INDIRA COLLEGE OF ENGINEERING AND MANAGEMENT, PUNE

(An Autonomous Institute Affiliated to Savitribai Phule Pune University Pune)

Parandwadi, Pune – 410506, Ph. 02114 661500, www.indiraicem.ac.in

Approved by AICTE & Government of Maharastra, Accredited by NAAC

Department of Mechanical Engineering

Second Year Engineering (B. Tech – Mechanical Engineering)

Structure and Syllabus

Prepared by: - Board of Studies in Mechanical Engineering

Approved by: - Academic Council, ICEM, Pune

(With effect from Academic Year 20225-26)

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Vision of the Institution

The institute envisions to develop itself into a centre of academic excellence in the field of Engineering and Management education in order to develop future technocrats and managers having right knowledge, skill and attitude to serve the society and industries to fulfil their ever changing requirements.

Mission of the Institution

- To train our students to become best Engineering Entrepreneurs today, who will lead the organizations successfully into the future; locally, nationally and globally.
- To provide an environment which fosters continuous improvement & innovation with related technical support & facilities to enhance student and faculty effectiveness.
- To provide programs focusing on the holistic development of the individual with the emphasis on personality grooming, physical fitness and a strong sense of social and environmental responsibility.
- To improve logic & scientific reasoning and to develop global mind-set amongst the students and prepare them to work in heterogeneous environment.

Quality policy

We are committed to quality engineering / management education and continual quality enrichment by establishing and applying mechanisms for satisfaction of our stakeholders.

Vision of the Department

Be a nationally recognized Mechanical Engineering Department that provides right academic ambience and nurtures innate talent of students.

Mission of the Department

Prepare engineering students for successful career in Mechanical Engineering by imparting knowledge, skills and attitude

Short Term Goal

- Improve passing rate.
- Identify weaker students and groom them through extra efforts.
- Increase first class index.
- Encourage students for research projects by providing financial support.

Long Term Goal

- Permanent affiliation.
- Recognized research centre of mechanical engineering department.
- Continuous improvement in Mechanical engineering departmental placements.
- Increase industrial MOUs.

Programme Outcomes [PO]

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.
PO2	**Problem analysis**	Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
PO3	**Design / Development of Solutions**	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.
PO4	**Conduct Investigations of Complex Problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage**	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
PO6	**The Engineer and Society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
PO7	**Environment and Sustainability**	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of Engineering practice.
PO9	**Individual and Team Work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication Skills**	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project Management and Finance**	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.
PO12	**Life-long Learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological

PSO Statements

After successful completion of B. E. (Mechanical) program student will,

1. Problem-Solving Skills: Execute fabrication, test, operation, documentation and specification of basic mechanical systems or processes.
2. Successful Career and Entrepreneurship: Work in Core/software industry for Design / Development and use of CAD/CAM/CAE Software and platforms in creating innovative career paths to be an entrepreneur and create employability for nation building

Program Educational Objectives (PEOs)

1. Graduates will apply knowledge gained in engineering and science to improve lives and livelihoods through a successful career in Mechanical Engineering and other related fields.
2. Graduates will become innovators, entrepreneurs to address social, technical and business challenges.
3. Graduates will engage in lifelong learning such as higher studies, research and other Continuous professional development activities.

Abbreviations

AEC	Ability Enhancement Course
BSC	Basic Science Course
CAE	Continuous Assessment Evaluation
CCE	Comprehensive Continuous Evaluation
CCE	Comprehensive Continuous Evaluation
CO	Course Outcome
ESC	Engineering Science Course
IKS	Indian Knowledge System
NEP	National Education Policy
PCC	Programme Core Course
PO	Program Outcomes
PR	Practical
PSO	Programme Specific Outcome
TAE	Teacher Assessment Evaluation
TH	Theory
TU	Tutorials
VSEC	Vocational and Skill Enhancement Course

S.Y. B. Tech (Mechanical) Structure Semester III

Course Code	Name of Course	Course Category (As per NEP2020)	Teaching Scheme				Credits	Evaluation Scheme					
			L	T	P	Total		Theory			Practical		Total Marks
								TAE	CAE	ESE	INT	EXT	
24UMEL301	Solid Mechanics	Program Core Course (PCC)	03	-	-	03	03	10	15	50	-	-	75
24UMEP301	Solid Mechanics Laboratory	Program Core Course (PCC)	-	-	02	02	01	-	-	-	25	-	25
24UMEL302	Thermodynamics	Program Core Course (PCC)	03	-	-	03	03	10	15	50	-	-	75
24UMEP302	Thermodynamics Laboratory	Program Core Course (PCC)	-	-	02	02	01	-	-	-	-	25	25
24UMEP303	Technology Craftsmanship	Program Core Course (PCC)	-	-	04	04	02	-	-	-	-	50	50
24UMEXXXX	Minor -I	Multidisciplinary Minor - I	02	-	-	02	02	-	-	50	-	-	50
24UXXXXXX	Open Elective -I	Open Elective (OE) –I (Other Program)	03	-	-	03	03	10	15	50	-	-	75
24UXXXXXX	Open Elective -I	Open Elective (OE) –I (Other Program)	-	-	02	02	01	-	-	-	25	-	25
24UESP305	Entrepreneurship Awareness I	Entrepreneurship/ Economics/ Management Course	-	-	04	04	02	-	-	-	25	-	25
24UVEL306	Understanding India	Value Education (VEC-I)	02	-	-	02	02	-	-	-	25	-	25
24UMEP307	Project Based Learning	Field Project (FP)	-	-	04	04	02	-	-	-	50	-	50
	Total		**13**	**-**	**18**	**31**	**22**	**30**	**45**	**200**	**150**	**75**	**500**

S.Y. B. Tech (Mechanical) Structure Semester IV

Course Code	Name of Course	Course Category (As per NEP2020)	Teaching Scheme				Credits	Evaluation Scheme					
			L	T	P	Total		Theory			Practical		Total Marks
								TAE	CAE	ESE	INT	EXT	
24UMEL401	Fluid Mechanics	Program Core Course (PCC)	03	-	-	03	03	10	15	50	-	-	75
24UMEP401	Fluid Mechanics Laboratory	Program Core Course (PCC)	-	-	02	02	01	-	-	-	-	25	25
24UMEL402	Theory of Machines	Program Core Course (PCC)	03	-	-	03	03	10	15	50	-	-	75
24UMEP402	Theory of Machines Laboratory	Program Core Course (PCC)	-	-	02	02	01	-	-	-	-	25	25
24UMEL403	Differential and Integral Calculus	Program Core Course (PCC)	02	-	-	02	02	10	15	50	-	-	75
24UMEXXXX	M-II	Multidisciplinary Minor - II	02	-	-	02	02	-	-	50	-	-	50
24UXXXXXX	OE-II	Open Elective (OE) -II (Other Program)	02	-	-	02	02	10	15	25	-	-	50
24UMEP405	Modelling and Drafting Laboratory	Vocational and Skill Enhancement Course (VSEC)	-	-	04	04	02	-	-	-	50	-	50
24UBSP406	Corporate Communication	Ability Enhancement Course (AEC)	-	-	04	04	02	-	-	-	25	-	25
24UESP407	Entrepreneurship Awareness II	Entrepreneurship/ Economics/ Management Course	-	-	04	04	02	-	-	-	25	-	25
24UVEP408	Environment Studies	Value Education (VEC-I)	-	-	04	04	02	-	-	-	25	-	25
	Total		12	-	20	32	22	40	60	225	125	50	500

Multidisciplinary Minor-I

Course Code	Robotics and Automation	Course Code	Electric Vehicle	Course Code	Smart Manufacturing
24UMEL3M11	H & P	24UMEL3M21	E-vehicle Technology	24UMEL3M31	Advanced Machining
24UMEL4M12	Mechatronics	24UMEL4M22	E-vehicle System design	24UMEL4M32	Advanced Welding
24UMEL5M13 /24UMEP5M13	Kinematic Synthesis	24UMEL5M23 / 24UMEP5M23	Motors & Battery Technologies for EV	24UMEL5M33 / 24UMEP5M33	Flexible Manufacturing
24UMEL6M14	Control Systems	24UMEL6M24	EV manufacturing & ecosystem infrastructure	24UMEL6M34	Lean Manufacturing
24UMEL7M15	Robot Programming	24UMEL7M25	Modelling & Simulation of EHV Control systems	24UMEL7M35	Group Technology
24UMEL8M16	Case Studies	24UMEL8M26	EV standards, Charging and Safety	24UMEL8M36	Automatic Guided Vehicle

Open Electives (OE)

Department of AI & DS Engineering

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UAIL304/ 24UAIP304 A	DMS administration	24UAIL405 A	Data Security & Privacy	24UAIL506 A	AI & ML
24UAIL304/ 24UAIP304 B	Analytics using Data Science	24UAIL405B	Design Thinking	24UAIL506 B	AR & VR applications in Industry
24UAIL304/ 24UAIP304 C	Gen AI	24UAIL405 C	Social Network analysis	24UAIL506 C	Deep Neural Network

Department of Computer Engineering

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UCEL304/ 24UAIP304 A	Advance Data Structure	24UCEL405 A	Database Management Systems	24UCEL505 A	Cloud Computing
24UCEL304/ 24UCEP304 B	Operating Systems	24UCEL405 B	Information Security	24UCEL505 B	Cryptology and Network Security
24UCEL304/ 24UCEP304 C	Computer Networks	24UCEL405 C	Software Engineering	24UCEL505 C	Software Testing and Quality Assurance

Department of IT Engineering

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UITL304/ 24UITP304 A	Software engineering and development	24UITL405 A	Design and Analysis of Algorithms	24UITL506 A	Big data analytics and R Programming
24UITL304/ 24UITP304 B	Data Structures	24UITL405 B	Deep Learning	24UITL506 B	Internet of Things (IoT)
24UITL304/ 24UITP304 C	Statistics for Engineers'	24UITL405 C	Android and IOS app development	24UITL506 C	Crypto Currency and Block Chain

Department of E&TC Engineering

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UETL304/ 24UETP304 A	Electromagnetics wave propagation and Antenna theory	24UETL403 A	Network Analysis	24UETL502 A	Wireless Sensor Networks
24UETL304/ 24UETP304 B	Digital Image Processing	24UETL403 B	ES and RTOS	24UETL502 B	Speech and Video Signal processing
24UETL304/ 24UETP304 C	Electronics and Electrical Engineering	24UETL403 C	Mechatronics	24UETL502 C	Renewable Energy Sources and Applications

Department of Mechanical Engineering

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UMEL304A / 24UMEP304A	Data Analysis Tools	24UMEL404A	Non-Conventional Energy Sources	24UMEL506A	Technology and Financial Management
24UMEL304B / 24UMEP304B	Data Visualization and Presentation	24UMEL404B	Additive Manufacturing	24UMEL506B	Product Design and Development
24UMEL304C / 24UMEL304C	Mathematical Simulation	24UMEL404C	Nano Technology	24UMEL506C	Process Planning and Management

Curriculum for S.Y. B. Tech (Mechanical)
Semester III

SE Mechanical Curriculum									
Course	**Solid Mechanics**			**Code**	24UMEL301				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:
Fundamentals of Engineering Mechanics, Engineering Mathematics

Course Objectives:

1. To gain fundamental knowledge of stress and strain arising from different types of loading conditions.
2. To illustrate Shear Force and Bending Moment Diagrams for beams subjected to transverse loads.
3. To analyze bending and shear stresses, along with slope and deflection in beams under various forces.
4. To solve numerical problems involving torsional shear stress in shafts and buckling in columns to ensure structural stability.
5. To implement the principles of Principal Stresses and Failure Theories for material strength evaluation.

Course Outcomes:
On completion of the course, learner will be able to
CO1: DESCRIBE different types of stress and strain occurring in determinate and indeterminate structural members.
CO2: CONSTRUCT Shear Force and Bending Moment Diagrams for various transverse loading conditions and support types.
CO3: DETERMINE the slope, deflection, bending stresses, and shear stresses in beams under different loading scenarios.
CO4: ANALYZE torsional shear stress in shafts and buckling behaviour in columns.
CO5: IMPLEMENT the principles of principal stresses and failure theories to evaluate stresses in two-dimensional elements.

Course Contents:

Unit 1 Simple Stresses and Strains 8 hrs.

Concept of stress and strain, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stresses and strains in determinate and indeterminate, homogeneous and composite bars under concentrated loads and self-weight (Numerical). Temperature stresses in simple members both plain and composite (Numerical).

Unit 2 Shear Force and Bending Moment Diagrams 8 hrs.

Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading, Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure. (Numerical)

Unit 3 **Structural Behavior of Beams: Stresses and Deflection** **7 hrs.**

Bending Stress on a Beam: Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section (Numerical)
Shear Stress on a Beam: Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section (Numerical)
Slope & Deflection on a Beam: Introduction to slope & deflection on a beam with application, slope, deflection and Radius of Curvature, Macaulay's Method, Slope and Deflection for all standard beams (Numerical)

Unit 4 **Torsion in Shafts and Buckling of Columns** **7 hrs.**

Torsion of circular shafts: Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory (Numerical). Torque transmission on strength and rigidity basis.
Buckling of columns: Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory

Unit 5 **Principal stresses and Theories of failure:** **7 hrs.**

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses (Numerical)
Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.

Textbooks

1. R. K. Bansal, "Strength of Materials", Laxmi Publication
2. S. Ramamurtham, "Strength of material", Dhanpat Rai Publication
3. S.S. Rattan, "Strength of Material", Tata McGraw Hill Publication Co. Ltd.
4. B.K. Sarkar, "Strength of Material", McGraw Hill New Delhi
5. Singer and Pytel, "Strength of materials", Harper and row Publication
6. R. C. Hibbeler, "Mechanics of Materials", Prentice Hall Publication

Reference books

1. G. H. Ryder, "Strength of Materials", Macmillan Publication
2. Beer and Johnston, "Strength of materials", CBS Publication
3. James M. Gere, "Mechanics of Materials", CL Engineering
4. Timoshenko and Young, "Strength of Materials", CBS Publication, Singapore
5. Egor P Popov, "Introduction to mechanics of solids", Prentice Hall Publication

E-content Links:

1. Prof. S.K. Bhattacharyya, IIT Kharagpur , "NPTEL Web course material" https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing
2. https://nptel.ac.in/courses/112107146
3. https://onlinecourses.nptel.ac.in/noc23_me140/preview

E-books:

1. "Strength of Materials" by N. M. Belyaev https://archive.org/details/BelyaevStrengthOfMaterialsMir1979/page/n581/mode/2up
2. Applied Strength of Materials for Engineering Technology" https://core.ac.uk/download/pdf/47233878.pdf
3. Strength of Materials" by R. Kinasoshvili https://archive.org/details/kinasoshvili-strength-of-materials

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SE Mechanical Curriculum									
Course	**Solid Mechanics Laboratory**			**Code**	24UMEP301				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	25	-
Total Credits	-	-	01	**Total Marks**	25				

The Term work shall consist of completion of Practicals, Self-learning Study Assignments and Presentations. Practical examination shall be based on the Termwork undertaken during the semester.

