindrical and spherical shells subjected to internal pressure, heads or covers. Storage vessels – storage of nonvolatile liquids, storage of volatile liquids, storage of gases. Supports for vessels – bracket or lug supports, leg supports, skirt supports, saddle supports.	8 Hrs
UNIT-III	
HEAT TRANSFER EQUIPMENT DESIGN: Design of double pipe heat exchangers, Shell and tube heat exchangers (1-2,2-4), optimum design and heat recovery, selection of suitable heat exchanger. Design of single and multiple effect evaporators without boiling point elevation.	8 Hrs
UNIT-IV	
MASS TRANSFER EQUIPMENT DESIGN: Finite-stage contactors- bubble cap tray, sieve tray and valve tray units, maximum allowable vapor velocities, plate and column efficiency, other design factors. Continuous contactors – types of packing, liquid distribution, pressure drop, packing efficiencies. Relative merits of plate and packed towers, selection of contacting equipment.	8 Hrs
UNIT-V	
REACTOR DESIGN: Types of reactors, process design of batch reactor and continuous flow reactors, selection of reactors, mechanical features of reactor design.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Discuss the aspects of design, flowsheets and scaleup in chemical plant design
CO2	Design pressure vessels by selecting a suitable material of construction
CO3	Design Heat exchangers and evaporators
CO4	Design Tray towers and Packed towers
CO5	Design batch and continuous reactors

Text Books	
1.	Process Equipment Design by M. V. Joshi, 3rd edition, Macmillan India Limited 2003.

Reference Books	
1.	Backhurst, J.R and Harker, J.H - Process Plant Design: Heinemann Chemical Engineering Series. Published by Kent: Elsevier Science, 2014.
2.	Thakore S.B. and Bhat, B.I, "Introduction to Process Engineering and Design", Tata McGraw Hill Publishing Co., New Delhi, 2007
3.	Kern D.Q., Process Heat Transfer, McGraw Hill book Co.Inc., 1982
Web links and Video Lectures (e-Resources):	
https://online.vtu.ac.in/course-details/Process-Equipment-Design	
https://archive.nptel.ac.in/courses/103/107/103107207/	
https://onlinecourses.nptel.ac.in/noc22_ch29/preview	
https://archive.nptel.ac.in/courses/103/107/103107143/	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
Innovation & Entrepreneurship		
Course Code:	MVJ22IE555	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Inspired; develop entrepreneurial mindset and attributes; entrepreneurial skill sets for venture creation and entrepreneurial leadership
2	Apply the process of problem-opportunity identification and feasibility assessment by developing a macro perspective of the real market, industries, domains, and customers while using design thinking principles to refine and pivot their venture idea.
3	Analyze Customer and Market segmentation, estimate Market size, and develop and validate Customer Persona.
4	Initiate Solution design, develop MVP, and determine Product-Market fit prototypes.
5	Craft initial Business plan, Develop go-to-market strategies apply storytelling skills in presenting a persuasive and defensible Venture Pitch.

UNIT-I	
Entrepreneurship Fundamentals & Context Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. Gamified role play-based exploration aligned to one's short-term career aspiration and ambition. An understanding of how to build an entrepreneurial mindset, skillsets, attributes, and networks while on campus. **Core Teaching Tool:** Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity	8Hrs

UNIT-II	
Problem & Customer Identification: Understanding and analyzing the macro-problem and Industry perspective, technological, socio-economic, and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problems using Design thinking principles. Analyzing problems and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity. **Core Teaching Tool:** Several types of activities including Class, game, Gen AI, 'Get out of the building', and Venture Activities.	8Hrs

UNIT-III	
Solution design & Prototyping: Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customers' needs and create a strong value proposition. Developing Problem-solution fit iteratively. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating values, features, and benefits. Initial testing for proof-of-concept and iteration on the prototype. **Core Teaching Tool:** Venture Activity, no code Innovation tools, Class activity	8Hrs

UNIT-IV	
Opportunity Assessment and Sizing, Business & Financial Model: Assess relative market position via competition analysis, sizing the market, and assessing the scope and potential scale of the opportunity. **Core Teaching Tool**: Class and Venture Activity Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build–Measure–Lean approach. Business planning: components of Business plan- Sales plan, People plan, and financial plan.	8Hrs
UNIT-V	
Go-to-Market Plan, Scale Outlook, and Venture Pitch Readiness: Financial Planning: Types of costs, preparing a financial plan for profitability using a financial template, understanding the basics of Unit economics, and analyzing financial performance. Introduction to Marketing and Sales, Selecting the Right Channel, creating a digital presence, and building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options. **Core Teaching Tool:** Founder Case Studies – Sama and Securely Share; Class activity and discussions; Venture Activities. **Scale Outlook and Venture Pitch readiness**: Understand and identify potential and aspiration for scale vis a vis your venture idea. Persuasive Storytelling and its key components. Build an Investor-ready pitch deck. **Core Teaching Tool**: Expert talks; Cases; Class activity and discussions; Venture Activities	8Hrs

Text Books	
1.	Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition.
2.	Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.

Reference Books	
1.	Collins Jim, Porras Jerry, (2004) Built to Last: Successful Habits of Visionary Companies.
2.	Brown Tim (2019) Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business
3.	Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited.

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B
Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.
Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.
The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: V		
Mini Project		
Course Code:	MVJ22MEP56	CIE Marks:100
L:T:P:S	0:0:4:0	SEE Marks: 0
Credits	02	Total Marks:100
Course Learning Objectives:		
1	Apply fundamental concepts from basic sciences, mathematics, and Information Technology to analyze and solve engineering and technological challenges across diverse disciplines effectively.	
2	Demonstrate proficiency in utilizing computer and telecommunication technologies for various tasks such as data storage, retrieval, transmission, manipulation, and analysis, with a focus on meeting the needs of business enterprises.	
3	Develop logical thinking skills and a commitment to lifelong learning, enabling the understanding and resolution of technical issues related to computing systems, and the ability to devise optimal solutions.	
4	Design hardware and software systems, considering social, business, and environmental factors to ensure alignment with human context and contribute positively to society's needs and aspirations.	
5	Prepare for employment in a variety of organizational settings, demonstrating professional competence in applying technical skills to address real-world challenges and adapt to the evolving needs of industry, academia, and research communities.	

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.
C05	To develop the required collaboration and communication skills to work in a professional team and multi-disciplinary context. To quickly develop Proof-of Concept of solutions to problems

Reference Books	
1.	IEEE papers, IEEE/ACM papers
2.	Reputed Articles from Springer, ScienceDirect, Elsevier Publications related to their domain of project

Scheme of Examination:
Project Report: 15 marks
Project Model: 25 marks
Viva Voce: 10 marks.

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

Semester: V		
RESEARCH METHODOLOGY AND IPR		
Course Code:	MVJ22RMI57	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To give an overview of the research methodology and explain the technique. of defining a research problem and explain the basic ethics in research.	
2	To develop a suitable outline for research studies through various sources of information from literature review and data collection.	
3	To develop an understanding of the results and on analysis of the work carried.	
4	To Demonstrate enhanced Scientific writing skills.	
5	To Develop an Understanding on Various Intellectual Property Rights and importance of filing patents.	

UNIT-I	
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem. Technique Involved in defining a problem and Illustrations. *Ethics in Engineering Research:* Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.	8 Hrs
UNIT-II	
Research Writing and Journal Publication Skills: Understanding the importance of quality research papers, Differences between conference papers, journal articles, and other academic publications, criteria for selecting a journal, understanding impact factors and journal rankings. place of the literature review in research, how to review the literature, structure of a research paper, effective use of figures and tables, preparing a cover letter and author contributions, Responding to reviewers' comments. Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Tools for citation management, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.	8 Hrs
UNIT-III	
Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs case of Exploratory research studies, case of descriptive and diagnostic research, case of hypothesis -testing , Basic	8 Hrs

Principles of Experimental Designs, Important Experimental Designs. *Results and Analysis:* Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.	
UNIT-IV	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, types of reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.	**8 Hrs**
UNIT-V	
Introduction to Intellectual Property Rights: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights. **Kinds of Intellectual property rights**—Copy Right, Patent, Trademark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge. **Patents:** Trips Definition, Patentable and Non-Patentable inventions, Legal requirements for patents. **Patent application process:** Prior art search, drafting of a patent, Filing of a patent, Patent document: specification and claims, Granting of patent, Management of IP, Commercialization of IP – Assignment, licensing and infringement.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Formulate the research problem and follow research ethics.
CO2	Carry out a Literature survey for the topic identified
CO3	Analyse the research and interpret the outcomes of the research.
CO4	Enhance their technical writing skills
CO5	Understand the importance of Patenting, Licensing and technology transfer.

Text Books	
1.	C.R. Kothari, Research Methodology, Methods and Techniques, 2nd Revised edition, New Age International Publishers, 2015
2.	Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, PHI Learning Pvt Ltd, 2014

Reference Books	
1.	Geoffrey Marczyk, David De Matteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.
2.	Carol Ellison (2010) McGraw-Hill's Concise Guide to Writing Research Papers, McGraw-Hill
3.	Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess Publications. 2nd volume.

4.	Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The theory exam consists of a written paper structured into two parts:
Part A: Carries 20 marks which include either objective-type or short descriptive questions. It is designed to cover the entire syllabus comprehensively.
Part B: This section carries a total of 80 marks and consists of 5 questions, with Either or choices. Students are required to answer one full question per module, selecting from the choices. Each question is valued at 16 marks and may include up to two sub-parts.

The SEE Theory marks of 100 will be scaled down to 50.
The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

High-3, Medium-2, Low-1

Semester: V		
Environmental Studies		
Course Code:	MVJ22ENV58	CIE Marks: 50
L: T:P:S	2:0:0:0	SEE Marks: 50
Credits:	2	Total :100
Hours:	24	SEE Duration: 2 Hrs.
1	Relate interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes	
2	Study drinking water quality standards and to illustrate qualitative analysis of water.	
3	Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability.	

UNIT-I	
Introduction to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development. **Ecosystems (Structure and Function):** Forest, Desert, Rivers, Ocean **Biodiversity:** Types, Hot spots; Threats and Conservation of biodiversity, Deforestation. Video link: https://nptel.ac.in/courses/127/106/127106004/	6 Hrs
UNIT-II	
Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, Tidal and Wind. **Natural Resource Management (Concept and case-study):** Disaster Management, Sustainable Mining and Carbon Trading. Video link: https://nptel.ac.in/courses/121/106/121106014/	6 Hrs
UNIT-III	
Environmental Pollution: Surface and Ground Water Pollution, Noise pollution, Soil Pollution and Air Pollution. **Waste Management & Public Health Aspects:** Bio-medical Waste, Solid waste, Hazardous waste and E-waste. Video link: • 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/	6 Hrs
UNIT-IV	
Global Environmental Concerns (Concept, policies, and case-studies): Global Warming, Climate Change, Acid Rain, Ozone Depletion and Fluoride problem in drinking water. Video link:	6 Hrs

• https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/120108004/ • https://onlinecourses.nptel.ac.in/noc19_ge23/preview	
UNIT-V	
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems. Video link: • https://nptel.ac.in/courses/105/102/105102015/ • https://nptel.ac.in/courses/120/108/120108004/	6 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe 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
CO5	Describe the realities that managers face when dealing with complex issues.