Practicals: (Any 6 experiments out of experiment no 1 to 8 from the following list whereas experiment no. 9 is mandatory. Minimum One experiment must be performed on IoT platform-Virtual Lab):

1. Tension test for Ductile material using extensometer on Universal Testing Machine.
2. Compression test for Brittle material on Universal Testing Machine.
3. Shear test of ductile material on Universal Testing Machine.
4. Tension test of Plastic/Composite material on low load capacity Tensile Testing Machine.
5. Measurement of stresses and strains using strain gauges.
6. Experimental verification of flexural formula in bending for cantilever/Simple supported beam.
7. Experimental verification of torsion formula for circular software tools bar.
8. Verification of results of any two from experiments no 1-8 using any FEA
9. Self-learning study practical: Following topics are distributed among the group of 3-5 Students and groups need to present and also submit the slides/poster on TW file.
   a. Mechanical properties of materials, Stresses and Design of components with case study.
   b. Failure Mode Analysis and Stresses with case study
   c. Experimental stress analysis, Strain Gauges rosette with case study.
   d. Residual stresses and Fatigue life with case study.
   e. Effect of heat treatment on the mechanical properties of a metal with case study.

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SE Mechanical Curriculum									
Course	**Thermodynamics**			**Code**	24UMEL302				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:
The learner should have prior knowledge of Engineering Mathematics I, II and Engineering Chemistry and Engineering Physics.

Course Objectives:
1. To introduce the fundamentals of thermodynamics.
2. To understand the concepts of laws of thermodynamics.
3. To apply the concepts of thermodynamics towards open and closed systems.
4. To understand the behaviour of a Pure substance and to analyse Vapour power cycles.
5. To undertake the performance analysis of a steam generator.

Course Outcomes:
On completion of the course, learner will be able to
CO1. DESCRIBE the basics of thermodynamics with heat and work interactions.
CO2.APPLY laws of thermodynamics to steady flow and non-flow processes.
CO3.APPLY entropy, available and non-available energy for an Open and Closed System.
CO4.DETERMINE the properties of steam and their effect on performance of vapour power cycle.
CO5.SELECT various instrumentations required for safe and efficient operation of steam generator.

Course Contents:

Unit 1 Basic Concepts of Thermodynamics 6 hrs.

Basic Definitions: Thermodynamic System and Control Volume, Surroundings. Macroscopic and Microscopic Analysis. Definition of Substance, Properties of Substance, Intensive and Extensive, Mathematical Representation of Property, State of substance. Thermodynamic Equilibrium, Concept of Quasi Equilibrium Process and Cycle. Fundamental Units, Units of Force, Energy, Specific Volume, Pressure etc. Equality of Temperature, The Zeroth Law of Thermodynamics, Temperature Scales.
Heat and Work: Definition of Thermodynamic Work, Forms of Work. Definition of Heat, Inter Convertibility of Heat/work into Work/heat, Governing Principles, Sign Convention.

Unit 2 Laws of Thermodynamics. 7 hrs.

First Law of Thermodynamics: First Law for Cyclic Process, First Law for Change of State of a System. Internal Energy, A New Thermodynamic Property. Enthalpy, The Constant Volume and Constant Pressure. (Numerical)

Second Law of Thermodynamics: Definition of Heat Engine and Reservoirs, Kelvin-Planck and Clausius Statements of the Second Law, Reversible and Irreversible Engines and processes, Causes of Irreversibility, Internal and External Irreversibility. (Numerical).

Unit 3 Ideal Gas and Entropy 6 hrs.

Properties and Processes of Ideal Gas: Ideal Gas definition, Gas Laws: Boyle's law, Charle's law, Avagadro's Law, Equation of State, Ideal Gas constant and Universal Gas constant, Ideal gas Processes- on P-v and T-s diagrams, Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytropic, Throttling Processes (Open and Closed systems), Calculations of Heat transfer, Work done, Internal Energy.
Carnot Cycle: Efficiency of a Carnot Cycle, Thermodynamic Temperature Scale, Ideal Gas Temperature Scale. Entropy: Clausius Inequality, Entropy - A Property of a System, Entropy of a Pure Substance, Entropy Change in Reversible Process, Thermodynamic Property Relation, Calculation of Change in Entropy, Principle of Increase of Entropy

Unit 4 Properties of Pure Substance and Analysis of Vapor power cycle. 7 hrs.

Properties of Pure substances: Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and h-s plots (Mollier Chart) for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined) Non-flow and Steady flow Vapour Processes, Change of Properties, Work and Heat transfer. (Numerical)
Analysis of Power Generation Cycles: Air-standard Power Cycles - Concept, Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Cycle, Brayton Cycle. Efficiency and Mean Effective Pressure. Vapor Power Cycle. (Moderate Numerical).

Unit 5 Steam Generators. 7 hrs.

Steam Generators: Classification, Constructional details of low pressure boilers, Primary Features of high pressure (Power) boilers, Location, Construction and working principle of boiler, Boiler mountings and accessories, Instrumentations required for safe and efficient operation, Introduction to IBR Act, Boiler performance Calculations-Equivalent Evaporation, Boiler efficiency, Heat balance Sheet. (Numerical).

Textbooks:

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill Publishers, 5th Edition.
2. Heat Engineering, V.P.Vasandhani & D.S Kumar, Metropolitan Book Depot, 2011 Edition.

Reference books:

1. Thermodynamics: An Engineering Approach Y.A. Cengel and M.A. Boles, Tata Mc-Graw Hill Publishers, 7th Edition.

2. Engineering Thermodynamics, Mayhew and Rogers, Longman Green & Co Ltd., London, E.L.B.S, 8th Edition
3. Fundamentals of Classical Thermodynamics (SI Version), Van Wylen. G.J. and Sonntag. R.E, 2nd Edition.

E-content Links:

1. https://www.nptel.ac.in/courses/112105123/1
2. https://www3.nd.edu/~powers/ame.20231/planckdover.pdf
3. https://www.eduinformer.com/engineering-thermodyna

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SE Mechanical Curriculum									
Course	**Thermodynamics Laboratory**			**Code**	24UMEP302				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	-	25
Total Credits	-	-	01	**Total Marks**	25				

The Term work shall consist of successful completion of Practical's, and Industrial Visits. Oral Examination shall be based on the term work.

Practical's:

1. Joule's experiment to validate, first law of thermodynamics.
2. Survey of temperature sensors used in various thermal systems.
3. Determination of dryness fraction of steam using combined separating and throttling calorimeter.
4. Study of different types of boilers its mountings and accessories.
5. Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
6. Thermodynamic Analysis of any System / Model by using any Computer Software.
7. Demonstration on Vapour power cycle.
8. Visit to any Process Industry/Plant having Boiler equipped with Accessories.

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SE Mechanical Curriculum									
Course	**Technology Craftsmanship**			**Code**	24UMEP303				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	-	50
Total Credits	-	-	02	**Total Marks**	50				

Prerequisites:
Basics of Engineering Materials, Engineering Drawing and Workshop Practice,Basic Physics

Course Objectives:

1. To develop hands-on skills in basic and advanced manufacturing processes.
2. To familiarize students with the working principles of various machining and fabrication techniques.
3. To enhance problem-solving skills through mini-projects and group work.
4. To introduce modern manufacturing concepts, including CNC and additive manufacturing.

Course Outcomes:
On completion of the course, learner will be able to
CO1: Demonstrate practical skills in fundamental manufacturing processes like casting, machining, welding, and forming.
CO2: Apply appropriate manufacturing techniques to fabricate simple components.
CO3: Work effectively in teams to plan and execute small-scale manufacturing projects.
CO4: Develop an understanding of quality control and safety measures in workshop environments.

Course Contents:

Unit 1 Introduction to Manufacturing 2 hrs.

Introduction to Manufacturing and safety measures in Workshop, Types of Hazards, Causes of Hazards

Unit 2 Casting Process/ Black Smithy 12hrs.

Pattern making and sand moulding, Demonstration of metal pouring and solidification Inspection and finishing of cast components.
Black Smithy Shop: Introduction to Black smithy, Tools used in Black Smithy, Handson Practice

Unit 3 Machining Processes 12 hrs.

Lathe operations: Facing, turning, knurling, threading, **Milling operations**: Slotting, face milling Introduction to Grinding and finishing techniques, **Drilling Operations:** Introduction to Radial drilling machine, Familiarization of drilling machine parts and its operations, Marking and drilling holes, Boring and counter boring, Reaming, Combination works.

Unit 4 Welding and Joining Processes 12 hrs.

Arc welding and gas welding demonstration, Hands-on practice on different joint configurations
Introduction to Brazing and soldering

Unit 5 **Metal Forming/Plastic Moulding** **8hrs.**

Sheet Metal Work: Familiarization of sheet metal tools, measuring instruments in sheet metal, Shearing, bending, and simple fabrication.

Guidelines for Practical Conduction

The student shall complete the following activity as a Term Work
The Termwork shall consist of completion of Practical, mini project, Practical examination shall be based on the Term work undertaken during the semester.
Practical (Any 1 experiments out of experiment no 1 to 2 and from the following list whereas experiment no. 8 is mandatory. Any five practicals to be performed by the students.Student need to appear for practical exam of 50 marks based on the learning from these practicals.

1. To study and observe various stages of casting through demonstration of sand-casting process from pattern making, sand mould preparation and melting and pouring of metal.
2. Manufacturing of a S- hook from the given round rod by hand forging operation OR Converting Round rod into square rod by hand forging operation.
3. Manufacturing of simple product e.g. Paper weight, incense stick stands etc using lathe machine operations
4. Manufacturing of Spur gear using indexing Mechanism of Milling machine
5. Manufacturing of one marketable product using Welding Techniques
6. Drilling Machine operations
7. Manufacturing of simple product from given sheet metal
8. A compulsory visit to any one metal forming industry out of: Rolling mill, Forging plant, Wire/Tube drawing unit and prepare a report on it.
9. Manufacturing of Marketable product in Carpentry Shop.
10. Shaper Machine Operations

Reference books:

1. Workshop Technology Vol. 1 & 2 – S.K. Hajra Choudhury
2. Manufacturing Processes – P.N. Rao
3. Elements of Workshop Technology – Raghuwanshi
4. Production Technology – HMT

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Multidisciplinary Minor-I Curriculum

Course Code	Robotics and Automation	Course Code	Electric Vehicle	Course Code	Smart Manufacturing
24UMEL3M11	H & P	24UMEL3M21	E-vehicle Technology	24UMEL3M31	Advanced Machining
24UMEL4M12	Mechatronics	24UMEL4M22	E-vehicle System design	24UMEL4M32	Advanced Welding
24UMEL5M13 /24UMEP5M13	Kinematic Synthesis	24UMEL5M23 / 24UMEP5M23	Motors & Battery Technologies for EV	24UMEL5M33 / 24UMEP5M33	Flexible Manufacturing
24UMEL6M14	Control Systems	24UMEL6M24	EV manufacturing & ecosystem infrastructure	24UMEL6M34	Lean Manufacturing
24UMEL7M15	Robot Programming	24UMEL7M25	Modelling & Simulation of EHV Control systems	24UMEL7M35	Group Technology
24UMEL8M16	Case Studies	24UMEL8M26	EV standards, Charging and Safety	24UMEL8M36	Automatic Guided Vehicle

Multidisciplinary Minor-I (Minor-I)

Set-1: Robotics and Automation

SE Mechanical Curriculum									
Course	**Hydraulics & Pneumatics**			**Code**	24UMEL3M11				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	50	-	-
Total Credits	02	-	-	**Total Marks**	50				

Prerequisites:
Mechanical Technology, Workshop Technology, Fluid Mechanics

Course Objectives:
1. To understand various applications of hydraulic and pneumatic systems.
2. To learn the specifications and functions of components in hydraulic and pneumatic system.
3. To understand the accessories used for hydraulic and pneumatic systems
4. To understand and evaluate Control Valves used for hydraulic and pneumatic systems.
5. To Design & Troubleshooting of hydraulic and pneumatic circuits.

Course Outcomes:
On completion of the course, learner will be able to
CO1: Identify the components & applications of hydraulic and pneumatic systems.
CO2: Classify the actuators and Power unit of hydraulic and pneumatic system.
CO3: Differentiate and Analyses the various hydraulic and pneumatic systems accessories.
CO4: Evaluate Control Valves usefulness in hydraulic and pneumatic system's circuits.
CO5: Design & Simulate hydraulic and pneumatic circuits, tackle troubleshooting of systems.

Course Contents:

Unit 1 Fluid Power Fundamentals & Applications 5 hrs.

Fluid Power Engineering Fundamentals, Fluid power basics (governing laws used in fluid power systems), Discuss fluid power transmission and explain basic methods of transmission of power, Advantages and disadvantages of fluid power systems.
Components of Fluid Power System, Components of hydraulic system, Components of pneumatic systems, Draw symbols of hydraulic and pneumatic components.
Explain role of fluid power engineering in today's industrial automation, Clarify the aims of automation.

Unit 2 Pumps & Actuators 5 hrs.

Hydraulic pumps. Introduction and classification, Advantages of positive displacement pumps, Types of pumps, External and internal gear pump, Vane pumps, Piston pumps, Axial pumps, Radial piston pumps. Calculation & Demonstration of Gear/Vane/Piston pump. (Numerical)

Actuators used in hydraulics and pneumatics, Introduction, Types of actuators, Linear actuators, Rotary actuators, Limited rotary actuators.
Test on linear /rotary actuator. Calculate force/speed/rpm/torque as per case (Numerical).

Unit 3 System Accessories of Hydraulics & Pneumatics 6 hrs.

Accessory used in hydraulic systems, Reservoirs, Accumulators: weight loaded, spring loaded, gas loaded, Intensifier, Fluid conductors/pipes; pipe fittings, Demonstration of electro hydraulic circuit. Accumulator/intensifier (numerical).
Compressed air generation and distribution system, Reservoir, Driers, Types of Regulators, Filters, Lubricators, FRL, Loop piping system. Calculation of pressure loss in piping system (manual/excel sheet/simulation tool/Numerical).

Unit 4 Controls Valves & Circuits 6 hrs.

Introduction, Types of control valves, Directional control valves, Pressure control valves, Circuits with pressure control valve i.e. pressure reducing/counterbalance/brake valve/Sequencing circuit, Flow control valves, Cartridge valves, Proportional control valves / Electro-hydraulics valves, Demonstration of cut-section / transparent / dismantling of any one valve. Hydraulic Circuit examples, Regenerative circuit, Speed control circuits, Transverse and feed circuit.
Pneumatic Circuit Examples, Automatic reciprocating circuit, Speed control circuit/Flow control valve, Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve, Electro pneumatic circuits.

Unit 5 Design, Simulation & Troubleshooting 8 hrs.

Design of industrial hydraulic and pneumatic circuits using manufacturers' catalogue, Simulation and analysis using any open source/free/commercial software or application. **Trouble shooting** of fluid power system, Common problems in pneumatic systems - troubleshooting of pneumatic systems.