Text Books	
1.	Raman Siva kumar, "Principals of Environmental Science and Engineering", 2nd Edition, Cengage learning, Singapur.

Reference Books	
1.	G.Tyler Miller, "Environmental Science – working with the Earth", 11th Edition, Jr. Thomson Brooks /Cole publications, California.
2.	Pratiba Singh, Anoop Singh & Piyush Malaviya , "Environmental and Ecology", 1st Edition , ACME Learning Pvt. Ltd. New Delhi.

Continuous Internal Evaluation (CIE) – 50 Marks

The CIE for the mandatory credit courses common across all disciplines comprises of two components as follows:

Internal Assessment Tests (30 Marks):

Two Internal Assessment tests will be conducted, each comprising 50 multiple choice questions for a total of 50 marks. The average of the two test scores will be scaled down to 30 marks.

Assignments (20 Marks):

Students are required to complete two assignments, each carrying 10 marks. These assignments may include projects*, poster presentations*, seminars*, or

similar academic activities. The marks of the two assignments are added to get 20 marks.

*Each assignment will undergo two rounds of evaluation to assess progress and quality

At the beginning of the semester, the instructor/faculty teaching the course has to announce the methods of Assignment for the course.

Together, these two components are added to get the Final CIE marks of 50.

Semester End Examination (SEE) – 50 Marks

A Semester End Examination is conducted for 50 marks comprising of multiple-choice questions (MCQ) type each of one mark.

The final score for the course out of 100 is the Sum Total of SEE and CIE.

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

Semester:3/4/5/6		
YOGA		
Course Code:	MVJ22YO39/49/59/69	CIE Marks:100
L: T:P:S	0:0:2:0	SEE Marks: --
Credits:	0	Total :100
Hours:	24 Hrs. of Practical	SEE Duration: ---

Course Objectives:

- Promote Holistic Wellness Practice in Students.
- Develop Physical Awareness and Flexibility.
- Improve Focus and Academic Performance.
- Encourage Healthy Lifestyle Habits.
- Support mental Health and Emotional balance.
- Maintain physical Body Health.

The Health Benefits of Yoga:

Yoga helps with a person-centered approach to well-being offering **physical, mental(cognitive), and spiritual(emotional) benefits** for students. These benefits can help students cope with the demands of academic journeys, improve their overall health, and promote personal development.

- **Key Benefits of Various Yoga Techniques:**

- Enhances Physical Well-being.
- Boosts Mental Focus.
- Promotes Emotional Stability.
- Reduces Stress Levels.
- Encourages Inner Growth.

It is also used as an adjunct therapy to support recovery from various physical health conditions such as:

- Chronic Pain.
- Back Pain.
- Arthritis.
- Cardiovascular Diseases.
- Asthma.
- Chronic Fatigue Syndrome.
- Menstrual Disorders.
- Digestive Issues.
- Thyroid Imbalances.
- Migraine and headache.

2) Core observations on how yoga functions as a complementary mind-body intervention to support the psychological, physiological and spiritual healing processes associated with various health conditions.

Psychological Benefits:

- Stress reduction.
- Anxiety relief.
- Trauma healing.
- Cognitive and clarity focus.
- Emotional Regulation.
- Aid in managing depression.

Physiological Benefits:

- Enhance Blood Circulation.
- Boost Cardiovascular Health.
- Supports Overall Gut Function.
- Promotes Thyroid Function.
- Relief from Headaches.
- Increased Energy level.

Spiritual Benefits:

- Cultivating gratitude and Compassion
- Self –realization
- Balance and Harmony
- Inner Peace
- Sense of oneness.
- Mindfulness.

Module I -Discipline and Awareness Reflect Habits s Thoughts	
• Basic theory of Yoga, Yamas s Niyamas Yoga definition, Aims and Objectives, importance of yoga in students. • Introduction to Yoga asana Yoga asana meaning, principle and health benefits. • Ashtanga yoga Meaning, breathing techniques. • Four paths of yoga Karma yoga, Bhakthi yoga, Raja yoga, Jnana yoga. • Surya namaskar Surya namaskar prayer and its meaning, benefits and importance.	6 h

• **Yoga asanas** Asanas it's need, importance, name and technique. **Sitting: -**Vajrasana, sukhasana **Standing: -** adasana, Ardhachakrasana **Prone line: -** Advasana, Bhujangasana **Supine line: -**Shavasana, Supta baddhakonasana **Balancing posture: -**Vrikshasana, Garudasana	
Module II-Building strength and focus Finding out the obstacle	
• **Kriya Yoga** Tapas, Svadhyaya, Ishwarapranidhana • **Five Kleshas** Obstacles. • **Pranayama** Introduction to Pranayama. • **Pratyahara** Preparing mind for meditation, Breathe focus techniques. • **Yoga asanas** Standing: -Virabhadrasana,Parshvakona Sitting: -Vajrasana, Paschimottanasana Prone Line: -Dhanurasana, Shalabhasana Supine Line: -Ananda Balasana, Supta Matsyendrasana Balancing: -Natarajasana (Dancer Pose)	6 h
Module III – Awareness and inner balance **Finding how focused is the mind**	
• **Dharana :** Concentration • **Dhyana:** Meditation • **Swasthya, Smrithi, Sankalpa.** Tool of academic excellence. • ***Samyama*** Patanjali's concept of samyama • **Yogasanas** **Standing**: - ArdhaChandrasana, Utkatasana **Sitting**: - Padmasana (or prep), Gomukhasana **Prone Line**: - Adho Mukha Svanasana, Naukasana **Supine Line: -** SuptaBaddhaKonasana, Chakrasana **Balancing**: - Garudasana (Eagle Pose)	6 h
Module IV – integrating Yoga in daily Life	
• **Yama niyama Acharam** Practice of ethical Discipline (practicing nonviolence, truth, cleanliness) • **Ahara- Vihara Samyama** Practice discipline in diet C lifestyle. • **Asana- pranayama sadhana**	6 h

Daily practice of asanas and pranayama

- **Yogasanas**
  Standing: -PrasaritaPadottanasana, ParivrttaTrikonasana
  Sitting: -Baddha Konasana, Marichyasana
  Prone Line: -Ustrasana (Camel), Makarasana (relaxation)
  Supine Line: -Sarvangasana, Shavasana
  Balancing: - Bakasana (Crow – optional or modified)

Course outcomes

1. Identify and reflect on personal habits and thoughts.
2. Explain the basic theory of Yoga, including Yamas C Niyama.
3. Understand the definition, aims, objectives, and importance of Yoga, especially for students.
4. Enhance physical and mental strength through advanced Yog asanas.
5. Practice Dharana (concentration) and Dhyana (meditation) to improve focus.

CO/PO Mapping											
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO 1		2						3	2	2	
CO 2	2						2	2			
CO 3	2					2	2	3			
CO 4					2		3	3			
CO 5		2					2	3			

Weekley assessment will be done by the instructor by giving different poses / Asanas. The final assessment scaled up to 100 marks.

Semester: VI semester		
HEAT TRANSFER		
Course Code:	MVJ22ME61	CIE Marks: 50
L: T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	40 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Build a strong foundation in heat transfer basics of conduction, convection, and radiation modes, two dimensional steady and unsteady heat transfer.	
2	Work on governing equations and solution procedures for the three modes along with solution of practical problems using empirical correlations	
3	Analysis and design of the heat exchangers.	
4	Boiling and condensation heat transfer.	

UNIT-I	
Introductory concepts and definitions: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Types of boundary conditions. General three dimensional Heat Conduction Equation: Derivation of the equation in (i) Cartesian, coordinate only. Discussion of three dimensional Heat Conduction Equation in (ii) Polar and (iii) Spherical Co-ordinate Systems. **Steady-state one-dimensional heat conduction problems in Cartesian System:**Steady-state one-dimensional heat conduction problems (i) without heat generation and (ii) constant thermal conductivity - in Cartesian system with various possible boundary conditions. Brief Introduction to variable thermal conductivity and heat generation [No numerical on variable thermal conductivity and heat generation] Thermal Resistances in Series and in Parallel. Critical Thickness of Insulation in cylinder and spheres Concept. Derivation. Numericals	8 hrs
UNIT-II	
Extended Surfaces or Fins: Classification, Straight Rectangular and Circular Fins, Temperature Distribution and Heat Transfer Calculations, Fin Efficiency and Effectiveness, Applications. Derivation. Numericals **Transient [Unsteady-state] heat conduction:** Definition, Different cases - Negligible internal thermal resistance, negligible surface resistance, comparable internal thermal and surface resistance, Lumped body, Infinite Body and Semi-infinite Body, Numerical Problems, Heisler and Grober charts.Derivation. Numericals.	8hrs
UNIT-III	
Numerical Analysis of Heat Conduction: Introduction, one-dimensional steady conduction and one dimensional unsteady conduction, boundary conditions, solution methods. **Thermal Radiation:** Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien's displacement law, Planck's laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff's Laws, View factor, Net radiation exchange between parallel plates, concentric cylinders, and concentric spheres, Radiation Shield.	8 hrs

UNIT-IV	
Forced Convection: Boundary Layer Theory, Velocity and Thermal Boundary Layers, Prandtl number, Turbulent flow, Various empirical solutions, Forced convection flow over cylinders and spheres, Internal flows –laminar and turbulent flow solutions. **Free convection:** Laminar and Turbulent flows, Vertical Plates, Vertical Tubes and Horizontal Tubes, Empirical solutions.	8 hrs
UNIT-V	
Heat Exchangers: Definition, Classification, applications, LMTD method, Effectiveness - NTU method, Analytical Methods, Fouling Factors, Chart Solution Procedures for solving Heat Exchanger problems: Correction Factor Charts and Effectiveness-NTU Charts. **Introduction to boiling:**Pool boiling, Bubble Growth Mechanisms, Nucleate Pool Boiling, Critical Heat Flux in Nucleate Pool Boiling, Pool Film Boiling, Critical Heat Flux, Heat Transfer beyond the Critical Point, filmwise and dropwise Condensation.	8 hrs
LIST OF EXPERIMENTS 1. Determination of Thermal Conductivity of a Metal Rod. 2. Determination of Overall Heat Transfer Coefficient of a Composite wall. 3. Determination of Effectiveness on a Metallic fin. 4. Determination of Heat Transfer Coefficient in a free Convection on a 5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe. 6. Determination of Emissivity of a Surface. 7. Determination of Steffan Boltzmann Constant. 8. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers. 9. Experiments on Boiling of Liquid and Condensation of Vapour. 10. Performance Test on a Vapour Compression Refrigeration. 11. Demonstration of Air Conditioner Trainer Kit. 12. Transient and Steady State heat transfer Analysis of plane slab and cylinder using numerical approach.	24 hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the modes of heat transfer and apply the basic laws to formulate engineering systems.
CO2	Understand and apply the basic laws of heat transfer to extended surface, composite material and unsteady state heat transfer problems.
CO3	Analyze heat conduction through numerical methods and apply the fundamental principle to solve radiation heat transfer problems.
CO4	Analyze heat transfer due to free and forced convective heat transfer.
CO5	Understand the design and performance analysis of heat exchangers and their practical applications, Condensation and Boiling phenomena.

Text Books	
1.	Heat and Mass Transfer, P K Nag, 3rd edition, McGraw Hill Education

Reference Books	
1.	Heat transfer: a practical approach, Yunus A. Cengel Tata Mc Graw Hill Fifth edition
2.	Heat Transfer, Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008
Web links and Video Lectures (e-Resources):	
1. https://www.youtube.com/watch?v=qa-PQOjS3zA 1. https://www.youtube.com/watch?v=sieo7oZGsWQ	

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks (B)

The score for the SEE is A+B of total 100 marks

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Machine Design		
Course Code:	MVJ22ME62	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity.
2	To understand and interpret different failure modes and application of appropriate criteria for design of machine elements.
3	Develop the capability to design elements like shafts, couplings and springs, welded joints, screwed joints.
4	To learn transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue.
5	To produce assembly and working drawings of various mechanical systems involving machine elements like clutches and brakes.

UNIT-I	
Design for static strength: Factor of safety and service factor. Failure mode: definition and types., Failure of brittle and ductile materials; even and uneven materials; Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory. Stress concentration, stress concentration factor Impact Strength: Introduction, Impact stresses due to axial, bending and torsion loads. Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit.	8 Hrs
UNIT-II	
Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading, Discussion on engineering applications. Design of couplings: Design of Flange coupling, and Bush and Pin type coupling. 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, Discussion on engineering applications.	8 Hrs
UNIT-III	
Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets, Discussion on engineering applications. Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints, Discussion on engineering applications. Threaded Fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints, Discussion on engineering applications.	8 Hrs

UNIT-IV	
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. Antifriction bearings: Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship, Discussion on engineering applications.	8 Hrs
UNIT-V	
Design of Clutches and Brakes: Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories. Design of band brakes, block brakes and internal expanding brakes.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyse the performance and failure modes of mechanical components subjected to combined loading and fatigue loading using the concepts of theories of failure.
CO2	Demonstrate the application of engineering design tools to the design of machine components like shafts, springs, couplings, fasteners.
CO3	Design the welded and riveted joint for the required applications.
CO4	Apply design concepts of hydrodynamic bearings for different applications and select Anti friction bearings for different applications using the manufacturers, catalogue.
CO5	Design a clutches and breaking system used in automobile and industrial machinery .

Text Books	
1.	Shigley's Mechanical Engineering Design Richard G. Budynas,and J. Keith Nisbett McGraw-Hill Education 10th Edition, 2015
2.	Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007 Wiley student edition

Reference Books	
1.	Design of Machine Elements V. B. Bhandari Tata Mcgraw Hill 4th Ed 2016.
2.	Machine Design- an integrated approach Robert L. Norton Pearson Education 2nd edition.
Design Data Books: Design Data Hand Book, K.Lingaiah, McGraw Hill, 2nd edition, 2003. Design Data Hand Book, K.Mahadevan and Balaveera Reddy, CBS publication. Design Data Hand Book, H.G.Patil, I.K.International Publisher, 2010 PSG Design Data Hand Book, PSG College of technology, Coimbatore.	
Web links and Video Lectures (e-Resources): https://archive.nptel.ac.in/courses/112/105/112105125/	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)

- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Total Quality Management		
Course Code:	MVJ22ME631	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To understand the concept of Total Quality Management.	
2	To Know the Customer, his Quality perception and his demands.	
3	To identify useful quality improvement techniques.	
4	To know the need of Leadership qualities and Team development in TQM	
5	To understand the need of Quality, ISO Certification and its procedure.	

UNIT-I	
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.	8 Hrs
UNIT-II	
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.	8 Hrs
UNIT-III	
Continuous Improvement Strategies - Deming Wheel, Zero Defect Concept, Bench marking, 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).	8 Hrs
UNIT-IV	
LEAN Six Sigma - Mapping; Kanban; team management; Process Improvement; process; six sigma; Leadership and Management; Lean Methods; lean six sigma; Trigonometric Integral.	8 Hrs
UNIT-V	
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.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
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.	A Mahajan "Statistical Quality Control", Dhanapat Rai & Co. (P) Ltd.
Web links and Video Lectures (e-Resources):	
1. https://nptel.ac.in/courses/110104080/	
2. https://onlinecourses.nptel.ac.in/noc20_mg19/preview	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Refrigeration and Air Conditioning		
Course Code:	MVJ22ME632	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Study the basic definition, ASHRAE Nomenclature for refrigerating systems	
2	Understand the working principles and applications of different types of refrigeration systems	
3	Study the working of air conditioning systems and their applications	

UNIT-I	
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.	8 Hrs
UNIT-II	
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.	8 Hrs
UNIT-III	
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.	8 Hrs
UNIT-IV	
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, Refrigerant mixtures – zeotropic and azeotropic mixtures. Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.	8 Hrs
UNIT-V	
Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, ASHRAE Nomenclature pertaining to Air-	8 Hrs

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.	

Course Outcomes: After completing the course, the students will be able to	
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 ISBN 13: 9780070616196, ISBN 10: 0070616191
2.	Roy J. Dossat, "*Principles of Refrigeration*", Wiley Limited, 1997, ISBN: 9780132333719, 0132333716

Reference Books	
1.	Mc Quistion, *"Heating, Ventilation and Air Conditioning"*, Wiley Students edition,5th edition 2000, ISBN 13: 9780471470151
2.	Arora C.P., "*Refrigeration and Air-conditioning*", Tata Mc Graw –Hill, New Delhi, 2nd Edition, 2001. ISBN 13: 9780070083905, ISBN 10: 0070083908
Web links and Video Lectures (e-Resources): https://archive.nptel.ac.in/courses/112/105/112105129/ https://nptel.ac.in/courses/112107208 https://onlinecourses.nptel.ac.in/noc22_me135/	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Hydraulics and Pneumatic		
Course Code:	MVJ22ME633	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to learn	
1	Basic laws of hydraulics and pneumatic.
2	Hydraulic Circuits Components
3	Pneumatic Actuators and Valves
4	Basic Pneumatic Circuit
5	Logic Control Circuit

UNIT-I	
UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS Introduction to Fluid power — Advantages and Applications — Fluid power systems — Types of fluids — Properties of fluids and selection — Basics of Hydraulics — Pascals Law — Principles of flow — Friction loss — Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory — Pump Classification — Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary — Fixed and Variable displacement pumps — Problems.	8 Hrs
UNIT-II	
UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS Hydraulic Actuators: Cylinders — Types and construction, Application, Hydraulic cushioning — Hydraulic motors — Control Components : Direction Control, Flow control and pressure control valves — Types, Construction and Operation — Servo and Proportional valves — Applications — Accessories : Reservoirs, Pressure Switches — Applications — Fluid Power ANSI Symbols — Problems.	8 Hrs
UNIT-III	
UNIT III HYDRAULIC CIRCUITS AND SYSTEMS Accumulators, Intensifiers, Industrial hydraulic circuits — Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.	8 Hrs
UNIT-IV	
UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS Properties of air — Perfect Gas Laws — Compressor — Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit — Cascade method — Electro Pneumatic System — Elements — Ladder diagram — Problems, Introduction to fluidics and pneumatic logic circuits.	8 Hrs

UNIT-V	
UNIT V TROUBLE SHOOTING AND APPLICATIONS Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools — Low cost Automation — Hydraulic and Pneumatic power packs.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the basic principles of Pneumatic and Hydraulics.
CO2	Master the operating principles of pumps, valves and actuators, and their circuits.
CO3	Design pneumatic and hydraulic circuits and predict the responses.
CO4	Design of hydraulic an pneumatic valves.
CO5	Design of hydraulic circuits

Text Books	
1.	Frank Ebel, G. Prede, M. Pany, D. Scholz, Electropneumatics textbook basic Level, Festo Didactic, 2003
2.	Peter Croser,Frank Ebel, Pneumatics textbook basic Level, Festo Didactic, 2002.

Reference Books	
1.	D. Waller, H. werner, Pneumatics work book basic Level, Festo Didactic, 2002.
2.	Andrew Parr MSc., CEng., MIEE, MInstMC, Hydraulics and Pneumatics A technician's and engineer's guide Second edition,Butterworth-Heinemann, 2006.

Web links and Video Lectures (e-Resources):

1. NPTEL :: Mechanical Engineering - NOC:Oil Hydraulics and Pneumatics
2. Course Introduction - Oil Hydraulics and Pneumatics (youtube.com)
3. Your World. Made Closer. (youtube.com)

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Design for Manufacturing and Assembly		
Course Code:	MVJ22ME634	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to learn	
1	Design Philosophy and steps in design process.
2	Various machining processes and general design rules.
3	Casting and forging tolerances.
4	Design guidelines for different metal working operations.
5	Compliance analysis and interference analysis.

UNIT-I	
Introduction: Design philosophy – steps in design process – general design rules for manufacturability – basic principles of designing for economical production – creativity in design, application of linear & non-linear optimization techniques. Materials: Selection of materials for design – developments in material technology – criteria for material selection – material selection interrelationship with process selection – process selection charts	8 Hrs
UNIT-II	
Machining process: Overview of various machining processes – general design rules for machining - dimensional tolerance and surface roughness – design for machining – ease – redesigning of components for machining ease with suitable examples, general design recommendations for machined parts. Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines – pre and post treatment of welds – effects of thermal stresses in weld joints – design of brazed joints.	8 Hrs
UNIT-III	
Metal casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting – casting tolerances – use of solidification simulation in casting design – product design rules for sand casting. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.	8 Hrs
UNIT-IV	
Extrusion and sheet metal work: Design guidelines for extruded sections - design principles for punching, blanking, bending, and deep drawing – Keeler Goodman forming line diagram – component design for blanking.	8 Hrs
UNIT-V	
Assembly: Compliance analysis and interference analysis for the design of assembly – design and development of features for automatic assembly – liaison diagrams. Environment: Introduction to environment; motivations for environment principles of environment- eco-efficiency, product life cycle perspective, environment tools and processes, environment design guidelines.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the basic principles of Design and Manufacturing.
CO2	Apply a systematic understanding of knowledge in the field of metal casting and forging.
CO3	Design basic parts and assemblies using the principles.
CO4	Design for forging and blanking parts.
CO5	Accomplish Compliance analysis and interference analysis

Text Books	
1.	A K Chitale and R C Gupta, "Product Design and Manufacturing", PHI, New Delhi, 2003.

Reference Books	
1.	George E Deiter, " Engineering Design", McGrawHill International, 2002.
2.	Boothroyd G, "Product design for Manufacture and Assembly", First Edition, Marcel Dekker Inc, New York, 1994.
Web links and Video Lectures (e-Resources): https://www.sw.siemens.com/en-US/technology/design-for-manufacturing-assembly-dfma/ https://quality-one.com/dfm-dfa/	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Operations and Project Management		
Course Code:	MVJ22ME641	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand the Role and Scope of Operations Management, Make Informed Operational Decisions and Develop and Analyze Forecasts.
2	Understand the need for location decisions and the general procedure for making these decisions and aggregate planning, including graphical and mathematical methods.
3	Apply master scheduling methods in different production scenarios.
4	Develop a project scope and work breakdown structure.
5	Develop project quality management plans and apply project quality tools.