Textbooks

1. Esposito A, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
4. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference books

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
4. ISO - 1219, Fluid Systems and components, Graphic Symbols
5. Standard manufacturing catalogues
6. Fundamentals of Pneumatics, Vol I, II and III. FESTO
7. Fundamentals of fluid power control, John Watton Cambridge University press 2012
8. Introduction to Fluid power, Thomson Prentice Hall 2004
9. Hydraulic Control Systems Herbert E. Merritt John Wiley and Sons, Inc

E-content Links:

1. https://nptel.ac.in/courses/112106175
2. https://nptel.ac.in/courses/112106300
3. https://www.digimat.in/nptel/courses/video/112105047/L01.html
4. https://nptel.ac.in/courses/112105423
5. https://mrcet.com/downloads/B.tech%20Digital%20Lecture%20notes/B.Tech%20III%20Year%20I%20Semester/Design%20of%20Hydraulic%20and%20Pneumatic%20Systems%20Digital%20Material.pdf
6. https://www.festo.com/us/en/

E-books:

1. Fluid Power with Applications, Anthony Esposito, 7th Edition, Pearson Education, 2013
2. Hydraulics and Pneumatics: A technician and engineer's guide, Andrew Parr, 1st Edition, Butterworth Heinmann, 2013.
3. https://www.rvstcc.ac.in/assets/img/pdf/AHP%20MANO%20SOFT%20COPY%20NOTES%202023%20BATCH.pdf
4. https://www.msajce-edu.in/academics/mech/ICTTools/ME8694-ICT.pdf

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Set-2: Electric Vehicle

SE Mechanical Curriculum									
Course	**E-vehicle Technology**			**Code**	24UMEL3M21				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	50	-	-
Total Credits	02	-	-	**Total Marks**	50				

Prerequisites:
Basics of Electrical and Electronics, Engineering Chemistry, Engineering Systems.

Course Objectives:
To understand the basic technologies used in e-vehicles and the necessary advancements in it.

Course Outcomes:
On completion of the course, learner will be able to
CO1: UNDERSTAND the basics related to e-vehicle
CO2: CLASSIFY the different hybrid vehicles
CO3: IDENTIFY and EVALUATE the significance of Lithium batteries and BMS
CO4: ILLUSTRATE the issues related to batteries and remedial measures
CO5: EVALUATE the different driving systems for e-vehicles

Course Contents:

Unit 1 E-Vehicle Technology - Introduction 5 hrs.

EV Technology, Significance of e-Vehicle. Types of electric vehicles and it components. Steps in formation of battery pack and its calculation for specific applications. Introduction to suspension system, Mechanical transmission and IoT systems.

Unit 2 Hybridization in E-Vehicles 6 hrs.

Types of hybridization in e-vehicles. Ragone plot, theory and working of Hybridization with IC engine and Battery (with various types), Hybridization of Solar and other non-conventional energy sources with batteries. Current scenarios and its availability in India for different batteries used in e-vehicles.

Unit 3 Lithium-Ion Batteries 6 hrs.

Introduction to lithium batteries and its extensions in different applications. Working principle, advantages and disadvantages. Different chemistries of lithium ion batteries. Evaluation of various battery parameters: State of charge, Depth of discharge, charging rate, etc. current and voltage variation as per different loads. Issues and remedies for battery balancing. Availability of lithium ion batteries and government policies to fulfill the demands of lithium batteries for Indian e-vehicles

Unit 4 Other Batteries and Battery Management System 7 hrs.

Nickel bromide: Working mechanism, advantages, disadvantages, applications; Lead acid batteries: Working mechanism, advantages, disadvantages, applications; Nickel-Metal Hydride Batteries: Working mechanism, advantages, disadvantages, applications; Li Ion supercapacitors: Working mechanism, advantages, disadvantages, applications. Introduction to BMS, BMS sensing and high voltage control, Thermal control and Protection

Unit 5 Introduction to Drive system for e-vehicle 6 hrs.

Introduction to drive systems in EV, Types of motors, selection and size of motors Classification and general characteristics, Motor drives and principle of operation and performance, Mechanical and electrical connections of motors

Textbooks

1. Advances in Battery Technologies for Electric Vehicles, by Bruno Scrosati, Jürgen Garche and Werner Tillmetz, Woodhead Publishing Series in Energy: Number 80.
2. Behaviour of Lithium-Ion Batteries in Electric Vehicles Battery Health, Performance, Safety, and Cost by Gianfranco Pistoia Boryann Liaw.
3. Fundamentals And Applications of Lithium-Ion Batteries in Electric Drive Vehicles Jiuchun Jiang and Caiping Zhang Beijing Jiaotong University, Wiley publications.
4. Electric Motor drives – Modelling, Analysis & Control, R. Krishnan, PHI India, Ltd.

Reference books

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Third Edition, Mehrdad Ehsani Yimin Gao Stefano Longo Kambiz M. Ebrahimi
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Fundamentals, Theory, and Design by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi.

E-books:

1. “Electric Vehicle Technology Explained” – James Larminie, John
2. “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles” – Mehrdad Ehsani
3. “Electric and Hybrid Vehicles” – Tom Denton

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Set-3: Smart Manufacturing

SE Mechanical Curriculum									
Course	**Advanced Machining**			**Code**	24UMEL3M31				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	50	-	-
Total Credits	02	-	-	**Total Marks**	50				

Pre-requisites: Basic Science, Basic Concept of Machine Tools, Workshop Technology

Course Objectives:

1. Working mechanisms of various machine tools and machining principles.
2. Acquire knowledge in the elementary mechanism and the machine ability of materials. with different advanced machining processes.
3. To understand detail of CNC machines.
4. IMPART the knowledge of machining phenomenon, grinding, surface finishing, etc.

Course Outcomes:

On completion of the course, learner will be able to

CO1: To Analyze various machining processes and calculate relevant quantities such as Feed rate, Depth of cut & MRR.

CO2: Illustrate advanced machining processes, mechanism of Mechanical machining processes, its applications and limitations.

CO3: Illustrate the features, interpolation schemes and functioning of CNC machines.

CO4: Develop CAD models for 3D printing.

CO5: SELECT appropriate grinding wheel and demonstrate the various surface finishing processes.

Course Contents:

Unit 1 Introduction : Basic Machining Processes & Their Tools 5 hrs.

Introduction, Classification of Machines, Conventional & Non-Conventional Machines. Conventional Machining: Lathe, Milling, Drilling (working principle and Operations) – Types, Tools, Tool Martials & Their Properties, Advantages & Disadvantages. Numerical on conventional Machining (Metal Removal Rate, Depth of Cut, Feed Rate).

Unit 2 Advanced Machining Processes 7 hrs.

Introduction, classification of advanced machining processes. Principles, Working, Process Parameters, Advantages, Limitations and Application for following processes: Electric Discharge Machining (EDM), LASER Beam Machining (LBM), Abrasive Jet Machining (AJM), Ultra Sonic Machining (USM) and Electro Chemical Machining (ECM), Introduction to micro machining.

Unit 3 Hybrid Non-Traditional Machining Processes 6 hrs.

Introduction - Various hybrid non-traditional machining processes, their working principles, equipment's, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non- traditional machining processes.

Unit 4 CNC Technology 5 hrs.

Introduction to CNC Machine working principle, History and development of CNC Technology. Conventional Vs Non-Conventional Machine Tools. Concept of numerical control tools. Introduction to G& M Code concept of block no end block .

Unit 5 Grinding & Surface finishing 7 hrs.

Types and Operations of grinding machines, Grinding wheel– Shapes, Designation and selection, Abrasives & classification, Bond & bonding, Grit, Grade &Structure of wheels, Types of grinding wheels.

Super-finishing processes: Introduction to Honing, Lapping, Buffing and Burnishing. (Construction, working and controlling parameters)

Textbooks

1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009.
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.
3. Production Technology by R.K. Jain and S.C. Gupta, Khanna Publications.
4. Production Technology by P.C. Sharma, S Chand publication.

Reference books

1. Machine Tools – C Elanchezhian and M. Vijayan, Anuradha Publications .
2. Workshop Technology – B.S.Raghu Vamshi – Vol II, Dhanpatrai publications.
3. Manufacturing Technology by P.N.Rao, Volume II, McGraw Hill
4. Workshop Technology – Hajra Choudhury – Vol I & II.

E-content Links:

1. www.academia.edu/29537874/Advanced_Machining_Processes
2. https://www.mdpi.com/2504-4494/4/4/102
3. https://dgt.gov.in/sites/default/files/Advanced%20CNC%20Machining%20Tech._CTS2.0_NSQF-4.pdf

E-books:

1. https://www.cnc-trainer.com/download-ebooks-cnc.html . – CNC Technology

https://www.iitg.ac.in/rkmittal/assets/me688/ME688_Introduction_2.pdf - Introduction Advance Machining Processes.

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Mechanical Engineering Open Electives (OE) Curriculum

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UMEL304A / 24UMEP304A	Data Analysis Tools	24UMEL404A	Non-Conventional Energy Sources	24UMEL506A	Technology and Financial Management
24UMEL304B / 24UMEP304B	Data Visualization and Presentation	24UMEL404B	Additive Manufacturing	24UMEL506B	Product Design and Development
24UMEL304C / 24UMEL304C	Mathematical Simulation	24UMEL404C	Nano Technology	24UMEL506C	Process Planning and Management

SE Mechanical Curriculum									
Course	**Data Analysis Tools**			**Code**	24UMEL304A				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:

1. Basic knowledge of Microsoft Excel (data entry, basic formulas, and formatting)
2. Familiarity with mathematical operations and logical reasoning.
3. Understanding of fundamental spreadsheet navigation and functions.

Course Objectives:

1. Develop expertise in advanced Excel functions and formulas.
2. Learn to perform data analysis using PivotTables, charts, and conditional formatting.
3. Understand data validation, protection, and automation techniques.
4. Use Macros and VBA to automate repetitive tasks.
5. Apply Excel tools for business and financial decision-making.

Course Outcomes: On completion of the course, learner will be able to

1. Use advanced functions like LOOKUP, INDEX-MATCH, and array formulas.
2. Create PivotTables & Pivot Charts for data summarization.
3. Apply conditional formatting and data validation for efficient data management.
4. Automate Excel tasks with Macros & VBA.
5. Perform financial analysis and predictive modeling using Excel.

Course Contents:

Unit 1 Introduction & Basic Excel Functions 5 hrs.

Understanding Excel Interface (Ribbon, Menus, Sheets, Cells) Basic Data Entry & Formatting (Font, Borders, Colors, Merge, Wrap) Basic Formulas (SUM, AVERAGE, MIN, MAX, COUNT) Sorting & Filtering Data (Basic Sorting, AutoFilter, Custom Filters) Data Validation (Drop-down Lists, Number & Text Restrictions)

Unit 2 Essential Excel Functions 6 hrs.

Logical Functions (IF, AND, OR, IFERROR) Lookup & Reference Functions (VLOOKUP, HLOOKUP, XLOOKUP) Text Functions (LEFT, RIGHT, MID, LEN, TRIM, CONCATENATE)

Date & Time Functions (TODAY, NOW, DATEDIF, NETWORKDAYS) Conditional Formatting (Highlight Rules, Custom Conditions)

Protecting & Securing Data (Cell Locking, Sheet & Workbook Protection)

Unit 3 Working with Data 5 hrs.

Introduction to Pivot Tables (Creating, Customizing, Summarizing) Charts & Graphs (Column, Line, Pie, Bar, Combination) Data Consolidation (Combining Data from Multiple Sheets) Introduction to Tables & Structured References Sorting & Filtering in Pivot Tables (Slicers & Timelines)

Unit 4 Automation & Efficiency Tools 5 hrs.

Introduction to Macros (Recording & Running Macros) Customizing Excel with Quick Access Toolbar & Shortcuts Data Cleaning Techniques (Removing Duplicates, Find & Replace)

Goal Seek & Scenario Manager (Simple What-If Analysis) Introduction to Power Query (Basic Data Transformation)

Unit 5 Real-Life Applications & Best Practices 5 hrs.

Creating Professional Reports (Formatting, Layout, Printing) Working with External Data (Importing from CSV, Web, SQL) Common Excel Errors & Troubleshooting (Ref Errors, Formula Fixes)

Best Practices for Speed & Efficiency (Shortcuts, Performance Tips) Final Project & Case Studies (Practical Application of Learned Skills)

Textbooks

1. Excel 2021 Bible – Michael Alexander, Richard Kusleika
2. Excel Formulas & Functions – Bernd Held

Reference books

1. Microsoft Excel Data Analysis and Business Modeling – Wayne L. Winston
2. Excel Power Programming with VBA – John Walkenbach

E-content Links:

1. Microsoft Official Excel Guide
2. Excel Formulas & Functions Cheat Sheet (ExcelJet)

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SE Mechanical Curriculum									
Course	**Data Analysis Tools**			**Code**	24UMEP304A				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	25	-
Total Credits	-	-	01	**Total Marks**	25				

Term Work shall consist of any 8 Hands on session out of 12:

1. Hands-on Navigating the Excel Interface using Ribbon, Menus, Sheets, Cells

2. Hands-on Data Entry and Cell Formatting using Font styling, Borders, Colors, Merge Cells, Wrap Text

3. Hands-on Organizing and Controlling Data using AutoFilter, Custom Filters, Drop-down Lists

4. Hands-on Making Decisions in Excel using IF, AND, OR, IFERROR

5. Hands-on Finding Information Easily using VLOOKUP, HLOOKUP, XLOOKUP

6. Hands-on Managing Strings and Dates using LEFT, RIGHT, MID, LEN, CONCATENATE, TRIM, TODAY, NOW, NETWORKDAYS

7. Hands-on Highlighting Key Insights using Conditional Formatting, Highlight Rules, Custom Rules

8. Hands-on Securing and Organizing Your Work using Cell Locking, Sheet & Workbook Protection

9. Hands-on Summarizing and Visualizing Data using Pivot Tables, Pivot Charts (Column, Pie, Line, etc.)

10. Hands-on Automating Tasks using Recording Macros, Quick Access Toolbar, Shortcuts

11. Hands-on Analyzing and Cleaning Data using Goal Seek, Scenario Manager, Power Query, Remove Duplicates

12. Hands-on Applying Skills to Solve Problems using Importing CSV, Generating Reports, Troubleshooting Errors

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SE Mechanical Curriculum									
Course	**Data Visualization and Presentation**			**Code**	24UMEL304B				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:

1. Basic knowledge of Microsoft Excel (Formulas, Tables, Pivot Tables)
2. Understanding of fundamental data concepts (Tables, Rows, Columns, Relationships)
3. Familiarity with Windows OS

Course Objectives:

1.Understand the fundamentals of Business Intelligence (BI) and Power BI.

2. Connect Power BI to multiple data sources and manage data transformations.

3. Clean, structure, and model data efficiently using Power Query.

4. Develop interactive dashboards and reports using Power BI visuals.

5. Utilize DAX (Data Analysis Expressions) for advanced data calculations.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Understand how to use Power BI for professional data visualization and analysis.

CO2: Perform data cleaning and transformation using Power Query.

CO3: Develop data models and create relationships between tables.

CO4: Write DAX formulas for custom calculations and business logic.

CO5: Create and design interactive reports and dashboards.

Course Contents:

Unit 1 Basics of Data Handling and Power BI 5 hrs

Introduction to Business Intelligen**ce** and Data Analytics**,** Overview of Power BI Components (Desktop, Service, Mobile, Report Server), Installing and Setting Up Power BI Desktop, Exploring the Interface, Connecting Power BI to Various Data Sources (Excel, CSV, SQL, Web, APIs)

Unit2 Data Cleaning and Transformation 5 hrs

Introduction to power Query and Data transformation concepts, cleaning data, removing duplicates, handling missing data, changing data types, transforming data,nesrging,appending merging, Creating Custom Columns and Implementing Business
Logic.

Unit 3 Data Modeling and DAX - 5 hrs.