UNIT-I	
Introduction to Operations Management: Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity. **Decision Making:** The decision process, characteristics of operations decisions, use of models, decision making environments. **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.	8 Hrs
UNIT-II	
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. **Aggregate Planning :** Aggregate planning – Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning – graphical and charting techniques, mathematical techniques	8 Hrs
UNIT-III	
Master Scheduling: The master production schedule, Master scheduling process, Master scheduling methods. **Material Requirement Planning (MRP):** Dependent versus independent demand, an overview of MRP – MRP inputs and outputs, MRP processing, ERP capacity requirement planning, benefits and limitations of MRP. **Purchasing and Supply Chain Management (SCM):** Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.	8 Hrs

UNIT-IV	
Introduction to Project Management: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects. **Planning Projects:** Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organization, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.	8 Hrs
UNIT-V	
Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines. **Performing Projects:** Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. 28 Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the concept and scope of operations management in a business context and Recognize the role of Operations management among various business functions and its role in the organizations' strategic planning and gaining competitive advantage.
CO2	Analyze the appropriateness and applicability of a range of operations management systems/models in decision making.Assess a range of strategies for improving the efficiency and effectiveness of organizational operations
CO3	Assess a range of strategies for improving the efficiency and effectiveness of organizational operations.
CO4	Understand the selection, prioritization and initiation of individual projects and strategic role of project management.Understand the work breakdown structure by integrating it with organization.
CO5	Understand the scheduling and uncertainty in projects.Understand risk management planning using project quality tools. Understand the activities like

	purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.

Text Books	
1.	Project Management Pennington Lawrence Mc Graw Hill
2.	Project Management, Bhavesh M. Patal Vikas publishing House

Reference Books	
1.	"Operation Management, Author- Joseph G Monks McGrew Hill Publication, International Edition-1987.
2.	"Production and Operation Management" ,Author-Pannerselvam R. PHI publications, 2nd edition
Web links and Video Lectures (e-Resources): https://onlinecourses.nptel.ac.in/noc20_mg06/preview https://archive.nptel.ac.in/courses/110/104/110104073/	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI semester		
SUSTAINABLE ENERGY SYSTEMS		
Course Code:	MVJ22ME642	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand the concept of various non-conventional energy resources
2	Acquire in-depth knowledge on the conversion of non-conventional energy resources into Electrical power
3	Become intellectual in new developments of renewable energy studies
4	Attain knowledge in green energy technologies

UNIT-I	
SOLAR ENERGY Various solar energy systems and their applications, Solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, daily variation, hour angle, Calculation of angle of incidence, Principle of photovoltaic conversion of solarenergy - Types of solar cells and fabrication, Photovoltaic - battery charger, domestic lighting, street lighting, water pumping etc, Solar Photovoltaic power plant – Net metering concept	8 hrs
UNIT-II	
WIND ENERGY Nature of the wind – wind power– factors influencing wind, Wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection, Types of wind turbines – Various control-Tip Speed Ratio – Solidity, Torque on wind-wind thrust calculations, Repowering concept	8 hrs
UNIT-III	
BIO-ENERGY Energy from Biomass - Biomass as Renewable Energy Source - Types of Biomass Fuels - Solid, Liquid and Gas, Biomass Conversion Techniques- Wet Process, Dry Process-Photosynthesis - Biogas Generation, Factors affecting Bio-digestion –Different digesters – Digesters sizing - Advantages and Disadvantages, Digesters power generated and problems, Energy Forming – Pyrolysis	8 hrs
UNIT-IV	
ENERGY FROM OCEANS Ocean Thermal Energy Conversion (OTEC): Principle- Lambert Law of absorption - Open and closed OTEC Cycles -.Major problems and operational experience, Tidal energy: Tide – Spring tide, Neap tide – Tidal range – Tidal Power – Types of Tidal power plant, Single and dual basin schemes-Requirements in tidal power plant, Wave Energy – Wave Characteristics, Different wave energy convertors -Saltor Duck , Oscillating water column and dolphin types	8 hrs
UNIT-V	
GEOTHERMAL ENERGY Geothermal Energy – Classification, Fundamentals of geophysics, Dry rock and hot aquifers energy analysis, Estimation of thermal power , Extraction techniques	8 hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the environmental aspects of renewable energy resources. In Comparison with various conventional energy systems, their prospects and limitations.
CO2	Describe the use of solar energy and the various components used in the energy production with respect to applications like-heating, cooling, desalination, power generation.
CO3	Understand the conversion principles of wind and tidal energy
CO4	Understand the concept of biomass energy resources and green energy.
CO5	Acquire the basic knowledge of ocean thermal energy conversion and hydrogen energy

Text Books	
1.	Rai , G.D.,"Non Conventional sources of Energy", Khanna Publishers ,5th Edition 2016
2.	Khan. B.H, "Non-Conventional Energy Resources", The McGraw Hills, 2nd Edition, 2016

Reference Books	
1.	Rao. S. & Pamlekar Dr.B.B. "Energy Technology ", Khanna Publishers, 3rd Edition 2016
2.	John W Twidell and Tony D Weir, "Renewable Energy Resources", Taylor and Francis, 2nd Edition 2006
Web links and Video Lectures (e-Resources):	

2. https://www.youtube.com/watch?v=HNjwoe4mSkE
3. https://www.youtube.com/watch?v=v93Hfz6Mzbw
4. https://www.youtube.com/watch?v=JyCY5tNhqh8

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Additive Manufacturing		
Course Code:	MVJ22ME643	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques	
2	To familiarize students with different processes in rapid prototyping systems.	
3	To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.	

UNIT-I	
Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing. Classification of AM processes: Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system. Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques. Guidelines for process selection: Introduction, selection methods for a part, challenges of selection AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=ICjQ0UzE2Ao	8 Hrs
UNIT-II	
System Drives and devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features Actuators: Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, Triacs, Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=akZjDHD6JC4	8 Hrs

UNIT-III	
POLYMERS & POWDER METALLURGY Basic Concepts: Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] Polymer Processing: Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques General Concepts: Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM Powder Production Techniques: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes. Characterization Techniques: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization Microstructure Control in Powder: Importance of Microstructure Study, Microstructures of Powder by Different techniques. Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting. Sintering: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components Application of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=yHQX9GWCk6w	8 Hrs
UNIT-IV	
NANO MATERIALS & CHARACTERIZATION TECHNIQUES: Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology Nano-materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of Nano-materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC). Optical Microscopy - principles, Imaging Modes, Applications, Limitations. Scanning Electron Microscopy (SEM) - principles, Imaging Modes, Applications, Limitations. Transmission Electron Microscopy (TEM) - principles, Imaging Modes, Applications, Limitations. X- Ray Diffraction (XRD) - principles, Imaging Modes, Applications, Limitations. Scanning Probe Microscopy (SPM) - principles, Imaging Modes, Applications, Limitations. Atomic Force Microscopy (AFM) - basic principles, instrumentation, operational modes, Applications, Limitations. Electron Probe Micro Analyzer (EPMA) - Introduction, Sample preparation, Working procedure, Applications, Limitations. Experiential Learning: (Experiments which can be conducted on the concepts of contents)	8 Hrs

Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=lFYs3XDu4fQ	
UNIT-V	
MANUFACTURING CONTROL AND AUTOMATION CNC technology - An overview: Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC Part programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming, Computer aided part programming (APT) Introduction: Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity Control Technologies in Automation: Industrial control system. Process industry vs discrete manufacturing industries. Continuous vs discrete control. Continuous process and its forms. Other control system components. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=PN_tGm5Gip4	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
CO2	Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting.
CO3	Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
CO4	Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
CO5	Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.

Text Books	
1.	Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies" ,Springer,2009

2.	Chua C. K., Leong K. F., and Lim C. S., "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific Publishers (2003)

Reference Books	
1.	Patri K. Venuvinod, Weiyin Ma "Rapid Prototyping: Laser-Based and Other Technologies" Springer , 2004
2.	Burns. M, "Automated fabrication", Prentice-Hall,1993.

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Modern Mobility		
Course Code:	MVJ22ME644	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To understand the different chassis design & main components of automobile
2	To understand the working of transmission and control system employed in automobiles
3	To understand the safety measures and control in vehicles with modern technologies
4	To understand the automotive pollution and alternative automotive technologies under trail
5	To understand the upcoming electric vehicle technology

UNIT-I	
Chassis & Power Plant History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System, super charged engines, hybrid engines, modern GT engines	8Hrs
UNIT-II	
Transmission & Suspension System Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel Gear Box; Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), intelligent manual Transmission (IMT) Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)- Working of Differential, Rear Axle types &construction. Suspension – layout & working of Hydraulic& Air suspension, Independent suspension, Functions& advantages of Leaf Spring, Coil Spring, Telescopic Shock Absorber, Torsion Bar	8Hrs
UNIT-III	
Control & Safety systems **Steering system**- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction & working, power Steering construction & working, steering geometry, Wheel balancing **Braking System**- Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS, **Safety system** – Safety measures in modern vehicle – safety frames – working of - air bags, seat belt, collapsible steering, spoilers, defoggers, fire safety measures in heavy vehicles, bullet proof vehicles	8Hrs
UNIT-IV	
Automotive Emission & Alternate Vehicles Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuels types, extraction& availability, BIO Fuels – Production and impact. Ethanol engines, CNG vehicles- operation, advantages& disadvantages, over view of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles over view, layout, transmission & control system, solar	8Hrs

powered vehicles- wind powered vehicles, super capacitors, supply rails	
UNIT-V	
Electric Vehicles& Storage Batteries Electric vehicles principle and components- layout of two & 4 wheeler, Motors used in Electric vehicles –types- over view of construction and working, power transmission & control system in Electric vehicles. Batteries – construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements, battery cooling, fire safety measures in EV vehicles	8Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the working of different systems employed in automobile
CO2	Analyse the limitation of present day automobiles
CO3	Evaluate the energy sources suitability
CO4	Apply the knowledge for selection of automobiles based on their suitability
CO5	Identify the technologies in electric vehicles and analyse the batteries principle

Text Books	
1.	Automotive mechanics, William H Course and Donal L Anglin 10 th Edition Tata MC Graw Hill Publishing Company Ltd., 2007
2.	Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc

Reference Books	
1.	Fundamentals of Automobile Engineering, K. K . Ramalingam, Scitech Publications (India) pvt. ltd
2.	Ata M. Khan, Susan A. Shaheen, Shared Mobility and Automated Vehicles

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=cLMctU9--S8&list=PLQmc-I2-FO2HVThlQuHrMVObXEP6tjY_r

https://www.youtube.com/watch?v=l-PdocKFI7A

https://www.youtube.com/watch?v=UXn5lgtqrpA&pp=ygUgVHJhbnNtaXNzaW9uICYgU3VzcGVuc2lvbiBTeXN0ZW0%3D

https://www.youtube.com/watch?v=nC6fsNXdcMQ&pp=ygUgVHJhbnNtaXNzaW9uICYgU3VzcGVuc2lvbiBTeXN0ZW0%3D

https://www.youtube.com/watch?v=bZ3_MVchfiA&pp=ygUoQXV0b21vdGl2ZSBFbWlzc2lvbiAmIEFsdGVybmF0ZSBWZWhpY2xlcw%3D%3D

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)

- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VI		
Project Phase I		
Course Code:	MVJ22MEP65	CIE Marks:100
L:T:P:S	0:0:4:0	SEE Marks: 0
Credits:	02	Total Marks: 100
Course Learning Objectives: The students will be able to		
1	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.	
2	As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills.	
3	To provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.	
4	Compile the results, discuss the findings and draw the conclusions for the project.	
5	Prepare quality document of project work.	

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.
Text Books:	
1.	J. P. Holman, "*Experimental Methods For Engineers*", McGraw-Hill Companies, Eighth edition, 2012.
Reference Books:	
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2	2	2	3	2	1	1	1	2	2
CO2	2	2	2	2	3	2	1	1	1	2	2
CO3	2	2	2	3	3	2	1	1	1	2	2
CO4	2	2	2	3	3	2	2	1	1	2	2
CO5	2	2	3	3	3	2	2	1	1	2	2

High-3, Medium-2, Low-1

Semester: VI		
Design Laboratory		
Course Code:	MVJ22MEL66	CIE Marks: 50
L: T:P:S	0:0:2:0	SEE Marks: 50
Credits:	1	Total :100
Hours:	24 Hrs. of Practical	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Analyze the performance and failure modes of mechanical components subjected to combined loading and fatigue loading using the concepts of theories of failure.
2	Determine the forces and their effects including inertia, acting on the mechanisms.
3	Construct force and couple polygons to achieve balancing in machine parts.
4	Calculate the gyroscopic couple and its effect in ships and aeroplane.
5	Describe the working of speed control governors and estimate their characteristics.

PART A EXPERIMENTS

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft.
4. Determination of stress concentration using Photoelasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D Crane hook.
5. Determination of Fringe constant of Photoelastic material using.
   a) Circular disc subjected to diametral compression.
   b) Pure bending specimen (four point bending)

PART B EXPERIMENTS

6. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Prowel /Hartnel Governor. (only one or more)
7. Determination of Pressure distribution in Journal bearing.
8. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
9. Determination of stresses in Curved beam using straing gauge.
10. Experiments on Gyroscope (Demonstration only)

Course Outcomes: After completing the course, the students will be able to	
CO1	Determine the forces and their effects including inertia, acting on the mechanisms.
CO2	Construct force and couple polygons to achieve balancing in machine parts.
CO3	Calculate the gyroscopic couple and its effect in ships and aeroplane.
CO4	Describe the working of speed control governors and estimate their characteristics.
CO5	Calculate the frequency of vibration in simple vibratory systems.

Text Books	
1.	Rattan S.S, "Theory of Machines", Tata McGraw–Hill Publishing Company Ltd, 5thEdition, 2019.
2.	John J. Uicker, Gordon R.Pennock and Joseph E. Shigley, "Theory of Machines and Mechanisms", Oxford University Press,4th Edition, 2014.

Reference Books	
3.	Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw–Hill Publishing Company Ltd, 1st Edition, 2010.
4.	William Cleghorn and Nikolai Dechev, "Mechanics of Machines", Oxford University Press, 2nd Edition, 2014.

CIE Laboratory (50 Marks)

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as (A+B) for 50 marks

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks
The final score for the course out of 100 is the SumTotal of SEE and CIE.

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

Semester VI			
IDEABOX (Level 3)			
Course Code	MVJ22A6013	CIE	50
L:T:P:S	1 : 0 : 2	SEE Marks	50
Credits	02	Total Marks	100
Hours	12 Hrs. of Theory and 24 Hrs. of Practical	Exam. Duration	2 hours

Course objectives: This course will enable students,

- To understand steps involved in developing MVP.
- To understand different types of prototypes and their benefits .
- To develop critical thinking skills by developing the prototypes and testing.

UNIT 1.	4 h and 8 h
Minimum Viable Product: Introduction to MVP, difference between proof of concept (PoC) and MVP , Types of MVPs, Steps to building an MVP, Minimum marketable product, minimum loveable product, Fully fledged product.	
UNIT 2.	**4 h and 8 h**
Creating an Business canvas model for the idea, Pitching Business model, What is start up?, essential requirements for the starting the startup. Unicorn start-ups and their journey: a case study of two Indian start-ups swiggy and paytm, Various Schemes by Indian Government to nurture Startups, Various Schemes from Government of Karnataka.	
UNIT 3.	**4 h and 8 h**
To develop Minimum Viable Product for the problem statement identified, Develop Business Model and Pitch, Apply to various Funding agencies.	

Course outcomes: Students will be able to	
CO1	Understand the Concepts MVP
CO2	Develop business model and understand types of startups.
CO3	Develop MVP, Business canvas mode .
Text/Reference Books:	
1.	Michael Michalko “Cracking Creativity”, Ten Speed Press; Revised edition ,13 April 2011.
2.	Austin Kleon “Steal like an Artist”, Workman Publishing; 1st edition, 15 April 2014.
3.	Sam Harrison “Idea Spotting: How to Find Your Next Great Idea”, Cincinnati, Ohio: HOW Books, 2006.

Semester VI			
TINKERING LAB (Level 3)			
Course Code	MVJ22A6033	CIE	50
L:T:P:S	1 : 0 : 2	SEE Marks	50
Credits	02	Total Marks	100
Hours	12 Hrs. of Theory and 24 Hrs. of Practical	Exam. Duration	2 hours

Course objective is to: To help build innovative solutions for unique problems, thereby supporting the nation's efforts to grow as a knowledge economy.	
UNIT 1.	**4 h and 8 h**
Introduction to Manufacturing and Mechanics of Materials: Here the material selection process for the given type of project will be explained	
UNIT 2.	**4 h and 8 h**
Material Requirement and estimation: Prepare the bill of materials (BOM) for their respective project	
UNIT 3.	**4 h and 8 h**
Project work: Constructing the working model for the idea generated and CAD model submitted in the level1 and level2	
Course outcomes:	
COs	1. Select a specific material for the given application. 2. Understand the innovative product development cycle
Text/Reference Books:	
1.	"Mechanics of Materials", by R.C.Hibbeler, Prentice Hall. Pearson Edu., 2005
2.	"Manufacturing Technology", Serope Kalpakjain, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006.

Semester VI			
CNC LAB (Level 3)			
Course Code	MVJ22A6113	CIE	50
L:T:P:S	1 : 0 : 2	SEE Marks	50
Credits	02	Total Marks	100
Hours	12 Hrs. of Theory and 24 Hrs. of Practical	Exam. Duration	2 hours

Course objectives: - This course will enable students to, • Understand the dimension system and structure of the CNC Part Program. • Understand the tool and working holding devices	
UNIT 1.	4 h and 8 h
Computer Aided CNC Part Programming: Need for computer aided part programming, Tools for computer aided part programming, APT, CAD/CAM based part programming for well-known controllers such as Fanuc, Heidenhain, Sinumerik etc., and generation of CNC codes from CAM packages.	
UNIT 2.	4 h and 8 h
TOOLING AND WORK HOLDING DEVICES: Introduction to cutting tool materials – Carbides, Ceramics, CBN, PCD–inserts classification, qualified, semi qualified and pre-set tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, modular fixtures, economics of CNC, maintenance of CNC machines	
UNIT 3.	4 h and 8 h
Activities and Project work To develop a part program for the project identified and perform simulations To develop fabricate the model of the project and test the model.	

Course outcomes:	
	1. Understand the fundamentals of CNC part Programing. 2. Develop part programs for tool handling.
Reference Books:	
1.	Mechatronics HMT Tata McGraw-Hill Publishing Company Limited, New Delhi 2005
2.	Computer Control of Manufacturing systems Koren Y McGraw Hill 1986
3.	Automation, Production Systems, and Computer –Integrated Manufacturing by Mikell P. Groover

Semester: VI		
INDIAN KNOWLEDGE SYSTEMS		
Course Code:	MVJ22IKK68	CIE Marks: 50
L: T:P:S	1:0:0:0	SEE Marks: 50
Credits:	1	Total :100
Hours:	12 Hrs. of Theory	SEE Duration: 2 Hrs.

Course Learning Objectives: The students will be able to	
1	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2	To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life.

Unit-I	05 Hrs
Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.	
Unit – II	**05 Hrs**
Traditional Knowledge in Humanities and Sciences: Lingistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.	
Unit -III	**05 Hrs**
Traditional Knowledge in Professional domain: Town planning and architecture-Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Provide an overview of the concept of the Indian Knowledge System and its importance.
CO2:	Appreciate the need for and importance of protecting traditional knowledge.
CO3:	Recognize the relevance of Traditional knowledge in different domains.
CO4:	Establish the significance of Indian Knowledge systems in the contemporary world.

Reference Books	
1	**Introduction to Indian Knowledge System- concepts and applications**, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN- 978-93- 91818-21-0
2	**Traditional Knowledge System in India**, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230,
3	**Knowledge Traditions and Practices of India**, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334.

	Suggested Web Links:
1.	https://www.youtube.com/watch?v=LZP1StpYEPM
2.	http://nptel.ac.in/courses/121106003/
3.	http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4.	https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5.	https://unctad.org/system/files/official-document/ditcted10_en.pdf
6.	http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7.	https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE

Continuous Internal Evaluation (CIE) – 50 Marks

The CIE for the mandatory credit courses common across all disciplines comprises of two components as follows:

Internal Assessment Tests (30 Marks):

Two Internal Assessment tests will be conducted, each comprising 50 multiple choice questions for a total of 50 marks. The average of the two test scores will be scaled down to 30 marks.

Assignments (20 Marks):

Students are required to complete two assignments, each carrying 10 marks. These assignments may include projects*, poster presentations*, seminars*, or similar academic activities. The marks of the two assignments are added to get 20 marks.

*Each assignment will undergo two rounds of evaluation to assess progress and quality

At the beginning of the semester, the instructor/faculty teaching the course has to announce the methods of Assignment for the course.

Together, these two components are added to get the Final CIE marks of 50.

Semester End Examination (SEE) – 50 Marks

A Semester End Examination is conducted for 50 marks comprising of multiple-choice questions (MCQ) type each of one mark.

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

High-3 : Medium-2 : Low-1

Semester: VII		
Finite Element Methods		
Course Code:	MVJ22ME71	CIE Marks: 50
L: T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	40 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Comprehend the underlying concepts and principles of formulation methods in Finite Element Method (FEM), including the variational principles and discretization techniques employed in solving engineering problems.	
2	Recognize the application domains and distinctive characteristics of Finite Element Analysis (FEA) elements such as bars, beams, plane elements, and iso-parametric elements, understanding their suitability for different types of structural and physical systems.	
3	Develop the characteristic equations for FEA elements and generate the global equation system by assembling the elemental equations, considering factors such as boundary conditions and material properties.	
4	Apply appropriate boundary conditions to the global equation system for various types of problems including bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi-symmetric, and dynamic systems, and solve them to determine displacements, stresses, and strains induced in the analyzed structures or systems.	
5	Demonstrate proficiency in solving practical engineering problems using Finite Element Analysis (FEA), including the ability to interpret and apply results to optimize designs and ensure structural integrity in diverse applications across mechanical engineering domains.	