Fundamentals of Data Modeling: Star Schema vs. Snowflake Schema, Creating Relationships Between Table, Introduction to DAX: Measures vs. Calculated Columns, Basic DAX Functions: SUM, AVERAGE, COUNT, IF, CONCATENATE, Aggregation and Iteration Functions: SUMX, AVERAGEX.

Unit 4 Data Visualization and Report Building 5 hrs.

Introduction to Power BI Visuals (Tables, Charts, Maps, Cards), Customizing Visuals: Formatting, Conditional Formatting, Tooltips, Adding Filters, Slicers, and Drill-Throughs for Interactivity, Designing Professional Dashboards: Best Practices and UX Principles, Creating Dynamic Reports and Applying Advanced Filters

Unit 5: Advanced Power BI Features and Deployment 5 hrs.

Advanced DAX Functions: CALCULATE, ALL, FILTER, RELATED, Time Intelligence Functions: YTD, QTD, MTD, Rolling Averages, Publishing Reports to Power BI Service and Managing Report Access, Sharing, Collaborating, and Managing Workspaces,

25. Capstone Project: Building a Real-World Power BI Dashboard

Textbooks

1. Book Name- Microsoft Power BI Quick Start Guide
2. Author Name: Devin Knight

Reference books

1. Book Name - Microsoft Power BI Cookbook
2. Author Name: Brett Powell

E-content Links:

1. https://www.coursera.org/learn/Data Visualization techniques

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SE Mechanical Curriculum									
Course	**Data Visualization and Presentation**			**Code**	24UMEP304B				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	25	-
Total Credits	-	-	01	**Total Marks**	25				

List of Practical's

1 Power BI Interface basics
2 Create bar chart, pie chart and column chart using imported data
3 Prepare sheet by adding slicers and using visual level filters
4 Create a Sales dashboard with 3-4 visuals
5 Create calculated column by DAX
6 Build model by linking multiple tables
7 Publish Report of activity 1
8 Publish Report of activity 2

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SE Mechanical Curriculum									
Course	**Mathematical Simulation**			**Code**	24UMEL304C				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:

Basic math, Calculus and linear algebra, differential equations.

Course Objectives:

1. To learn what mathematical models are and how computers can help us study them.
2. To learn how to turn simple math ideas into computer simulations using easy software.
3. To get some hands-on practice with simulation software (like MATLAB or free alternatives).
4. To learn how to see what the simulations show us and connect it back to math.
5. To see how math models and simulations are used in different areas.

Course Outcomes:

On completion of the course, learner will be able to
CO1: Understand the main ideas of mathematical models and how simulation helps us study them.
CO2: Create simple math models for real-world situations.
CO3: Use software to run basic simulations of these math models.
CO4: Look at the simulation results and understand what they mean in terms of the math model.
CO5: Recognize how computers can help us explore and understand math models in different fields.

Course Contents:

Unit 1 Mathematical Models and Simulation **6 hrs.**

Definition and Importance of Mathematical Modelling, Types of Models: Deterministic vs. Stochastic, Discrete vs. Continuous, Steps in the Modeling Process, Case Studies in Engineering and Science.

Unit 2 Simulating How Things Grow or Shrink **6 hrs.**

First-order differential equations in modelling, Systems of differential equations, Applications: population dynamics, chemical kinetics, and mechanical systems.
Simple Models of Growth and Decay, Using the Computer to See Growth/Decay, simple math rules into the software and running the simulation step-by-step.
Looking at the Pictures (Graphs): How to see the growth or decay on a graph, changing the starting point or the rate of change affects the simulation.

Unit 3 Simulating Movement **6hrs.**

Simple Math for Movement, Simulating the position and speed of something moving over time, graphs of position and speed, initial speed and position affect the movement.

Unit 4 Introduction to Simulating Waiting Lines **6 hrs.**

Waiting Lines (Queues), Basic Idea of How Queues Work, People arriving and being served, Trying a Simple Waiting Line on Paper: Manually tracking a very short waiting line. Using the Computer for Simple Waiting Line Ideas A basic introduction to simulating arrivals and service

Unit 5 Introduction to Simulating Random Events **6 hrs.**

Randomness Matters: When things don't happen in a perfectly predictable way (like flipping a coin). Making the Computer Do Random Things: Using software to simulate coin flips or rolling dice. Doing it Many Times to See Patterns, Guessing Game with Randomness.

Textbooks

1. Kapur, J.N. Mathematical Modelling. New Age International Publishers, 1988.
2. Giordano, F.R., Weir, M.D., and Fox, W.P. A First Course in Mathematical Modeling. Brooks/Cole, 2013.

Reference books

1. Burghes, D.N. and Borrie, M.S. Modelling with Differential Equations. Ellis Horwood, 1981.
2. Meyer, W.J. Concepts of Mathematical Modeling. McGraw-Hill, 1984.

For Software: Any very basic introductory guide to MATLAB or the chosen open-source software with a focus on plotting.

E-content Links:

1. NPTEL Course on Mathematical Modelling: https://nptel.ac.in/courses/111/105/111105090/
2. MIT OpenCourseWare: Introduction to Mathematical Modeling: https://ocw.mit.edu/courses/mathematics/18-086-mathematical-modeling-spring-2006/

E-books:

1. Kapur, J.N. Mathematical Modelling. Available at: https://archive.org/details/mathematicalmode0000kapu
2. Giordano, F.R., Weir, M.D., and Fox, W.P. A First Course in Mathematical Modeling. Available at: https://www.pdfdrive.com/a-first-course-in-mathematical-modeling-d15772272.html

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SE Mechanical Curriculum									
Course	**Mathematical Simulation**			**Code**	24UMEP304C				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	25	-
Total Credits	-	-	01	**Total Marks**	25				

The practical sessions will involve using either MATLAB or a free alternative to do the simulations discussed in the theory. The focus will be on easy-to-use commands and seeing the results visually.

List of Experiments (using MATLAB or GNU Octave/Python with simple commands):

1. Getting familiar with the software.
2. Simulating simple growth and plotting the results.
3. Simulating simple decay and plotting the results.
4. Simulating movement with a constant speed and showing the position over time.
5. Simulating movement with constant acceleration and showing position and speed over time.
6. Manually simulating a very short waiting line.
7. Using the software to simulate random coin flips or dice rolls and looking at the outcomes.
8. Using the software to try a simple Monte Carlo method (like guessing a number within a range).
9. Changing the starting values or rates in the simulations and seeing what happens to the results.
10. A small project where you choose a simple real-world situation, create a very basic math idea for it, and try to simulate it on the computer.

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SE Mechanical Curriculum									
Course	**Entrepreneurship Awareness I**			**Code**	24UESP305				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	25	-
Total Credits	-	-	02	**Total Marks**	25				

Prerequisites:

1. Basic knowledge of understanding fundamental business concepts like supply and demand.
2. Familiarity with different types of business-like sole proprietorship, partnership and corporation etc.

Course Objectives:

1. Understand the fundamental concepts of entrepreneurship.
2. Learn how to identify business opportunities and create a business plan.
3. Develop problem-solving, decision-making, and leadership skills.
4. Gain knowledge of financial management, marketing, and legal aspects of starting a business.
5. Build an entrepreneurial mindset, including risk-taking and innovation.

Course Outcomes:

1. To develop a basic business plan outline, incorporating market research, competitive analysis, and financial projections.
2. Identify and evaluate business opportunities.
3. Develop and present a basic business plan.
4. Apply marketing and financial strategies in business.
5. Understand the legal and ethical considerations in entrepreneurship.
6. Demonstrate leadership, teamwork, and communication skills.

Course Contents:

Unit 1 INTRODUCTION 5 hrs.

- **Basics of Entrepreneurship:** Defining entrepreneurship, its importance in economic development, and dispelling common myths.
- **Types of Entrepreneurships:** Classifying businesses (small, medium, large, startups, social enterprises). Examples: Comparing a local bakery to a large chain bakery, a non-profit educational institute to a for-profit coaching center.
- **Entrepreneur vs. Entrepreneur:** Understanding the difference between starting your own business and being innovative within a company. Examples: Discussing how an engineer might develop a new product within their existing company or start their own company to develop the same.

- **Become an Entrepreneur** Motivations, advantages, and disadvantages. Discussion: Brainstorming reasons why students might consider entrepreneurship (independence, impact, financial rewards, etc.).
- **Myths and Realities of Entrepreneurship:** Addressing common misconceptions. Discussion: Analyzing popular "rags to riches" stories and separating fact from fiction.

Unit 2 The Entrepreneurial Mindset 5 hrs

Qualities of a Successful Entrepreneur: Resilience, creativity, risk-taking, problem-solving, communication, networking. Activity: Self-assessment questionnaires to gauge entrepreneurial traits.

- **Developing a Growth Mindset:** The importance of continuous learning and adaptability. **Idea Generation and Opportunity Recognition:** Brainstorming techniques, identifying unmet needs, and recognizing market opportunities. Activity: Group brainstorming sessions to generate business ideas based on everyday problems.
- **Design Thinking:** A human-centered approach to problem-solving, emphasizing empathy, ideation, prototyping, and testing. Practical Exercise: Applying design thinking principles to improve a simple everyday object.

Unit 3: From Idea to Business 5 hrs

- **Market Research:** Understanding the target market, competition, and market trends. Practical Exercise: Conducting a simple market survey for a chosen product or service.
- **Business Plan Basics:** Components of a business plan (executive summary, market analysis, financial projections, etc.). Simplified Example: Developing a basic business plan outline for a small food stall.
- **Legal Structures:** Sole proprietorship, partnership, LLC, etc. Brief overview of the legal implications of each structure.
- **Funding Options:** Bootstrapping, angel investors, venture capital, loans. Simplified Examples: Discussing how a student might initially fund a small online business.
- **Startup Costs and Financial Projections:** Estimating initial investment, projecting revenue and expenses. Simplified Example: Calculating the startup costs for a small online

Unit 4 Marketing and Sales 5 hrs

- **Digital Marketing:** Social media marketing, search engine optimization (SEO), content marketing. Practical Exercise: Creating a simple social media marketing plan for a hypothetical business.
- **Sales Techniques:** Building relationships, closing deals, customer service. Role-playing: Simulating sales interactions.
- **Branding and Customer Loyalty:** Creating a strong brand identity and building customer relationships. Examples: Discussing the brand image of companies like Apple or Nike.
- **Customer Relationship Management (CRM):** The importance of managing customer interactions and data.

Unit 5 Managing and Growing a Business 5 hrs

- **Operations Management:** Production, logistics, supply chain management. Simplified Examples: Discussing how a local restaurant manages its food supply and kitchen operations.
- **Financial Management:** Basic accounting principles, budgeting, and financial statements. Simplified Examples: Understanding basic profit and loss statements.
- **Human Resources:** Recruiting, training, and managing employees. Simplified Examples: Discussing the importance of teamwork and employee motivation.
- **Scaling a Business:** Strategies for growth and expansion. Examples: Case studies of successful startups that scaled rapidly.
- **Ethics and Social Responsibility:** The importance of ethical business practices and social impact. Discussion: Debating the ethical implications of different business decisions.

List of Assignments-

Sr No	Name of Assignment
1	Assignment on “Identify problem and Propose Solution”
2	Assignment on “Business Plan for Startup”
3	Assignment on “Reverse Engineering and Market Study”
4	Assignment on “Design to cost –Build a Low-Cost Product”
5	Assignment on “Sustainable Product Design”
6	Visit to Start-Up
7	Presentation on your “Startup Idea”
8	Prepare Prototype of start up

Textbooks-

1. 1. "Entrepreneurship: Successfully Launching New Ventures" – Bruce R. Barringer, R. Duane Ireland
2. "Entrepreneurship" – Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd

Reference Books-

1. "Essentials of Entrepreneurship and Small Business Management" – Norman M. Scarborough
2. "Business Model Generation" – Alexander Oster alder, Yves Pigneur.

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SE Mechanical Curriculum									
Course	**Understanding India**			**Code**	24UVEL306				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	-	25	-
Total Credits	02	-	-	**Total Marks**	25				

Prerequisites: Basic understanding of Indian history and political science.

Course Objectives:

1. To provide students with a foundational understanding of the Indian Constitution's structure and significance.
2. To elucidate the roles and functions of the Union and State governments.
3. To highlight the importance of Fundamental Rights, Duties, and Directive Principles.
4. To foster an appreciation for the constitutional values that guide India's democratic governance.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Comprehend the historical context and development of the Indian Constitution.

CO2: Analyze the structure and functions of Union and State governments

CO3: Interpret the Fundamental Rights, Duties, and Directive Principles

CO4: Apply constitutional principles to contemporary issues

Course Contents:

Unit 1 Historical Background and Making of the Constitution **3 hrs.**

Introduction to Constitutional Law and Constitutionalism. Historical Background of the Constituent Assembly. Government of India Act 1935 and Indian Independence Act 1947.

Unit 2 Salient Features and Preamble of the Indian Constitution **3 hrs.**

Salient Features of the Indian Constitution. The Preamble: Philosophy and Key Concepts. Citizenship: Provisions and Significance.

Unit 3 Fundamental Rights, Duties, and Directive Principles **3 hrs.**

Fundamental Rights: Scope and Limitations. Directive Principles of State Policy: Relevance and Application. Fundamental Duties: Importance in Nation Building.

Unit 4 Union and State Governments **3 hrs.**

Union Government: Structure and Functions. State Government: Structure and Functions. Centre-State Relations: Legislative, Administrative, and Financial.

Unit 5 Constitutional Amendments and Emergency Provisions **3 hrs.**

Amendment Procedure: Significance and Process. Emergency Provisions: Types and Implications. Judicial Review and Basic Structure Doctrine.

Textbooks

1. Basu, D.D. Introduction to the Constitution of India. LexisNexis.
2. Pylee, M.V. India's Constitution. S. Chand & Company.
3. Austin, Granville. The Indian Constitution: Cornerstone of a Nation. Oxford University Press.

E-content Links:

1. National Portal of India: https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text
2. Samvidhaan: The Making of the Constitution of India (Rajya Sabha TV Series): https://www.youtube.com/playlist?list=PLVOgwA_DiGzoFR3j1mSGn5Z_OQLxgodQi
3. Ministry of Law and Justice: https://legislative.gov.in/constitution-of-india

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SE Mechanical Curriculum									
Course	**Project Based Learning**			**Code**	24UMEP307				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	50	-
Total Credits	-	-	02	**Total Marks**	50				

Preamble

Currently, engineering education is undergoing significant structural changes worldwide. The rapidly evolving technological landscape forces educators to constantly reassess the content of engineering curricula in the context of emerging fields and with a multidisciplinary focus. In this process, it is necessary to devise, implement and evaluate innovative pedagogical approaches for the incorporation of these novel subjects into the educational programs without compromising the cultivation of the traditional skills. In this context, the educational community is showing rapidly rising interest in project-based learning approaches.

The mainstream engineering education follows traditional classroom teaching, in which the major focus is mainly on the lecture and the student has very little (if any) choice on the learning process. However rapid development in engineering and technology requires adopting a teaching approach that would assist students not only in developing a core set of industry relevant skills, but also enable them to adapt to changes in their professional career.

Course Objectives

1. To emphasize project-based learning activities that are long-term, interdisciplinary and student- centric.
2. To inculcate independent and group learning by solving real world problems with the help of available resources.
3. To be able to develop applications based on the fundamentals of mechanical engineering by possibly applying previously acquired knowledge.
4. To get practical experience in all steps in the life cycle of the development of mechanical systems: specification, design, implementation, and testing.
5. To be able to select and utilize appropriate concepts of mechanical engineering to design and analyze selected mechanical system.

Course Outcomes: On completion of the course, learner will be able to
CO1. IDENTIFY the real-world problem (possibly of interdisciplinary nature) through a rigorous literature survey and formulate / set relevant aims and objectives.
CO2. ANALYZE the results and arrive at valid conclusions.
CO3. PROPOSE a suitable solution based on the fundamentals of mechanical engineering by possibly integration of previously acquired knowledge.
CO4. CONTRIBUTE to society through proposed solutions by strictly following professional ethics and safety measures.
CO5. USE of technology in proposed work and demonstrate learning in oral and written form. CO6. DEVELOP ability to work as an individual and as a team member.

Group Structure

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

1. Create groups of 5 (five) to 6 (six) students in each class
2. A supervisor/mentor teacher is assigned to 3-4 groups or one batch

Project Selection

The project can be selected by undertaking a survey of journal papers, patents or field visit (A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific). The problem shall consist of following facets: feasibility of arriving at a solution, analyzing the problem, design and development of the system (hardware or virtual).

There are no commonly shared criteria/ guidelines for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the activity undertaken.

Solution to problem-based projects through ***"learning by doing"*** is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students" wandering within different disciplines and professional environments. As stated in the preamble as the world has adapted and propagated multidisciplinary approach, hence the proposed project activity preferably should not be restricted to only mechanical domain specific projects rather should be Interdisciplinary in nature. However the chosen problem should be integration of other streams of engineering with Mechanical engineering. Although in a genuine case 100% software/ virtual project topic may be allowed.

Ethical Practices, teamwork and project management:

Use Indian standards or any relevant standards for project manufacturing, respect the time of others, attend the reviews, poster presentation and model exhibitions, strictly follow the deadline of project completion, comply with all legislation requirements that govern workplace health and safety practices.

Effective Documentation

In order to make our engineering graduates capable of preparing effective documentation, it is required for the students to learn the effective writing skills. The PBL final report is expected to consist of the Literature Survey, Problem Statement, Aim and Objectives, System Block Diagram, System Implementation Details, Discussion and Analysis of Results, Conclusion, System Limitations and Future Scope. Many freely available software tools (for instance Mendley (Elsevier), Grammarly) are expected to be used during the preparation of PBL synopsis and final report. It is expected that the PBL guides/mentors shall teach students about utilizing valid sources of information (such as reference papers, books, magazines, etc) related to their PBL topic.

Evaluation & Continuous Assessment

The institution/head shall be committed to ensuring the effective and rigorous implementation of the idea of project based learning. Progress of PBL shall be monitored regularly on a weekly basis. Weekly review of the work shall be necessary. During the process of monitoring and continuous assessment and evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.

The effectiveness of the concept PBL lies in rigorous and continuous assessment and evaluation of the student performance. It is recommended that all activities are required to be recorded regularly. A regular assessment of PBL work is required to be maintained at the department in PBL log book by students. It is expected that the PBL log book must include following:

1. Information of students and guide
2. Weekly monitoring by the PBL guide,
3. Assessment sheet for PBL work review by PBL guide and PBL Evaluation Committee (PEC).

The PEC structure shall consist of Head of the department, 1/2 senior faculties of the department and one industry expert (optional). Continuous Assessment Sheet (CAS) is to be maintained by the department.

Recommended parameters for assessment, evaluation and weightage

1. Idea Inception (kind of survey). (10%)
2. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (15%)
3. Attended reviews, poster presentation and model exhibition. (10%)
4. Demonstration (Poster Presentation, Model Exhibition etc). (10%).
5. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (5%)
6. Outcome (physical model/prototype/ virtual model/ product development/ assembly & disassembly and analysis of standard mechanism or system, design and development of small applications using Arduino, design of control systems, development of various systems/ subsystems of BAJA/SUPRA/Robots/GoKart/ Sunrisers/Hackathon/ application development and similar activities/ System performance and analysis) (40%)
7. Participation in various competitions/ publication/ copyright/ patent) (10%)

Learning Resources

Reference Books / Research Articles

1. John Larmer, John R. Mergendoller, and Suzie Boss, “Setting the Standard for Project Based Learning”
2. John Larmer and Suzie Boss, “Project Based Teaching: How to Create Rigorous and Engaging Learning Experiences”
3. Erin M. Murphy and Ross Cooper, “Hacking Project Based Learning: 10 Easy Steps to PBL and Inquiry”

Web resources

1. https://www.edutopia.org/project-based-learning
2. www.howstuffworks.com
3. https://www.pblworks.org/
4. www.wikipedia.org

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Curriculum for S.Y. B. Tech (Mechanical)

Semester IV

S.Y. B. Tech (Mechanical) Structure Semester IV

Course Code	Name of Course	Course Category (As per NEP2020)	Teaching Scheme				Credits	Evaluation Scheme					
			L	T	P	Total		Theory			Practical		Total Marks
								TAE	CAE	ESE	INT	EXT	
24UMEL401	Fluid Mechanics	Program Core Course (PCC)	03	-	-	03	03	10	15	50	-	-	75
24UMEP401	Fluid Mechanics Laboratory	Program Core Course (PCC)	-	-	02	02	01	-	-	-	-	25	25
24UMEL402	Theory of Machines	Program Core Course (PCC)	03	-	-	03	03	10	15	50	-	-	75
24UMEP402	Theory of Machines Laboratory	Program Core Course (PCC)	-	-	02	02	01	-	-	-	-	25	25
24UMEL403	Differential and Integral Calculus	Program Core Course (PCC)	02	-	-	02	02	10	15	50	-	-	75
24UMEXXXX	M-II	Multidisciplinary Minor - II	02	-	-	02	02	-	-	50	-	-	50
24UXXXXXX	OE-II	Open Elective (OE) -II (Other Program)	02	-	-	02	02	10	15	25	-	-	50
24UMEP405	Modelling and Drafting Laboratory	Vocational and Skill Enhancement Course (VSEC)	-	-	04	04	02	-	-	-	50	-	50
24UBSP406	Corporate Communication	Ability Enhancement Course (AEC)	-	-	04	04	02	-	-	-	25	-	25
24UESP407	Entrepreneurship Awareness II	Entrepreneurship/ Economics/ Management Course	-	-	04	04	02	-	-	-	25	-	25
24UVEP408	Environment Studies	Value Education (VEC-I)	-	-	04	04	02	-	-	-	25	-	25
	Total		12	-	20	32	22	40	60	225	125	50	500

SE Mechanical Curriculum									
Course	**Fluid Mechanics**			**Code**	24UMEL401				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:

Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics

Course Objectives:

1. To understand basic properties of fluids.
2. To learn fluid statics and dynamics
3. To study basics of flow visualization
4. To understand Bernoulli's theorem and its applications.
5. To understand losses in flow, drag and lift forces
6. To learn to establish relation between flow parameters.

Course Outcomes: On completion of the course, learner will be able to

CO1. DETERMINE various properties of fluid and APPLY the laws of fluid statics and concepts of buoyancy
CO2. IDENTIFY types of fluid flow and terms associated in fluid kinematics
CO3. APPLY principles of fluid dynamics to laminar flow
CO4. ESTIMATE friction and minor losses in internal flows and DETERMINE boundary layer formation over an external surface
CO5. CONSTRUCT mathematical correlation considering dimensionless parameters, also ABLE to predict the performance of prototype using model laws

Course Contents:

Unit 1 Properties of Fluid and Fluid Statics 8 hrs.

Properties of Fluid: Definition of fluid, concept of continuum, density, specific weight, specific gravity, viscosity, Newtons law of viscosity (Numerical), types of fluid and rheology,

Laws of fluid statics: forces acting on fluid element, pascal's law, hydrostatics law (Numerical), hydraulic ram,

Forces acting on surfaces immersed in fluid: total pressure and center of pressure on submerged plane surfaces vertical, inclined (Numericals), curved surface submerged in liquid
Buoyancy: flotation, stability of bodies floating and submerged

Unit 2 Fluid Kinematics 7 hrs.

Flow description methods, types of flows, velocity and acceleration fields (Numericals), continuity equation in 1D & 3D flow, flow visualization (path line, stream line and streak line),

stream tube, angularity, vorticity, stream function and velocity potential function(Numericals), flow net

Unit 3 Fluid Dynamics 7 hrs.

Euler's equation of motion differential form and Navier Stokes equation, Euler's equation of motion along streamline, Bernoulli's theorem and modified Bernoulli's theorem (Numerical), stagnation pressure, HGL, TEL

Flow measurement: Pitot tubes, static pitot tube (Numerical), introduction to coriolis flow meter, introduction to orifices, notches & weirs

Laminar flow: Entrance region theory, velocity and shear Stress distribution for laminar flow through pipe, fixed parallel plates and Couette flow (Numericals), velocity profile of turbulent flow

Unit 4 Internal & External Flow 9 hrs.

Internal Flow: Losses - major & minor losses (Numericals), hydro dynamically smooth and rough boundaries, Moody's chart, compounding of pipes & equivalent pipe, siphons, transmission of power (Numericals)

External Flow: Boundary layer formation over a flat plate, boundary layer thickness, displacement thickness, momentum thickness and energy thickness (Numericals), boundary layer separation and methods to control separation, drag and lift concepts, types of drag, drag & lift coefficient, aerofoil, bluff body, streamline body

Unit 5 Dimensional Analysis & Similitude 6 hrs.

Dimensional Analysis: Introduction, system of dimensions, Dimensional homogeneity, Buckingham-Pi Theorem, repeating variables (Numericals), dimensionless numbers and their physical significance

Similitude & Model Testing:Model & prototype, similarity, scaling parameters , model laws, objectives , importance and application of model studies.

Textbooks

1. R. K. Bansal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publication
2. Cengel & Cimbla, "Fluid Mechanics",TATA McGraw-Hill
3. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics",Standard Book House.
4. F. M. White, "Fluid Mechanics", TATA McGraw-Hill
5. Sukumar Pati, "Fluid Mechanics and Hydraulics Machines", TATA McGraw Hill.
6. Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics", Wiley India
7. Potter Wiggert, "Fluid Mechanics", Cengage Learning
8. Fox, Pichard, "Introduction to Fluid Mechanics", McDonald- Wiley

Reference books

1. Kundu, Cohen, Dowling, “Fluid Mechanics”, Elsevier India
2. Chaim Gutfinger David Pnueli, “Fluid Mechanics” Cambridge University press.
3. Edward Shaughnessy, Ira Katz James Schaffer, “Introduction to Fluid Mechanics”,Oxford University Press

E-content Links:

1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/104/112104118/
3. https://nptel.ac.in/courses/112/105/112105269/
4. http://www.efluids.com/efluids/books/efluids_books.htm
5. http://web.mit.edu/hml/ncfmf.html
6. http://www.efluids.com/efluids/pages/edu_tools.htm
7. https://spoken-tutorial.org/tutorial-search/?search_foss=OpenFOAM&search_language=

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SE Mechanical Curriculum									
Course	**Fluid Mechanics Laboratory**			**Code**	24UMEP401				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	-	25
Total Credits	-	-	01	**Total Marks**	25				

The student shall complete the following activity as a Term Work Total 10 experiments from the following list must be performed. During Oral, the Student is evaluated based on the completion of Practical, Assignments using Virtual Lab and Detailed Mini project / Industrial Visit Report/ Simulation of fluid flow / Programming using any suitable software.

Practical (Experiment 1,2,3,7,9 are compulsory; Select any One Simulation of Experiments from Experiment # 4 & 6; Perform any Eight experiments)

1. Study of Various Pressure measurement devices and determination of pressure using manometers (minimum two)
2. Determination of fluid viscosity and its variation with temperature.
3. Determination of Metacentric height of floating object.
4. Determination of Reynolds number and flow visualization of laminar and turbulent flow using Reynolds apparatus.
5. Measurement of static pressure distribution, lift and drag around an aero foil using wind tunnel apparatus
6. Verification of modified Bernoulli's equation.
7. Study of flow measurement through venturimeter and orificemeter and Calibration of Orifice meter/ Venturimeter/Notch.
8. Determination of minor/major losses through metal/non-metal pipes.
9. Industrial visit
10. Assignments using Virtual Laboratory (Any Two Virtual Lab experiments from experiment # 2,5,8 mentioned above)

Please visit the links given below for exploring and performing experiments on Fluid Mechanics using Virtual Laboratory. Write brief Reports using Virtual Laboratories:

1. *https://eerc03-iiith.vlabs.ac.in/*
2. *http://fm-nitk.vlabs.ac.in/*

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SE Mechanical Curriculum									
Course	**Theory of Machines**			**Code**	24UMEL402				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	03	-	-	**Marks**	10	15	50	-	-
Total Credits	03	-	-	**Total Marks**	75				

Prerequisites:

Engineering Mechanics, Strength of Materials,Basic knowledge of Differential Equations and Linear Algebra

Course Objectives:

1. To impart fundamental knowledge of mechanisms and machines.
2. To analyze the kinematic and dynamic behavior of machine elements.
3. To develop the competency to understand & apply the principles of gear theory to design various applications.
4. To develop the competency to design a cam profile for various follower motions.
5. To develop the skill to propose and synthesize the mechanisms using graphical and analytical
6. technique.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Understand and analyze various types of mechanisms and their applications.

CO2: Perform kinematic analysis of planar mechanisms.

CO3: Design and evaluate cam and gear mechanisms.

CO4: Construct cam profile for given follower motion

CO5: Synthesize a four-bar mechanism with analytical and graphical methods

Course Contents:

Unit 1 Simple Mechanisms **8 hrs.**

Basic concepts of mechanisms and machines, Types of links, pairs, chains, and structures, Degrees of freedom and mobility criteria, Kutzbach criterion, Grubler's criterion, Grashoff's law for four bar kinematic chain. Inversions of four-bar, slider-crank, and double slider-crank chains. (Numerical)

Unit 2 Kinematic Analysis of Mechanisms **8 hrs.**

Analytical methods for displacement, velocity and acceleration analysis of Four-Bar and Slider crank mechanisms using Vector and Complex Algebra Methods. Analysis of Single and Double Hook's joint. Velocity and acceleration analysis: Graphical methods - Relative

velocity and acceleration methods (Numerical), Coriolis's component of acceleration (Theoretical treatment only).

Unit 3 Gears and Gear Trains **7 hrs.**

Classification and terminology of gears, Law of gearing and gear tooth profiles, Design and analysis of simple, compound, and epicyclic gear trains (Moderate Numerical), Applications of gear trains in mechanical systems.

Unit 4 Cams and Followers **7 hrs.**

Introduction, Classification of Followers and Cams, Terminology of Cam Displacement diagram for the Motion of follower as Uniform velocity, Simple Harmonic Motion (SHM), Uniform Acceleration and Retardation Motion (UARM), Cycloid motion, Cam Profile construction for Knife-edge Follower and Roller Follower (Numerical), Cam jump Phenomenon

Unit 5 Forces and Motion in Machinery **7 hrs.**

Steps in Synthesis: Type synthesis, Number Synthesis, Dimensional synthesis, Tasks of Kinematic synthesis - Path, function and motion generation (Body guidance), Precision Positions, Chebychev spacing, Mechanical and structural errors.