UNIT-I	
Introduction to Finite Element Method: General description of the finite element method. Engineering applications of finite element method. Boundary conditions: homogeneous and nonhomogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretization process, Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects. **Interpolation models:** Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.	08 h
UNIT-II	
One-Dimensional Elements-Analysis of Bars and Trusses: One-Dimensional Elements - Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA8), 2D iso-parametric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two point formulae, 2D integrals. Force in terms of Body force, traction force	08 h

and point loads. Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses.	
UNIT-III	
Beams and 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. **Torsion of Shafts:** Finite element formulation of shafts, determination of stress and twists in circular shafts.	08 h
UNIT-IV	
Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored insolid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.	08 h
UNIT-V	
Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels. **Dynamic Considerations:** Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	08 h
LABORATORY EXPERIMENTS	**24 hrs.**
1. Analysis of Bars of constant cross section area, tapered cross section area and stepped bar. 2. Analysis of Trusses (Minimum 2 exercises of different types). 3. Analysis of Beams Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. (Minimum 6 exercises). 4. Stress analysis of a rectangular plate with a circular hole. 5. Thermal Analysis 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises of different types). 6. Dynamic Analysis to find: a) Natural frequency of beam with fixed end condition. b) Response of beam with fixed end conditions subjected to forcing function. c) Response of Bar subjected to forcing functions. 7. Static Structural analysis for different boundary conditions. 8. Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis. 9. Demonstrate at least two different types of examples to model and analyze bars or plates made from composite material. 10. Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand foundational concepts and principles of FEM, including variational principles and discretization techniques.
CO2	Recognize diverse application domains of FEA elements (bars, beams, plane elements, iso-parametric elements).
CO3	Develop proficiency in formulating characteristic equations for FEA elements and assembling them into a global equation system.
CO4	Apply appropriate boundary conditions to analyze displacements, stresses, and strains in various systems.
C05	Demonstrate competence in solving practical engineering problems using FEA, optimizing designs, and ensuring structural integrity in mechanical engineering applications.

Text Books	
1.	Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2.	Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.

Reference Books	
1.	J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2.	Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks (B)

The score for the SEE is A+B of total 100 marks

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VII		
MECHANICAL VIBRATIONS		
Course Code:	MVJ22ME72	CIE Marks: 50
L: T:P:S	3:0:2:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	40 Hrs. of Theory and 24 Hrs. of Practical	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	Analyse vibrational measurement data to draw conclusions about the measured system's vibrational nature and describe how the system behaves with respect to vibration concepts.	
2	Create simple mathematical and computational models of real vibrating systems that can be used to answer specific questions about the system by concisely demonstrating the vibrational phenomena.	
3	Design a mechanical system that has desirable vibrational behaviour.	
4	Use the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems.	
5	Characterize the multi degree freedom systems using numerical techniques	

UNIT-I	
Fundamental Aspects of Vibrations: Vibration, main causes, advantages and disadvantages; engineering applications of vibration and noise; vector method of representing harmonic motion; characteristics of vibration, harmonic analysis and beats phenomenon, work done by harmonic forces on harmonic motion; periodic, non- harmonic functions- Fourier series analysis; evaluation of coefficients of Fourier series; elements of vibratory system; lumped and distributed parameter systems. Undamped Free Vibrations: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Systems involving angular oscillations: the compound pendulum. **Experiential Learning**: Study of numerical models and analysis of Fourier theorems and Beats using MATLAB **Video Links/Any other special information:** http://vdol.mae.ufl.edu/CourseNotes/EML4220/vibrations.pdf https://en.wikipedia.org/wiki/Vibration	08Hrs
UNIT-II	
Damped Free Vibrations: Viscous damping: coefficient of damping; damping ratio; under damped, over damped and critically damped systems; logarithmic decrement; frequency of damped free vibration; Coulomb or dry friction damping; frequency, decay rate and comparison of viscous and Coulomb damping; solid and structural damping; slip or interfacial damping. **Experiential Learning:** Study of numerical models and analysis of vibratory systems using MATLAB **Video link / Additional online information:** https://nptel.ac.in/courses/112/103/112103112/ https://oaktrust.library.tamu.edu/handle/1969.1/93266	08Hrs

UNIT-III

Harmonically excited Vibration: One degree of freedom- forced harmonic vibration; vector representation of forces; excitation due to rotating and reciprocating unbalance; vibration Isolation, force and motion transmissibility; absolute and relative motion of mass (Seismic Instruments). Whirling Motion and Critical Speed: Whirling motion and Critical speed: Definitions and significance. Critical speed of a vertical, light flexible shaft with single rotor: with and without damping **Experiential Learning**: Study of forced vibration system on rotating and reciprocating machines. **Video Links/Any other special information:** https://www.youtube.com/watch?v=xe365qgH3K8&pp=ygUeaGFybW9uaWNhbGx5IGV4Y2l0ZWQgdmlicmF0aW9u https://www.youtube.com/watch?v=vLaFAKnaRJU&t=575s&pp=ygUeaGFybW9uaWNhbGx5IGV4Y2l0ZWQgdmlicmF0aW9u https://www.youtube.com/watch?v=vX_ekcUjXA4&pp=ygUeaGFybW9uaWNhbGx5IGV4Y2l0ZWQgdmlicmF0aW9u https://www.youtube.com/watch?v=tmPgze7jar8&pp=ygUeaGFybW9uaWNhbGx5IGV4Y2l0ZWQgdmlicmF0aW9u	08 Hrs

UNIT-IV

Systems with two degrees of Freedom: Principal modes of vibrations, Normal mode and natural frequencies of systems (without damping) – Simple spring mass systems, masses on tightly stretched strings, double pendulum, torsional systems, combined rectilinear and angular systems, geared systems and Problems. Undamped dynamic vibration absorber and Problems. **Experiential Learning**: Study of two-degree freedom systems like vehicle suspension and vibration absorber. **Video link / Additional online information:** https://www.youtube.com/watch?v=p1S-Ohvdvxk&pp=ygUjU3lzdGVtcyB3aXRoIHR3byBkZWdyZWVzIG9mIEZyZWVkb20%3D https://www.youtube.com/watch?v=dqtZwZmMh4w&pp=ygUjU3lzdGVtcyB3aXRoIHR3byBkZWdyZWVzIG9mIEZyZWVkb20%3D	08 Hrs

UNIT-V

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 **Experiential learning:** Develop basic numerical simulation skills using MATLAB to simulate the dynamic and oscillatory response of physical models **Video link / Additional online information:** https://www.youtube.com/watch?v=oPpW2DliCZc&pp=ygUjU3lzdGVtcyB3aXRoIHR3byBkZWdyZWVzIG9mIEZyZWVkb20%3D	08 Hrs

Experiments	24 Hrs.
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 solve vibration in single degree of freedom system. 4 To find the initial velocity of a projectile by solving a system of linear equations.	

5.Finding the Fourier Transform of a given signal and plotting its magnitude and phase spectrum. 6.Finding the damping coefficient of a damped free vibration system. 7. Simple and Compound Pendulums 8. To write a code to plot the animation of displacement of slider crank mechanism with respect to input angle. 9. Transverse Vibration of a Beam.

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain different types of vibration, forcing functions and applications of vibrations such as isolation and control.
CO2	Demonstrate the vibration problems.
CO3	Design major and realistic vibration problems in mechanical engineering design.
CO4	Analyze and formulate mathematical models for several degree of freedom systems using different numerical techniques.
CO5	Analyze and discus on different vibration measuring instruments. Ability to understand and formulate mathematical models for two degree of freedom systems of theoretical and real-life engineering systems.

Text Books	
1.	S. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw-Hill, 2000.
2.	S. S. Rao, Mechanical Vibrations, Pearson Education, 4th Edition.

Reference Books	
1.	P. Srinivasn, Mechanical vibration Analysis, Tata McGraw Hill
2.	D. Hartog, Mechanical Vibration, Tata McGraw Hill.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Laboratory- 50 Marks

Weekly Evaluation 30 Marks

Weekly evaluation will be conducted for every experiment. Marks of each evaluation includes Weekly Attendance + Experiment conduction along with Record / Observation + Weekly viva for all the experiments. The total of all these evaluated marks are added and the total marks will be scaled to 30 marks. (A)

Two CIE for 20 Marks each and take the average for 20 Marks (B)

Final CIE Marks will be calculated as A+B for 50 marks

For IPCC Final CIE Marks will be calculated as Average of CIE and Lab CIE for 50 marks.

Semester End Examination (SEE)

SEE Theory Examination (100 Marks)

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50 (A)

SEE Laboratory Examination (50 Marks)

The laboratory SEE is also evaluated for 50 marks, distributed as follows:
Experiment Conduction with Results: 40 marks
Viva Voce: 10 marks
Total 50 marks (B)

The score for the SEE is A+B of total 100 marks

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

High-3, Medium-2, Low-1

Semester: VII		
Operations Research		
Course Code:	MVJ22ME73	CIE Marks: 50
L: T:P:S	4:0:0:0	SEE Marks: 50
Credits:	4	Total :100
Hours:	50 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.	
2	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.	

UNIT-I	
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).	10 Hrs
UNIT-II	
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, Degeneracy in LPP.	10 Hrs
UNIT-III	
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, application of transportation problem. **Assignment Problem:** Formulation, Solutions to assignment problems by Hungarian method, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Numerical Problems.	10 Hrs
UNIT-IV	
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, 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.	10 Hrs

UNIT-V

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, 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.	10 Hrs

Course Outcomes: After completing the course, the students will be able to	
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, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006
2.	Operations Research, Paneerselvan, PHI

Reference 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.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/112/106/112106134/
2. https://nptel.ac.in/courses/111/107/111107128/
3. https://nptel.ac.in/courses/110/104/110104063/
4. https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VII		
Additive Manufacturing		
Course Code:	MVJ22ME741	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques
2	To familiarize students with different processes in rapid prototyping systems.
3	To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

UNIT-I	
Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing. Classification of AM processes: Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system. Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques. Guidelines for process selection: Introduction, selection methods for a part, challenges of selection AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=ICjQ0UzE2Ao	8 Hrs
UNIT-II	
System Drives and devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features Actuators: Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, Triacs, Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=akZjDHD6JC4	8 Hrs

UNIT-III	
POLYMERS & POWDER METALLURGY Basic Concepts: Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] Polymer Processing: Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques General Concepts: Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM Powder Production Techniques: Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes. Characterization Techniques: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle Friction, Compression ability, Powder Structure, Chemical Characterization Microstructure Control in Powder: Importance of Microstructure Study, Microstructures of Powder by Different techniques. Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting. Sintering: Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components Application of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=yHQX9GWCk6w	8 Hrs
UNIT-IV	
NANO MATERIALS & CHARACTERIZATION TECHNIQUES: Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology Nano-materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of Nano-materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC). Optical Microscopy - principles, Imaging Modes, Applications, Limitations. Scanning Electron Microscopy (SEM) - principles, Imaging Modes, Applications, Limitations. Transmission Electron Microscopy (TEM) - principles, Imaging Modes, Applications, Limitations. X- Ray Diffraction (XRD) - principles, Imaging Modes, Applications, Limitations. Scanning Probe Microscopy (SPM) - principles, Imaging Modes, Applications, Limitations. Atomic Force Microscopy (AFM) - basic principles, instrumentation, operational modes, Applications, Limitations. Electron Probe Micro Analyzer (EPMA) - Introduction, Sample preparation, Working procedure, Applications, Limitations. Experiential Learning: (Experiments which can be conducted on the concepts of contents)	8 Hrs

Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=lFYs3XDu4fQ	
UNIT-V	
MANUFACTURING CONTROL AND AUTOMATION CNC technology - An overview: Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC Part programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming, Computer aided part programming (APT) Introduction: Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity Control Technologies in Automation: Industrial control system. Process industry vs discrete manufacturing industries. Continuous vs discrete control. Continuous process and its forms. Other control system components. Experiential Learning: (Experiments which can be conducted on the concepts of contents) Video Links/Any other special information(Papers): (For additional study on the concepts of contents) https://www.youtube.com/watch?v=PN_tGm5Gip4	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
CO2	Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting.
CO3	Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
CO4	Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
CO5	Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.