Graphical Synthesis: Inversion and relative pole method for three position synthesis of Four-Bar and Single Slider Crank Mechanisms Analytical Synthesis: Three position synthesis of Four-Bar mechanism using Freudenstein's equation, Blotch synthesis

Textbooks

1. R.S. Khurmi and J.K. Gupta, "Theory of Machines," S. Chand & Company Ltd.
2. J.J. Uicker, G.R. Pennock, and J.E. Shigley, "Theory of Machines and Mechanisms," Oxford University Press.

Reference books

1. A.G. Ambekar, "Mechanism and Machine Theory," Prentice-Hall of India.
2. N.K. Mehta, "Machine Tool Design and Numerical Control," Tata McGraw-Hill Publishing Company.
3. Ghosh and Malik, "Theory of Mechanism and Machines," East-West Press Pvt. Ltd.

E-content Links:

1. NPTEL Course on "Kinematics of Machines" by IIT Kharagpur: https://nptel.ac.in/courses/112/105/112105268/
2. MIT OpenCourseWare on "Dynamics and Vibration": https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/

E-books:

1. "Theory of Machines" by R.S. Khurmi and J.K. Gupta: https://archive.org/details/TheoryOfMachinesByDr.R.S.Khurmi
2. "Mechanism and Machine Theory" by A.G. Ambekar: https://archive.org/details/MechanismAndMachineTheory

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SE Mechanical Curriculum									
Course	**Theory of Machines Laboratory**			**Code**	24UMEP402				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	02	**Marks**	-	-	-	-	25
Total Credits	-	-	01	**Total Marks**	25				

The student shall complete the following activity as a Term Work : Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments using Drawing Aids, Assignments using Software & Programming Languages, Assignments using Virtual Laboratory and Detailed Industrial Visit Report.

Practical (Experiment # 1 is compulsory and Select any Two from Experiment # 2 to 4)

1. To make a model of any mechanism by using waste material by the group of 4 to 6 students and to give a presentation using PPTs.

2. Speed and torque analysis of epicyclic gear train to determine holding torque.

3. To study and verify cam jump phenomenon.

4. To study manufacturing of gear using gear generation with rack as a cutter and to generate an involute profile.

Assignments using Drawing Aids (Experiment #1 to 3 and 6 are compulsory and Select any One from Experiment #4-5)

Do following graphical assignments on Half Imperial drawing sheet:

1. Identify mechanisms in real life and Analyze for types and number of links, pairs, obtain degrees of freedom. Submit the sheet and working video of the mechanism.

2. To solve two problems on velocity and acceleration analysis using relative velocity and acceleration method.

3. To solve two problems on velocity analysis using the ICR method.

4. To draw conjugate profile for any general type of gear tooth.

5. To study various types of gearboxes.

6. To draw cam profile for any two problems with combination of various follower motion with radial and off-set cam.

Assignments using Software (Any Three Assignments - Minimum one computer programming based and Minimum one based on use of software)

Do following assignments by using Software or by using Coding/Programming Languages:

1. To design a simple Planer Mechanism by using any software (Geogebra, SAM, Working Model, any 3D Modelling Software, etc.)

2. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Slider Crank Mechanism using Analytical Method

3. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Hooke's joint Mechanism using Analytical Method

4. To generate a Cam Profile using any Modelling Software (Mech Analyser, any 3D Modelling Software)

5. To synthesize the Four-Bar and Slider Crank Mechanism (Geogebra, SAM, any 2D/3D

Modelling Software)

6. To do computer programming (using software/programming languages like C, Python, Scilab,Matlab etc.) for the Synthesis of Mechanism using Chebychevs spacing, Freudensteins equation and function generation

Assignments using Virtual Laboratory (minimum Two experiments)

Please visit the links given below for exploring experiments on Kinematics of Machinery using Virtual Laboratory. Write a Brief Reports of using Virtual Laboratory to perform following assignment:

1. Mechanics-of-Machines Lab (All Experiments), http://mm-nitk.vlabs.ac.in/index.html

2. Mechanisms and Robotics - Oldham Coupling Mechanism,

http://vlabs.iitkgp.ernet.in/mr/index.html

3. Mechanisms and Robotics - Quick Return Mechanism,
http://vlabs.iitkgp.ernet.in/mr/index.html

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SE Mechanical Curriculum									
Course	**Differential and Integral Calculus**			**Code**	24UMEL403				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	10	15	50	-	-
Total Credits	02	-	-	**Total Marks**	75				

Prerequisite Courses

1. Basic knowledge of high school algebra and geometry
2. Familiarity with fundamental trigonometry
3. Basic understanding of physical quantities in mechanics
4. Logical reasoning and analytical skills
5. Elementary graph plotting and interpretation

Course Objectives

1. To **introduce** foundational concepts of algebra, matrices, calculus, vectors, transforms, and statistics relevant to mechanical engineering.
2. To **explain** the rules and procedures for algebraic operations and equation solving techniques.
3. To **familiarize** students with the basics of calculus and its applications in motion and mechanical systems.
4. To **provide** an understanding of vector operations and coordinate geometry with practical engineering examples.
5. To **develop** awareness of the importance of Laplace/Fourier transforms and basic statistics in mechanical and manufacturing systems.

Course Outcomes On completion of the course, learner will be able to

1. **Recall** and **apply** fundamental algebraic operations and solve linear and quadratic equations.
2. **Understand** and **use** matrix methods such as Cramer's Rule and Row Reduction to solve systems of equations in mechanical applications.
3. **Interpret** functions, **differentiate** and **integrate** basic expressions, and **apply** them in solving engineering problems related to motion and area.
4. **Apply** vector operations and coordinate geometry to solve real-life engineering problems like force, work, and 3D motion.
5. **Understand** and **apply** basic concepts of probability, statistics, and transforms (Laplace/Fourier) in engineering contexts like quality control, heat transfer, and vibration analysis.

Course Contents:

Unit 1 Basic Algebra & Matrices **7 Hours**

Algebraic Operations (Addition, Subtraction, Multiplication, Division) - Linear & Quadratic Equations - Basics of Matrices (Types, Addition, Multiplication) - Determinants and their

Properties - Solving Simple Equations using Matrices (Cramer's Rule, Row Reduction Method) - Applications in Mechanical Engineering (Solving Equations in Mechanics)

Unit 2 Fundamentals of Calculus 8 Hours

Functions and Graphs (Basic Types & Properties) - Limits and Continuity (Simple Examples) - Basics of Differentiation (First & Second Derivatives, Rules) - Simple Applications of Differentiation (Rate of Change, Maxima & Minima in Mechanical Systems) - Basics of Integration (Indefinite & Definite) - Applications of Integration (Area under Curve, Velocity & Displacement in Motion

Unit 3 Vectors & Coordinate Geometry 7 Hours

Basics of Vectors (Magnitude, Direction) - Vector Operations (Addition, Subtraction, Dot & Cross Product) - Coordinate Geometry (2D & 3D) - Equation of a Line and Plane - Applications in Mechanical Engineering (Force, Work Done, Motion in 3D Space)

Unit 4 Laplace & Fourier Transforms (Basic Concepts) 7 Hours

Introduction to Laplace Transform (Basic Definition, Standard Functions) - Inverse Laplace Transform (Basic Examples) - Fourier Series Basics (Introduction, Simple Trigonometric Functions) - Applications in Mechanical Engineering (Vibration Analysis, Heat Transfer, Signal Processing)

Unit 5 Basic Probability & Statistics 7 Hours

Introduction to Probability (Basic Rules, Simple Examples) - Probability Distributions (Binomial & Normal Distribution) - Introduction to Statistics (Mean, Median, Mode) - Standard Deviation & Variance - Correlation & Regression (Basic Concepts) - Applications in Manufacturing & Quality Control (Six Sigma, Statistical Process Control)

Text Books

1. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publication, Delhi

Reference Books

1. Erwin Kreyszig, "Advanced Engineering Mathematics', 10e, by Wiley India.
2. M. D. Greenberg, "Advanced Engineering Mathematics", 2e, by Pearson Education.
3. Peter V. O'Neil , "Advanced Engineering Mathematics", 7e, by Cengage Learning
4. S. L. Ross, "Differential Equations", 3e by Wiley India.
5. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 5e, by Elsevier Academic Press

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Multidisciplinary Minor-I Curriculum

Course Code	Robotics and Automation	Course Code	Electric Vehicle	Course Code	Smart Manufacturing
24UMEL4M12	Mechatronics	24UMEL4M22	E-vehicle System design	24UMEL4M32	Advanced Welding
24UMEL5M13 /24UMEP5M13	Kinematic Synthesis	24UMEL5M23 / 24UMEP5M23	Motors & Battery Technologies for EV	24UMEL5M33 / 24UMEP5M33	Flexible Manufacturing
24UMEL6M14	Control Systems	24UMEL6M24	EV manufacturing & ecosystem infrastructure	24UMEL6M34	Lean Manufacturing
24UMEL7M15	Robot Programming	24UMEL7M25	Modelling & Simulation of EHV Control systems	24UMEL7M35	Group Technology
24UMEL8M16	Case Studies	24UMEL8M26	EV standards, Charging and Safety	24UMEL8M36	Automatic Guided Vehicle

Multidisciplinary Minor-II Curriculum

Set-1: Robotics and Automation

SE Mechanical Curriculum									
Course	**Mechatronics**			**Code**	24UMEL4M12				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	50	-	-
Total Credits	02	-	-	**Total Marks**	50				

Prerequisites:

Basic Electrical Engineering, Basic Electronic Engineering

Course Objectives:

1. To UNDERSTAND the key elements of mechatronics, principle of sensor and its characteristics.
2. To REVIEW the concept of signal processing and use of interfacing systems such as ADC, DAC, Digital I/O.
3. To ANALYSE the block diagram representation, concept of transfer function, control system modeling and analysis in frequency domain.
4. To APPLY the system modeling and analysis in time domain, controller modes and its industrial applications.
5. To CREATE the PLC system and its ladder programming for industrial application.

Course Outcomes: On completion of the course, learner will be able to

CO1: DEFINE key elements of mechatronics, principle of sensor and its characteristics.
CO2: RELATE concept of signal processing and interfacing systems e.g. ADC, DAC, Digital I/O.
CO3: EVALUATE transfer function by using block diagram reduction technique, Poles and Zero, frequency domain parameter for mathematical modeling for mechanical system.
CO4: APPLY the concept of different controller modes to an industrial application.
CO5: DEVELOP the ladder programming for industrial application.

Course Contents:

Unit 1 Introduction to Mechatronics, Sensors & Actuators **5 hrs.**

Introduction to Mechatronics and its Applications. Sensors: Types of sensors; Motion Sensors, MEMS Accelerometer; Temperature sensors, Force / Pressure Sensors; Flow sensors; Color sensors; Biosensors. Actuators: Servo motor; Hydraulic and Pneumatic (must be restricted to classification and working of one type of linear and rotary actuator); linear electrical actuators. Selection of Sensor & Actuator.

Unit 2 Data Acquisition System **5 hrs.**

Introduction to DAQ, Types, Components of a Data Acquisition System (Sensor, Signal conditioning, processing, controlling and storage/display/action) Data Acquisition: Signal collection, Signal conditioning – Isolation& Filtering, Amplification, Sampling, Aliasing, Sample and hold circuit, Quantization, Analog-to-digital converters (4 bit Successive Approximation type ADC), Digital-to-Analog converters (4 bit R2R type DAC) (Numerical), Data storage. Applications: DAQ in Household, Digital Pressure Gauge, Digital Flow measurement, DVB Digital Video Broadcast, AM/FM.

Unit 3 Control systems & transfer function-based modelling **8 hrs.**

Introduction to control systems, need, Types- Open and Closed loop, Concept of Transfer Function, Block Diagram & Reduction principles and problems; Applications (Household, Automotive, Industrial shop floor) Transfer Function based modeling of Mechanical, Thermal and Fluid system; Concept of Poles & Zeros; Pole zero plot, Stability Analysis using Routh Hurwitz Criterion (Numerical Approach) Time Domain Analysis – Unit step Response analysis via Transient response specifications (Percentage overshoot, Rise time, Delay time, Steady state error etc.) Frequency Domain Analysis – Frequency Domain Parameters - Natural Frequency, Damping Frequency and Damping Factor; Mapping of Pole Zero plot with damping factor, natural frequency and unit step response (Numerical Approach); Introduction to Bode Plot, Gain Margin, Phase Margin.

Unit 4 Controllers **6 hrs.**

Introduction to controllers, Need for Control, Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems in parallel form; (Numerical approach), Feed forward anticipatory control Manual tuning of PID control, Ziegler–Nichols method Applications: Electro–Hydraulic/Pneumatic Control, Automotive Control.

Unit 5 Programmable Logic Controller (PLC) **6 hrs.**

Introduction to PLC; Architecture of PLC; Selection of PLC; Ladder Logic programming for different types of logic gates; Latching; Timers, Counters; PLC control of Hydraulics / Pneumatics / Mechatronics systems involving timing and counting operations.

Textbooks

1. William Bolton, Mechatronics: Electronics Control Systems in Mechanical and Electrical Engineering, 6th Ed, 2019
2. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008

Reference books

1. Alciatore and Histand, Introduction to Mechatronics and Measurement Systems, 5th Ed, 2019
2. Bishop (Editor), Mechatronics – An Introduction CRC 2006.

3. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi.
4. C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall,New Delhi
5. Bolton, Programmable Logic Controller, 4th Ed, Newnes, 2006.

E-content Links:

1. https://onlinecourses.nptel.ac.in/noc21_me27/preview
2. https://www.mechatronic.me/2021/02/intro-to-mechatronics-e-book-pdf.html

E-books:

1. https://www.freebookcentre.net/Mechanical/Mechatronics-Books.html

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Set-2: Electric Vehicle

SE Mechanical Curriculum									
Course	**E-vehicle System design**			**Code**	24UMEL4M22				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	50	-	-
Total Credits	02	-	-	**Total Marks**	50				

Prerequisites:

1. The learner should know the basics of a Engineering Mathematics
2. The learner should be familiar with Engineering Mechanics and Solid Mechanics
3. The learner should have prior knowledge of Material Science
4. Basics of Machine Design, Basics of Kinematics

Course Objectives:

1. To Understand E vehicle System
2. To analyze various steering, suspension, wheel, braking, powertrain, and battery system configurations.
3. To apply system integration knowledge for efficient and safe EV design.

Course Outcomes: On completion of the course, learner will be able to

CO1: DISCOVER wheel based steering systems
CO2: CLASSIFY and EVALUATE suspension systems.
CO3: USE of tyres and braking systems
CO4: DESIGN of powertrains and allied transmission systems
CO5: CATAGORIZE battery pack layouts.

Course Contents:

Unit 1 Steering System 7 hrs.

Classification, Topology Design (Bicycle, Dicycle, Tricycle, Quadricycle), 2W Configurations (Bicycle, Dicycle), 3W Configurations (Delta, Tadpole, Sidecar layouts), 4W Configurations (2/3/4-seater), Steering Geometry, Steering System Types and Design**.**

Unit 2 Suspension System 7 hrs.

Classification and Topology of Front & Rear Suspension, Front Suspension Design (Short-Long Arm with Coil Spring-over-Shock Absorber), Rear Suspension (Multi-link, Panhard Rod with Aluminum Beam), Design of Shock Absorbers, Coil Springs, and Linkages.

Unit 3 Wheels and Braking System 6 hrs.

Classification and Topology of Wheels/Tyres, Braking System Types, Vehicle and Body Centre of Gravity Considerations in EVs, Wheel and Traction Motor Integration, Braking System Design, Regenerative Braking.

Unit 4 Powertrain, Differential, and Transmission System 8 hrs.

Gearbox Design, Hub Motor Direct Drive, Centrally Mounted Configurations, Front/Rear Wheel Coupling, Drive Layouts (One/Two/Four/All-Wheel Drive), Transmission Component Design, Differential Types (Open, Locked, Spool/Welded, Limited Slip, Torsen, Active, Torque Vectoring).

Unit 5 Battery Compartment 6 hrs.

Battery Location Selection, Battery Pack Structure, Battery Compartment Design for Crashworthiness and Cooling, Vent Management System, Pack Cooling System, Battery Life Analysis, Battery Performance Degradation Modeling and Analysis.

Textbooks

1. John C. Dixon, J. C., (2009), "Suspension Geometry and Computation", Wiley, NY, ISBN-13: 978-0470510216
2. Matschinsky, M., (1997), "Road Vehicle Suspensions," Wiley, ISBN: 978-1-860-58202-8
3. Guiggiani,M., (2018), "The Science of Vehicle Dynamics: Handling, Braking, and Ride of Road and Race Cars," Springer, ISBN-13 : 978-3319732190
4. Milliken, W. F., (2002), "Chassis Design: Principles and Analysis," SAE International, ISBN-13 : 978-0768008265
5. Law Relating to Intellectual Property Rights, M.K. Bhandari, Central Law Publications, 6th Edition, 2021

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Set-3: Smart Manufacturing

SE Mechanical Curriculum									
Course	**Advanced Welding**			**Code**	24UMEL4M32				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	-	-	50	-	-
Total Credits	02	-	-	**Total Marks**	50				

Pre-requisites: Workshop Technology.

Course Objectives:

1. Know about fundamental concept of different welding processes, and their applications.
2. Classify & Describe Various advanced welding Processes.
3. Understand weld metallurgy and weld characterization techniques.
4. Understand welding variables and preparation of PQR / WPS.

Course Outcomes:

On completion of the course, learner will be able to

CO1: **DEFINE** Working Principle of Welding Processes & Power Sources.

CO2: **COMPARE** the working principles of traditional and modern welding processes.

CO3: **CLASSIFY** Various advanced welding Process and suitable welding processes for particular applications

CO4: **ANALYSE** the effect of HAZ on microstructure and mechanical properties of materials.

CO5: **DEVELOPE** a Welding Procedure Qualification Record (PQR), Welding Procedure Specification Record (WPS), and Welder Qualification Record.

Course Contents:

Unit 1 Introduction :Welding Technology **5 hrs.**

Introduction to welding, application, Classification and process selection criterion, Health& safety in welding.
Welding Arc: Physical of Welding arc, arc initiation, voltage distribution, arc characteristics, arc efficiency, arc temperatures and arc blow, Mechanism and types of metal transfer.
Welding power sources: Types of welding power sources, operation characteristics and specification.

Unit 2 Welding Processes **7 hrs.**

Shielded metal arc welding (SMAW), Gas Metal arc welding (GMAW), Gas Tungsten arc welding (GTAW), Plasma arc, Submerged arc welding, electro gas and electroslag, Resistance welding, Friction welding, Brazing, Soldering & Braze welding, Laser beam welding, Electron

beam welding, Ultrasonic welding Explosive welding, Friction stir Welding, Underwater welding.

Unit 3 Advance Welding Processes **5 hrs.**

Narrow Gap, Tandem (Twin/Multi Wire) Welding, A TIG, MIG, Hybrid welding processes, magnetically impelled arc butt (MIAB) Welding, Welding automation and robotic applications.

Unit 4 Heat Flow & Metallurgy Welding **6 hrs.**

Weld Thermal cycle, Temperature distribution, Peak temperature; Heat affected Zone (HAZ), heating, cooling and Solidification rates. Fundamental of physical metallurgy, Principle of solidification of weld metal, Reaction in weld pool-gas metal reaction, factor affecting changes in microstructure and mechanical properties of HAZ, Micro structure in weld metal and HAZ.

Unit 5 Welding Codes, WPS & PQR **7 hrs.**

Introduction to welding codes, ISO, ASME and BIS specifications, welding Procedure specification (WPS) & Procedure Qualification Record(PQR), Welding of Pipe-Lines and Pressure vessels.

Textbooks

1. Welding Technology by N.K Srinivasan.
2. Welding Engineering and Technology by R.S.Parmar
3. Welding-Technology-Design-V-M-Radhakrishnan.

Reference books

1. Advanced welding processes by John Norrish, ISBN: 978-1-84569-130-1.
2. Principles of Welding by Robert W. Messler Jr., ISBN: 978-0-471-25376-1..
3. Welding Technology by G. den Ouden and M. Hermans, ISBN: 978-90-6562-205.
4. The Physics of Welding, J.F. Lancaster, ISBN: 0-08-034076.

E-content Links:

1. https://archive.nptel.ac.in/courses/112/103/112103263/
2. https://americantorchtip.com/blog/why-mig-welding-is-better-than-tig-welding
3. https://www.youtube.com/watch?v=Pg9mhrHdBdk
4. https://www.youtube.com/watch?v=y-OKi8oSNQ4

E-books:

1. https://www.twi-global.com/technical-knowledge/faqs/what-is-arc-welding

https://www.worldstainless.org/Files/issf/non-image-files/PDF/welding-handbook-v68.pdf

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` Mechanical Engineering Open Electives (OE) Curriculum Semester IV

Course Code	OE1	Course Code	OE2	Course Code	OE3
24UMEL304B / 24UMEP304B	Data Visualization and Presentation	24UMEL404B	Additive Manufacturing	24UMEL506B	Product Design and Development
24UMEL304C / 24UMEL304C	Mathematical Simulation	24UMEL404C	Nano Technology	24UMEL506C	Process Planning and Management

SE Mechanical Curriculum									
Course	**Non-Conventional Energy Sources**			**Code**	24UMEL404A				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	10	15	25	-	-
Total Credits	02	-	-	**Total Marks**	50				

Course Objectives:

1. To study about the various non-conventional energy resources that are available in the earth.
2. To learn about the operation of solar energy system, wind energy conversion system, biomass, Geothermal energy, MHD generation, OTEC energy and Fuel cell systems.

Course Outcomes:

On completion of the course, learner will be able to
CO1: Understand the basic concepts and operation of renewable energy systems
CO2: Remember the ideas and statistics of current RES availability and usage.
CO3: Analyze the theory and designing solar, wind mills, MHD, Fuel cells.
CO4: Identify the other NCES and available sources improvement.
CO5: Apply the renewable energy systems in real time applications.

Course Contents:

Unit 1 Introduction NCES: 7 hrs.

Definition-Concepts of Energy Sources, concept of CE and NCE sources, Limitations of Renewable Energy Sources, Statistics on conventional and non-conventional energy sources and supply in developing countries, criteria for evaluating the potential of non-conventional energy sources. Classification of NCES - Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of different conventional and Non- conventional energy sources.

Unit 2 Solar Energy 7 hrs.

SOLAR ENERGY: Solar Energy, Solar radiation at Earth's surface, Solar radiation Geometry, Principle of Solar energy conversion into heat, concept of Flat plate collectors, concentrating collectors-focusing type, Introduction to Solar Photovoltaic cell, Solar Applications- solar distillation, solar drying, solar cooker, solar pond

Unit 3 Wind Energy & Bio-Mass Energy 7 hrs.

WIND ENERGY: Wind Energy, Basic components of wind energy conversion system, Types of Wind Mill, Site selection criteria, horizontal and vertical axis windmills.
BIO-MASS ENERGY: Definition, Bio fuels, Principles of Bio-Conversion, Bio mass as source of energy, Methods of obtaining energy from Bio mass , Bio mass gasifier

Unit 4 Ocean Energy & Geothermal Energy 7 hrs.

OCEAN ENERGY: Ocean thermal electric conversion (OTEC) methods: Open cycle and Closed cycle Principles of tidal power generation-Advantages and limitations of tidal power generation, types of OTEC plants, mini-hydel power plants
GEOTHERMAL ENERGY: Geothermal resources- Vapor dominated geothermal plant- Liquid dominated geothermal plant- Applications of Geothermal Energy.

Unit 5 MHD Generators & Fuel Cell 7 hrs.

MHD Generators: Basic principles of magneto hydrodynamic power generator, MHD system, advantages of MHD system.

Fuel Cells: Introduction, principle of fuel cells, thermodynamic analysis of fuel cells, types of fuel cells, fuel cell batteries, applications of fuel cells

Textbooks

1. G.D. Rai, Non-Conventional Energy Sources, Khanna publishers, 5th edition,2014.
2. Sukhatme S.P, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
3. S. Rao and B. B.Parulekar, Energy Technology- Non conventional, Renewable and Conventional, Khanna Pub ,3rd Edition, 1999
4. Ashok V Desai, Non-Conventional Energy, Wiley Eastern Ltd, New Delhi, 2003

Reference books

1. Ramesh R & Kumar K U, Renewable Energy Technologies, Narosa Publishing, House, New Delhi, 2004
2. Chetan Singh Solanki, Solar Photovoltaic's, Fundamentals, Technologies and Applications,PHI Learning Private Limited,New Delhi 2009
3. B. H. Khan, Non-Conventional Energy Sources, Tata Mc Graw-hill Publishing Company, 2nd edition,2013.
4. B.T. Nijaguna, Biogas Technology, New Age International Pub, First edition 2002.
5. Tiwari and Ghosal, Renewable Energy resources, Narosa, 2nd edition 2005

E-content Links:

1. https://www.coursera.org/learn/renewable-energy-technology-fundamentals
2. https://nptel.ac.in/courses/121106014
3. https://onlinecourses.nptel.ac.in/noc23_ge47
4. https://www.bioenergyconsult.com
5. https://therenewables.org/types-of-solar-energy-technologies/
6. How Does Solar Work? | Department of Energy
7. How Do Wind Turbines Work? | Department of Energy

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SE Mechanical Curriculum									
Course	**Additive Manufacturing**			**Code**	24UMEL404B				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	10	15	25	-	-
Total Credits	02	-	-	**Total Marks**	50				

Prerequisites: Manufacturing processes, Engineering metallurgy, Solid mechanics.

Course Objectives:

1. To know the principle, methods, possibilities and limitations as well as environmental hazards of Additive Manufacturing technologies.
2. To get familiar with the characteristics of the different materials used in Additive Manufacturing technologies
3. To explore the potential of additive manufacturing technologies in real life applications.

Course Outcomes: On completion of the course, learner will be able to

CO1. USE and CLASSIFY the fundamentals of Additive Manufacturing Technologies for engineering applications.
CO2. IDENTIFY and CATEGORIZE the methodology to manufacture the products using light-based photo-curing, LASER based technologies and STUDY their applications, benefits.
CO3. IDENTIFY and CATEGORIZE the methodology to manufacture the products using extrusion-based deposition, inkjet-based technologies and STUDY their applications, benefits.
CO4. SYNTHESIZE, RECOMMEND and DESIGN the suitable material and process for fabrication and build behavior of verities of product.
CO5. DEVELOP the knowledge of additive manufacturing for various real-life applications.

Course Contents:

Unit 1 Introduction to Additive Manufacturing 6 hrs.

Introduction to AM, Historical Development, Additive v/s Conventional Manufacturing, Role of AM in Product development cycle, Relevance of AM in Industry 4.0, Current industry and manufacturing trends driving AM, AM Process-Chain, Advantages, Types of materials, Classification of AM Processes (Process-based, material form based, application-based - direct and indirect processes and Micro- and Nano-additive processes), Process Planning for Additive Manufacturing

Unit 2 Light and LASER based Techniques 6 hrs.

Introduction, Process and mechanism, Materials, Process Physics, Parameters, Benefits, Drawbacks, Limitations and Applications of: Stereo lithography (SLA), Digital Light Processing (DLP), Direct Laser Writing (DLW), Continuous Liquid Interface Production

(CLIP), Laser-Based Melting: Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Selective Laser Melting (SLM), Electron-Beam Melting (EBM), Laser Blown Powder, Laser Wire Deposition, Laser Engineered Net Shaping (LENS), 3D Laser Cladding

Unit 3 Extrusion and energy based Techniques 6 hrs.

Introduction, Process and mechanism, Materials, Process Physics, Parameters, Benefits, Drawbacks, Limitations and Applications of Extrusion-Based Deposition: Fused Deposition Modeling (FDM), Fused Filament Fabrication(FFF), Direct Ink Writing (DIW), Robocasting, Bio-printing Inkjet(droplet)-Based Deposition and Fusion: Multi-jet Modeling (MJM), Polyjet Printing, Nanoparticle Jetting, Binder Jetting, Multi-Jet Fusion, Color-jet Printing (CJP),

Unit 4 Materials and Design for AM 6 hrs.

Introduction, Materials: Metals, Polymers, Ceramics & Bio-ceramics, Composites, Hierarchical Materials, Biomimetic Materials, Shape-Memory Alloys, 4D Printing & Bio-active materials, Material selection, AM Material Specific Process Parameters: Processes, Heat or Chemical Treatments, Phase Transformations, Process Selection for various applications, DfAM: Process specific strategies, Rules and Recommendations, Quality considerations and Post-Processing techniques: Requirements and Techniques, Support Removal, Sanding, Acetone treatment, Polishing.

Unit 5 Softwares and applications 6 hrs.

Types of In-fill, Types of slicing, Software Integration (with Process, Slicing, etc), Control system (PLC and safety PLC, micro control/ Microcontroller, Micro-processor control), CAD Software and Controller Interfacing, CURA Software, Relevant G/M Codes, Standard firmware (Merlin Software, etc), In-process Monitoring, Calibration Case Studies and Application of AM: 3D printing in prominent industries (Aerospace, Electronics, Defense, Construction, Architectural), Other industrial applications (Health-Care, Personalized Surgery, Bio-medical Applications, Assistive Devices, Food-Processing, Fashion, Jewelry, Toys) Special Topics: 4D/5D Printing, Bio-printing, Bio-materials

Textbooks

1. Chua Chee Kai, Leong Kah Fai, Printing and Additive Manufacturing: Principles & 4th Edition, World Scientific, 2015
2. Amit Bandyopadhyay, Susmita Bose, CRC Press, Taylor & Francis Group, 2016 3
3. Ian Gibson, David W. Rosen, Brent Stucker Manufacturing Technologies: Rapid Prototyping to Direct Digital Springer, 2010.