Text Books	
1.	Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies" ,Springer,2009

2.	Chua C. K., Leong K. F., and Lim C. S., "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific Publishers (2003)

Reference Books	
1.	Patri K. Venuvinod, Weiyin Ma "Rapid Prototyping: Laser-Based and Other Technologies" Springer , 2004
2.	Burns. M, "Automated fabrication", Prentice-Hall,1993.

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VII		
AI & ML for Mechanical Engineers		
Course Code:	MVJ22ME742	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	be familiar with basic concept of Artificial Intelligence
2	well-acquainted with Artificial intelligence in Robotics
3	be familiar with application of AI in Mechanical and Manufacturing Industry
4	familiar with the concepts of Machine learning and its variants
5	impart knowledge about use of machine learning in various industries

UNIT-I	
Introduction to Artificial Intelligence Introduction to Al, Problem formulation, Problem Definition, Production systems, Control strategies, Search strategies, Problem characteristics, Production system characteristics, Specialized production systems, Problem solving methods,	8 Hrs
UNIT-II	
Artificial Intelligence in Robotics Reinforcement Learning- planning and search, localization, tracking, mapping and control- A* search algorithms- path smoothing algorithms - SLAM algorithm- Precision agriculture- Assistance robots-Robot Performance optimization-Case studies.	8 Hrs
UNIT-III	
Application of Artificial Intelligence in Mechanical Manufacturing Industries Fault diagnosis- Quality inspection- Improving the safety of working places-Material modeling and smart materials-Automobile engineering- building self-driving cars and autonomous vehicles, Auto parking-Machine learning in Machine Tools and Manufacturing Industries.	8 Hrs
UNIT-IV	
Introduction to Machine Learning Introduction and basic concepts - Need for machine learning - Types of machine learning - Supervised, Unsupervised learning - Reinforced learning - Deep learning Versus Machine Learning - Relation between - Machine Learning and Statistics - Machine Learning methods based on time	8 Hrs
UNIT-V	
Applications of Machine Learning in Industrial Sectors Applications of machine learning in Industrial sectors - Energy sector: oil and gas - Basic materials sector: Chemicals and Basic resources - Industrials sector - Industrial manufacturing - Industry 4.0: Industry smartization; Production level case study - Opportunities within Smart Industries	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	discuss the basics and the purpose of Artificial Intelligence
CO2	apply the concept of AI in Robotics field
CO3	apply the concept of Artificial Intelligence in Mechanical and Manufacturing Industries
CO4	knowing the basic concepts of machine learning

CO5	ability to apply the machine learning concepts in Industry

Text Books	
1.	. Mangey Ram, J. Paulo Davim, Soft Computing Techniques and Applications in Mechanical Engineering, IGI Global, USA, DOI: 10.4018/978-1-5225-3035-0,2022.ISBN13: 9781522530350
2.	E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.
3.	Kaushik Kumar, Divya Zindani, Paulo Davim, Artificial Intelligence in Mechanical and Industrial Engineering , ISBN 9781003011248, CRC Press, 2021.

Reference Books	
1.	Russell Stuart, Norvig Peter, "Artificial Intelligence Modern Approach", Pearson Education series in AI, 3rd Edition, 2010.
2.	Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013
3.	Simeone O. Machine learning for engineers. Cambridge University Press; 2022 Nov 3.
4.	Aurélien Géron, Hands on Machine Learning with Scikit-learn and Tensor Flow, O'Reilly Publishers, 2016.
Web links and Video Lectures (e-Resources):	
https://www.youtube.com/watch?v=SSE4M0gcmvE	
https://www.youtube.com/watch?v=VYA17BrH9rU	
https://www.youtube.com/watch?v=_-g8PR7XKsE	
https://www.youtube.com/watch?v=T3PsRW6wZSY&list=PLIg1dOXc_acbdJo-AE5RXpIM_rvwrerwR	
https://www.youtube.com/watch?v=NhyRPVszj0A	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VII		
Tribology and Surface Engineering		
Course Code:	MVJ22ME743	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To educate the students on the importance of friction, the related theories/laws of sliding and rolling friction and the effect of viscosity of lubricants.	
2	To expose the students to the consequences of wear, wear mechanisms, wear theories and analysis of wear problems.	
3	Tomake the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.	
4	To expose the students to the factors influencing the selection of bearing materials for different sliding applications.	
5	To introduce the concepts of surface engineering and its importance in tribology	

UNIT-I	
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. Types of lubricants	8 Hrs
UNIT-II	
Hydrodynamic Lubrication: Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, and mechanism of pressure development in an oil film, Reynolds's investigation and Reynolds's equation in 2D. Idealized Journal Bearing: Introduction to idealized journal bearing, load carrying capacity, condition for equilibrium, Sommerfeld's numbers and significance of it; Partial bearings, end leakages in journal bearing, Numerical problems.	8 Hrs
UNIT-III	
Slider / Pad Bearing with a Fixed and Pivoted Shoe: Pressure distribution, Load carrying capacity, coefficient of friction, frictional resistance in a pivoted shoe bearing, numerical examples. Oil Flow And Thermal Equilibrium Of Journal Bearing: Oil flow through bearings, self-contained journal bearings, bearings lubricated under pressure, thermal equilibrium of journal bearings.	8 Hrs
UNIT-IV	
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. Advantages and disadvantages of bearing materials.	8 Hrs
UNIT-V	
Behaviour of Tribological Components: Selection, friction, Wear of ceramic materials, wear measurements, effects of speed, temperature and pressure. Tribological measures, Material selection, improved design, surface engineering.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the fundamentals of tribology and associated parameters.
CO2	Apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
CO3	Analyse the requirements and design hydrodynamic journal and plane slider bearings for a given application
CO4	Select proper bearing materials and lubricants for a given tribological application.
CO5	Apply the principles of surface engineering for different applications of tribology.

Text Books	
1.	Introduction to Tribology Bearings, Mujumdar B. C., S. Chand company pvt. Ltd 2008.
2.	Fundamentals of Tribology , Basu S K., Sengupta A N., Ahuja B.B., , PHI 2006

Reference Books	
1.	Theory and Practice of Lubrication for Engineers, Fuller, D., New York company 1998
2.	Tribology in Industries, Srivastava S., S Chand and Company limited, Delhi 2002

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

Semester: VII semester		
CRYOGENICS		
Course Code:	MVJ22ME744	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.
Course Learning Objectives: The students will be able to		
1	To analyze the Cryogenic systems	
2	To know cryogenic applications in aerospace engineering	
3	To have a detailed knowledge of cryo-coolers, Gas-Liquefaction, Refrigeration Systems, Cryogenic Insulations and Vacuum Technology	
4	To embark on a research career in Cryogenic Engineering	

UNIT-I	
INTRODUCTION TO CRYOGENIC SYSTEMS Introduction , Cryogenic propellants and its applications, Properties of cryogenic fluids at cryogenic temperature - Mechanical properties, Thermal properties, Electrical properties, Safety in Cryogenics, Applications in Space Technology, Applications Areas of Cryogenic Engineering Low temperature properties of engineering materials – Mechanical properties, Thermal properties, Electrical properties.	8 hrs
UNIT-II	
GAS LIQUEFACTION SYSTEMS Introduction The Thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion. Liquefaction systems- Introduction, Joule Thomson effect ,Joule Thomson Coefficient, Liquification systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems.	8 hrs
UNIT-III	
GAS CYCLE CRYOGENIC REFRIGERATION SYSTEMS Classification of Cryo coolers - Stirling Cryo – cooler, Gifford-McMahon Cry cooler, Pulse tube refrigerator, Solvay cycle refrigerator, Vuilleumier refrigerator, Cryogenic regenerators, Numericals on Cryogenic Refrigeration system	8 hrs
UNIT-IV	
GAS SEPARATION AND GAS PURIFICATION SYSTEMS Thermodynamic ideal separation system, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems, Pre purification of Air, Cryogenic Gas Adsorption ,Cryo-condensation Process	8 hrs
UNIT-V	
VACUUM TECHNOLOGY, CRYOGENIC FLUID STORAGE AND TRANSFER SYSTEMS Vacuum Technology- Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Cryogenic fluid storage vessels-Insulation, Evacuated porous insulation, Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Propellant servicing ,Propellant managemenY, Cryogenic fluid transfer systems	8 hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe various methods to produce low temperature and phenomennas at cryogenic temperature.
CO2	Understand the working principle of different cryogenic refrigeration and liquification system.
CO3	Understand the functions and working principles of insulations and various low temperature measuring and storage devices.
CO4	Understand the application of Cryogenic technology in engineering research and Industry.
CO5	Understand the significance of vacuum technology, cryogenic fluid storage and transfer systems.

Text Books	
1.	Haseldom, G, "Cryogenic Fundamentals", Academic Press, 2001
2.	Randall F. Barron., "Cryogenic Systems", Oxford University, 1985

Reference Books	
1.	J.H.Bell ,"Cryogenic Engineering" , Prentice Hall, Englewood Cliffs,1963
2.	Parner, S. F., "Propellant Chemistry", Reinhold Publishing Corpn., New York,1985
Web links and Video Lectures (e-Resources): https://www.youtube.com/watch?v=4gGMBNEzeuc&list=PLSGws_74K01-n2CgfQbgZGif2aAi-D4oZ https://www.youtube.com/watch?v=JQG2m9jSkws&list=PLSGws_74K01-n2CgfQbgZGif2aAi-D4oZ&index=5 https://www.youtube.com/watch?v=0J6HUzznZNI&list=PLSGws_74K01-n2CgfQbgZGif2aAi-D4oZ&index=10	

Continuous Internal Evaluation (CIE):

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- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks

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

Semester: VII		
Digitial Manufacturing		
Course Code:	MVJ22ME751	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand the evolution and current state of digital manufacturing technologies.
2	Implement digital manufacturing techniques to streamline production processes.
3	Design and deploy IIoT architectures that enhance connectivity and interoperability in digital manufacturing environments.
4	pply Industry 4.0 Concepts in a Manufacturing Plant to Improve Productivity and Profits.
5	Evaluate the impact of cloud computing on operational efficiency, scalability, and cost- effectiveness in a networked economy.

UNIT-I	
Introduction: Development of Manufacturing Engineering, Status of Digital Manufacturing, Research Methods, Architecture, Organization Model and Function Model of Digital Manufacturing System, Industrial Internet, Case studies. **Design for Additive Manufacturing:** Design for Manufacturing and Assembly, Core DFAM Concepts and Objectives, CAD Tools for AM, Synthesis Methods.	8 Hrs
UNIT-II	
Computing Manufacturing: Virtual Prototyping, Reverse Engineering, Application of Reverse Engineering, Discrete Model of Manufacturing Computing, Information Model of Manufacturing computing, Geometric Modeling in Manufacturing Computing, Computational Geometry **Manufacturing Informatics:** Information Characteristics, Activities and Manufacturing Informatics, Integration, Sharing and Security of Manufacturing Information. Integration Model, Principle and Mechanism of Sharing Manufacturing Resources.	8 Hrs
UNIT-III	
Intelligent Manufacturing System: The Application of Sensor in the Processing Data Mining, Data Mining Applied to Digital Manufacturing, Knowledge Reasoning in Engineering Design, Intelligent Knowledge- Based Manufacturing System, Self-Learning of Manufacturing System, Adaptation of Manufacturing System, The Concepts and Features of Intelligent Manufacturing, Multi-Agent Manufacturing System. **Future Development of Digital Manufacturing Science:** The Precision of Digital Manufacturing, The Externalization of Digital Manufacturing, The Environmental Protection of Digital Manufacturing.	8 Hrs

UNIT-IV	
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	8 Hrs
Cloud and Fog: M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
UNIT-V	
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance, Assembly, Collaborative Operations, Training. **Smart Factories:** Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the working process and technology development in Digital Manufacturing
CO2	Apply the principles of DM in the manufacturing industry
CO3	Analyze and Implement Modern IIoT Communication Protocols and Architectures in DM.
CO4	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO5	Evaluate the effectiveness of Cloud Computing in a networked economy.

Text Books	
1.	Alp Ustundag • Emre Cevikcan "Industry 4.0: Managing The Digital Transformation", Springer, 2018 ISBN978-3-319-57869-9
2.	Kumar, K., Zindani, D., & Davim, J.P. (Eds.). (2019). Digital Manufacturing and Assembly Systems in Industry 4.0 (1st ed.). CRC Press. https://doi.org/10.1201/9780429464768

Reference Books	
1.	Zude Zhou, Shane (Shengquan) Xie, Dejun Chen "Fundamentals of Digital Manufacturing Science" 2012.Springer ISBN 978-0-85729-564-4,
2.	Alasdair Gilchrist "Industry 4.0 The Industrial Internet of Things" A press Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
Web links and Video Lectures (e-Resources): https://www.twi-global.com/technical-knowledge/faqs/what-is-digital-manufacturing	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

Semester: VII		
Product Design and Development		
Course Code:	MVJ22ME752	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Describe the characteristics used for product design and development
2	Analyze the relative importance of customer needs and reflect on the results.
3	Identify various steps in testing a new concept.
4	Analyze various aspects of product architecture.
5	Explain principles and technologies of prototyping.

UNIT-I	
Introduction: Characteristics of successful product development, design and development of products, duration, and cost of product development, the challenges of product development. Development Processes and Organizations: Generic development process, concept development: the frontend process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.	8 Hrs
UNIT-II	
Product planning: Product planning process, identify opportunities, evaluate and prioritize projects, allocate resources and plan timing, complete pre-project planning, reflect all the results and the process Identifying customer needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.	8 Hrs
UNIT-III	
Concept Generation: Activities of concept generation, need for systems level thinking, TRIZ and its comparison with brainstorming and lateral thinking, TRIZ tools Ideality and IFR, problem formulation and functional analysis, use of 40 principles to solve contradiction, use of S-curves and technology evolution trends. Concept selection: Overview of methodology, concept screening, and concept scoring, Pugh matrix and its application. Concept testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process, Failure Mode Effect Analysis (DFMEA and PFMEA).	8 Hrs
UNIT-IV	
Product architecture: implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.	8 Hrs

Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design. Design for X (DFX): Design for manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors, design for assembly, service and quality.	
UNIT-V	
Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes Product development economics: Elements of economic analysis, base case financial mode, sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the characteristics used for product design and development.
CO2	Assess the customer requirements in product design.
CO3	Apply structural approach to concept generation, selection and testing.
CO4	Identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture.
CO5	Explain various principles and technologies used for the preparation of prototype.

Text Books	
1.	George E Deiter, Engineering Design, 5th Edition, McGraw-Hill , 2012 .
2.	Boothroyd G, Dewhurst P and Knight W, Product Design for Manufacture and Assembly, 2nd Edition, Marcel Dekker, New York, 2002.

Reference Books	
1.	G Altshuller, H Altov, Lev Shulyak, And Suddenly the Inventor Appeared: TRIZ, The theory of Inventive Problem Solving, Technical Innovation Centre, 2nd Edition, May 1996.
2.	Vladimir Petrov, Theory of Inventive Problem Solving, Level 1, Springer Series, 2019, ISBN: 978-3-030-04253-0.
Web links and Video Lectures (e-Resources): **1.** https://www.youtube.com/watch?v=HN9GtL21rb4&list=PLSGws_74K018yZOnbSaqWJZ837QyBB7vu&pp=iAQB **2.** https://www.youtube.com/watch?v=85hH76qjilE **3.** https://www.youtube.com/watch?v=dcup4kRxSEs	

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

Semester: VII		
Operations Research		
Course Code:	MVJ22ME753	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
2	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.

UNIT-I	
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).	08 Hrs
UNIT-II	
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, Degeneracy in LPP.	08 Hrs
UNIT-III	
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, application of transportation problem. **Assignment Problem:** Formulation, Solutions to assignment problems by Hungarian method, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Numerical Problems.	08 Hrs
UNIT-IV	
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, 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.	08 Hrs

UNIT-V

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, 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.	08 Hrs

Course Outcomes: After completing the course, the students will be able to	
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, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006
2.	Operations Research, Paneerselvan, PHI Publishers.

Reference 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.

Web links and Video Lectures (e-Resources):

5. https://nptel.ac.in/courses/112/106/112106134/
6. https://nptel.ac.in/courses/111/107/111107128/
7. https://nptel.ac.in/courses/110/104/110104063/
8. https://onlinecourses.nptel.ac.in/noc21_mg43/preview

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

Semester: VII		
Statistical Design and DoE		
Course Code:	MVJ22ME754	CIE Marks: 50
L: T:P:S	3:0:0:0	SEE Marks: 50
Credits:	3	Total :100
Hours:	40 Hrs. of Theory	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Understand the significance of Design of Experiments in Research.
2	Know the concepts of optimization in their project work.
3	Get familiarized with the Multi variable unconstraint optimization
4	Gain knowledge on Multi variable constrain optimization
5	Elucidate the various stochastic methods for constrained optimization.

UNIT-I	
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	**8 Hrs**
UNIT-II	
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=qzXPaWl-BzM	**8 Hrs**

UNIT-III	
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	8 Hrs
UNIT-IV	
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	8 Hrs
UNIT-V	
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	8 Hrs

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the importance of Design of Experiments for research.
CO2	Apply the optimization techniques in real time engineering problems.
CO3	Explain multivariate constraint optimization.

CO4	Explain multi objective optimization techniques for experiments.
CO5	Define the Principles of genetic algorithm for constrained optimization

Textbooks

1. K Krishnaiah, P. Shahabudeen, Applied Design of Experiments and Taguchi Methods, PHI Learning Pvt. Ltd., 2012.
2. Anup Goel, Numerical Methods and Optimization, Technical Publications, 2020.
3. Dr. Hari Arora, Numerical Methods and Optimization, 4th Edn., S.K. Kataria & Sons, 2013.

Reference Books

1.	Design and Analysis of Experiments, Douglas C. Montgomery, 5th Edition Wiley India Pvt. Ltd. 2007
2.	Quality Engineering using Robust Design, Madhav S. Phadke, Prentice Hall PTR, Englewood Cliffs, New Jersey 07632, 1989.
3.	Experiments Planning, analysis, and parameter Design optimization, C.F. Jeff Wu Michael Hamada, John Wiley Editions. 2002.
4.	Sergiy Butenko, Panos M. Pardalos, Numerical Methods and Optimization: An Introduction (Chapman & Hall/CRC Numerical Analysis and Scientific Computing Series), CRC Press 2014.
5.	Design and Analysis of Experiments (English, Paperback, Das, M. N. ,Giri, N.C.), Publisher: New Age International, Genre: Engineering, ISBN: 9789386418906, 9386418908, Edition: Third Edition, 2017

Continuous Internal Evaluation (CIE):

- Three CIE Will be conducted for 50 marks each and average of three will be taken (A)
- Three Quizzes will be conducted along with CIE for 10 Marks Each. Sum of three quizzes will be considered for 30 marks (B)
- Two Assignments for 10 marks each and the sum of both the assignments will be taken for 20 Marks (C)

Final CIE Marks will be calculated as (A+B+C)/2 for 50 marks

Semester End Examination (SEE):

The question paper consists of two parts, A and B

Part A: consists of 10 questions of 2 marks each. It is designed to cover the entire syllabus comprehensively.

Part B: The question paper will have 10 questions. Each question is set for 16 marks. There will be 2 questions from each module, with a maximum of 2 subdivisions. Students have to answer any 5 questions choosing one full question from each module.

The SEE Theory marks of 100 will be scaled down to 50.

The final score for the course in the ratio of 50:50 of CIE and SEE Marks.

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

Semester: VII		
Major Project Phase – II		
Course Code:	MVJ22MEP76	CIE Marks: 100
L: T:P:S	0:0:12:0	SEE Marks: 100
Credits:	6	Total :200
Weeks:	12-13	SEE Duration: 3 Hrs.

1	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.
2	As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills.
3	To provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.
4	Compile the results, discuss the findings and draw the conclusions for the project.
5	Prepare quality document of project work.

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

Semester: VIII		
INTERNSHIP		
Course Code:	MVJ22MEI83	CIE Marks: 100
L: T:P:S	0:0:20:0	SEE Marks: 100
Credits:	10	Total :200
Weeks:	14 - 20	SEE Duration: 3 Hrs.

Course Learning Objectives: The students will be able to	
1	Get an inside view of an industry and organization/company
2	Gain valuable skills and knowledge
3	Make professional connections and enhance student's network
4	Get experience in a field to allow the student to make a career transit
5	To build a record of work experience and construct a good relationship with the employers.

Guidelines

- Students have to undergo this training for a period of 6 weeks (minimum) during the vacation between even and odd semesters.
- 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
- The department shall nominate a faculty as a mentor for a group of students to prepare and monitor the progress of the students
- The students shall report the progress of the internship to the mentor/guide at regular intervals and may seek his/her advice.
- After completion of Internship, students shall submit a report to the department with the approval of both internal and external guides/mentors.
- Evaluation of Internship shall be conducted during VIII semester by internal and external examiners for 100 marks.
- 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
- 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
- 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	
1. Relevance of the Field training/Industrial Internship	10 Marks
2. Report	25 Marks
3. Evaluation	40 Marks
Total	100

Course outcomes:	
CO1	To experience internship training, enabling the student for onsite visits, study projects and practical training.
CO2	To develop a skill for handling multiple situations, practical problems, analyzing teamwork and communication abilities
CO3	To integrate theory with practice and carry out performance objectives on strong work ethics, persistence, adaptability and critical
CO4	To analyze work environment and create solution to problems.
CO5	To build a record of work experience and construct a good relationship with the employers.

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