Reference Books

1. L. Lu, J. Y. H. Fuh and Y.S. Wong, -Induced Materials and Processes for Rapid Springer, 2001

2. Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing" Hanser Publishers, Munich, 2016.
3. Ben Redwood, FilemonSchöffer& Brian Garret, "The 3D Printing Handbook: Technologies, design and applications", 3D Hubs B.V. 2017
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, CRC Press, 2004
5. Andreas Gebhardt, Hanser Publishers, Munich, 2011
6. Ben Redwood, Filemon Schöffer & Brian Garret, 3D Printing Handbook Technologies, Design and Part One:3D Printing Technologies and Materials, 3D Hubs, 2017
7. Chee Kai, Kah Fai, Chu Sing, Prototyping: Principles and 2nd Ed., 2003
8. D. T. Pham and S.S. Dimov, Springer, 2001
9. Rupinder Singh J. Paulo Davim, Manufacturing - Applications and CRC Press Taylor& Francis Group, 2019
10. I. Gibson, D. W. Rosen, B. Stucker, Manufacturing Springer, 2010
11. L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny, Printing and Additive Manufacturing Springer, 2019

E-content Links:

1. NPTEL Course on Fundamentals of Additive Manufacturing Technologies by Prof. SajanKapil, IIT Guwahati, https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. Introduction to Additive Manufacturing, https://www.youtube.com/watch?v=LCQoi10cG
3. NPTEL IIT Kanpur, Dt. Janakarajan Ramkumar Prof. Amandeep Singh, https://onlinecourses.nptel.ac.in/noc20_me50/preview

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SE Mechanical Curriculum									
Course	**Nano Technology**			**Code**	24UMEL404C				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	02	-	-	**Marks**	10	15	25	-	-
Total Credits	02	-	-	**Total Marks**	50				

Prerequisites:

1. The learner should know the basics sciences.
2. The learner should be familiar with basic materials properties.

Course Objectives:

1. To introduce nanotechnology and essential material properties.
2. To explain syntheses and fabrication processes.
3. To explain various Characterization Techniques.
4. To explain Carbon Nano Technology.
5. To describe the various application of nanotechnology in science, engineering and technology.

Course Outcomes:

On completion of the course, learner will be able to
CO1: Identify the essential concepts used in nanotechnology and understand the properties of nanomaterials
CO2: Explain syntheses and fabrication techniques processes.
CO3: To impart basics of various characterization tools/methods in the field of Nano Technology
CO4: Illustrate Carbon Nano Technology
CO5: Understand the applications of nanotechnology in various science, engineering and technology fields.

Course Contents:

Unit 1 Introduction and Properties Of Materials **8 hrs.**

History of Nano science, definition of Nano meter, Nano materials, Nano technology. Classification of Nano materials. Crystal symmetries, crystal directions, crystal planes. Band structure. Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of Nano materials.

Unit 2 Synthesis And Fabrication **6 hrs.**

Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of Nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography. Requirements for realizing semiconductor Nano structures, growth techniques for Nano structures.

Unit 3 Characterization Techniques **8 hrs.**

X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezo response microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.

Unit 4 Carbon Nano Technology **6 hrs.**

Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of Nano crystalling diamond

Unit 5 Applications Of Nano Technology **6 hrs.**

Applications in material science, biology and medicine, surface science, energy and environment. Applications of Nano structured thin fins, applications of quantum dots.

Textbooks

1. Nano science and Nano technology by M.S Ramachandra Rao, Shubra Singh, Wiley publishers.
2. Nanotechnology: technology Revolution of 21st Century Rakesh Rathi (S. Chand & Company, New Delhi)
3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee,PHI Learning Pvt Ltd, 2009.

Reference books

1. Introduction to Nanotechnology by Charles P. Poole Jr and. Frank J. Owens, Wiley-Inter science, 2003.
2. Textbook of Nanoscience and Nanotechnology, B.S. Muty, P. Shankar, Baldev Raj, B.B Rath and James Murday, University Press, IIM (ISBN-978 81 7371 738 3).
3. Nanotechnology by Jermy J Ramsden, Elsevier publishers.
4. Nanotechnology the Science of Small by M.A Shah, K.A Shah, Wiley Publishers.
5. Principles of Nanotechnology by Phani Kumar, Scitech.

E-content Links:

1. https://nptel.ac.in/courses/118104008
2. https://www.coursera.org/learn/nanotechnology
3. https://www.udemy.com/cart/subscribe/course/4276674/

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SE Mechanical Curriculum									
Course	**Modelling and Drafting Laboratory**			**Code**	24UMEP405				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	50	-
Total Credits	-	-	02	**Total Marks**	50				

Prerequisites:

1. Engineering Graphics
2. Experience of Any CAD Software.

Course Objectives:

1. To understand basic structure of CAD systems to create geometric models of simple engineering parts, the curves and surfaces implementation in geometric modeling.
2. To apply basic concepts of 3D Solid Part modeling, viewing and evaluate mass properties of components and assemblies.
3. To apply concepts of 3D Surface modeling and geometrical transformations in CAD models.
4. To create engineering drawings, design documentation and use in manufacturing activities.
5. To understand data exchange standards and translators for various applications

Course Outcomes: On completion of the course, learner will be able to

CO1: UNDERSTAND concepts of CAD system and scope in Product Lifecycle Management.
CO2: CONSTRUCT solid models, assemblies using various modeling techniques & PERFORM mass property analysis, including creating and using a coordinate system.
CO3: UTILIZE knowledge of curves and surfacing features and methods to create complex solid geometry.
CO4: APPLY geometric transformations to simple 2D geometries. USE PMI & MBD approach for communication.
CO5: USE CAD model data for various CAD based engineering applications viz. production drawings, 3D printing, FEA, CFD, MBD, CAE, CAM, etc.

Guidelines for Instructor's Manual

The instructor manual shall contain a list of examples to be performed by students for the level of skill acquired using CAD tool.

Guidelines for Student's Lab Journal

The student shall complete the following Practical in laboratory using suitable CAD modeling software (FreeCAD/SolidWorks). Learner will demonstrate skills to communicate drawings as per industry standards.

Guidelines for LAB/TW Assessment

The student shall complete the following Practical activity as a Term Work Journal. On-time Completion of Practical has assessment weightage.

Course Contents: 10 Practical should be performed from the list of Instructor manual

Practical 1 Sketcher (2 Example) 4 hrs.

An example includes 2D detailing of any Mechanical part.

Practice of 2-D sketching with geometrical and dimensional constraints.

Practical 2 Part Modelling (2 Example) 4 hrs.

Solid modeling for simple mechanical components (Output file as Production drawing and Model Based Definition (MBD)

(a) Sheet-Metal (b) Machining (c) Fabrication (d) Casting (e) Forgings (f) Plastic Molding

Practical 3 Surface Modelling (2 Example) 4 hrs.

Surface modeling for simple mechanical components (Output file as Production drawing and Model Based Definition (MBD)

(a) Sheet-Metal (b) Machining (c) Fabrication (d) Casting (e) Forgings (f) Plastic Molding

Practical 4 Machine Assembly Drawing (2 Example) 6 hrs.

Assembly modeling (Output file as Assembly drawing and detailing) of the parts modeled in Practical assignment - 2 & 3 using proper assembly constraint conditions and

Generation of exploded view for assemblies like Couplings, Clutches, Gear Assemblies, Engine/Pump/Turbine Components, Valves, Machine Tools, Automobile Components, Gear-Box, Pressure Vessels, etc.

Practical 5 Reverse Engineering & CAD file Exchange (2 Example) 6 hrs.

Reverse Engineering of surface/solid modeling using Point Cloud Data.

Assembly Modeling by importing parts/components from free online resources like CAD and Product development software websites, forums, blogs, etc.

Textbooks

1. Zeid, I and Sivasubramania, R., (2009), “CAD/CAM : Theory and Practice”, 2nd edition, McGraw Hill Education, ISBN-13: 978-0070151345
2. Rao, P. N., (2017), “CAD/CAM: Principles and Applications”, 3rd edition, McGraw Hill Education, ISBN-13: 978-0070681934
3. Chang, Kuang-Hua, (2015), "e-Design: Computer-Aided Engineering Design", Academic Press, ISBN-13: 978-0123820389

Reference books

1. Lee, Kunwoo, (1999), "Principles of CAD/CAM/CAE Systems", Pearson/Addison-Wesley, ISBN-13: 978-0201380361
2. Bordegoni, Monica and Rizzi, Caterina, (2011), "Innovation in Product Design: From CAD to Virtual Prototyping", Springer, ISBN-13: 978-1447161875
3. Vukašinovic, Nikola and Duhovnik, Jože, (2019), "Advanced CAD Modeling: Explicit, Parametric, Free-Form CAD and Re-engineering", Springer, ISBN-13: 978-3030023980
4. Um, Dugan, (2018), "Solid Modeling and Applications: Rapid Prototyping, CAD and CAE Theory", 2 nd edition, Springer, ISBN-13: 978-3319745930
5. Rogers, D. and Adams, J. A., (2017), “Mathematical Elements for Computer Graphics”, 2nd edition, McGraw Hill Education, ISBN-13: 978-0070486775
6. Hearn, D. D. and Baker, M. P., (2013), "Computer Graphics with OpenGL", 4th edition, Pearson Education India, ISBN-13: 978-9332518711
7. Gokhale, N. S., Deshpande, S. S., Bedekar, S. V. and Thite, A. N., (2008), “Practical Finite Element Analysis”, Finite to Infinite, Pune, India, ISBN-13: 978-8190619509
8. Bucalo, Joe and Bucalo, Neil, (2007), “Customizing SolidWorks for Greater Productivity”, Sheet Metal Guy, LLC, ISBN-13: 978-0979566608

E-content Links:

1. https://www.mcgill.ca/engineeringdesign/step-step-design-process
2. https://vemu.org/uploads/lecture_notes/28_12_2022_788486088.pdf
3. https://mechanical-engineering.gsfc.nasa.gov/files/GSFC-X-673-64-1F.pdf

E-books:

1. https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf - Machine Drawing By Dr. K. L. Narayana, at el.
2. https://www.gutenberg.org/files/39033/39033-h/39033-h.htm - AN INTRODUCTION TO MACHINE DRAWING AND DESIGN By DAVID ALLAN LOW.
3. https://soaneemrana.com/onewebmedia/ENGINEERING%20DRAWING%20BY%20N.D%20BHATT.pdf - Engineering Drawing.

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SE Mechanical Curriculum									
Course	**Corporate Communication**			**Code**	24UMEP406				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	25	-
Total Credits	-	-	02	**Total Marks**	25				

Course Objectives:

1. To understand the importance of effective corporate communication in achieving organizational goals.
2. To develop skills in written and oral communication within a corporate context.
3. To learn crisis communication strategies and develop skills to handle communication challenges during crises.
4. To develop critical thinking and problem-solving skills in corporate communication scenarios.

Course Outcomes: On completion of the course, learner will be able to

CO1. Understand and evaluate the responsibility of corporate communication as a broker of information, ideas, opinion and attitudes within a democratic and global society.
CO2. Apply the writing process to invent, draft, revise, and edit corporate context.
CO3. Identify different types of crises, understand the crisis communication lifecycle, effectively develop and implement tailored communication strategies to manage crisis situations.
CO4. Inquiry and Analysis; Problem Solving; Creativity; and Depth and Breadth of Understanding.

Course Contents: 10 Practical should be performed from the list of Instructor manual

Practical 1 Understanding Corporate Communications 4 hrs.

- Overview of the Corporate
- Communications Function. Importance of Effective Communications in Organizations.
- Key Stakeholders in Corporate Communications.
- Types of Corporate Communications.
- Communication Models and Theories.
- Corporate Communication Channels.

Practical 2 Effective Business Writing and Presentation Skills 4 hrs.

- Business Writing Essentials.
- Principles of effective business writing (clarity, conciseness, coherence, and professionalism).
- Writing emails, reports, and memos.
- Proofreading and editing techniques
- Professional Presentation Skills.
- Structuring a compelling presentation (introduction, body, conclusion).

- Using visual aids effectively (slides, charts, graphs).
- Public speaking tips and techniques.
- Practice sessions and peer feedback on presentations.

Practical 3 Crisis Communication and Reputation Management 4 hrs.

- Crisis Communication Strategies
- Identifying potential crises in corporate settings.
- Developing a crisis communication plan.
- Managing communication during crises and handling media inquiries.
- Reputation Management
- Importance of corporate reputation in business success.
- Online reputation management and social media monitoring.
- Case studies on companies that successfully managed their reputations during crises.
- Internal Communication and Employee Engagement
- Strategies for effective internal communication.

Reference books:

1. Corporate Communication: A Guide to Theory and Practice" by Joep Cornelissen.
2. The Handbook of Corporate Communication and Public Relations" edited by Sandra Oliver.
3. Effective Business Communication" by Herta A. Murphy, Herbert W. Hildebrandt, Jane P. Thomas.
4. Corporate Communication: Strategic Adaptation for Global Practice" by Michael B. Goodman.
5. The Corporate Communications Bible: Everything You Need to Know to Communicate Effectively in Today's Business World" by Paul A. Argenti

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SE Mechanical Curriculum									
Course	**Entrepreneurship Awareness II**			**Code**	24UMEP407				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	25	-
Total Credits	-	-	02	**Total Marks**	25				

Pre-requisites: Basic knowledge of Entrepreneurship

Course Objectives:

To introduce engineering students to the fundamentals of technology entrepreneurship, its various types, key concepts, the role of technology in startups, startup registration, funding schemes, government policies, digital sales platforms, and incubation support.

Course Outcomes: On completion of the course, learner will be able to
CO1:**(Tech Opportunity & Innovation): To** identify, analyze, and evaluate technology-driven opportunities, applying design thinking and lean startup methodologies to develop innovative solutions and assess their market potential. (Combines Knowledge, Comprehension, Application, Analysis, Evaluation)
CO2:**(Startup Planning & Strategy): To** develop a comprehensive business plan for a technology startup, incorporating a technology roadmap, intellectual property strategy, market analysis, and financial projections, demonstrating an understanding of legal and regulatory considerations. (Combines Knowledge, Comprehension, Application).
CO3:**(Tech Development & Team Building):**To describe the technology infrastructure needs of a startup, understand the importance of team building, and demonstrate knowledge of the startup registration process in India/Maharashtra. (Combines Knowledge, Comprehension).
CO4:**(Funding & Growth Strategies):**To evaluate various funding options for tech startups, understand government schemes and support available in India/Maharashtra, and develop effective pitching skills for attracting investors. (Combines Knowledge, Comprehension, Application, Evaluation)
CO5**:(Marketing, Sales & Customer Support):** To formulate and implement digital marketing strategies, utilize online sales platforms, and demonstrate an understanding of customer support and the benefits of incubation programs for tech startups. (Combines Knowledge, Comprehension, Application)

Course Contents:

Unit 1 Introduction to Technology Entrepreneurship 7hrs.
Technology Entrepreneurship: Definition, Importance, Entrepreneurship Examples, Types of Technology-Based Startups**:** Software, hardware, biotech, cleantech, AI, etc. Role of Technology in Startups: Create innovative products/services, improve efficiency, and reach wider markets. Examples.

Become a Tech Entrepreneur: Motivations, advantages, and challenges. Discussion on Brainstorming, Current Trends in Technology: Emerging technologies relevant to startups (e.g., IoT, block chain, 3D printing).

Unit 2 Idea Generation and Validation 7hrs.

Tech Opportunities: Recognizing market needs and developing technology-driven solutions. Applying design thinking principles to develop user-centric tech products.

Lean Startup Methodology: Building a minimum viable product (MVP) and iterating based on user feedback. Examples. **Market Research for Tech Ventures:** Understanding the target market, competition, and market trends in the tech industry. **Protecting Intellectual Property:** Patents, trademarks, copyrights, and trade secrets.

Unit 3 Building the Tech Startup 5hrs.

Team Building for Tech Ventures: Identifying the necessary skills and building a strong team. Technology Infrastructure (Choosing the right technology stack, cloud services, and development tools). **Legal and Regulatory Considerations for Tech Startups:** Data privacy, cyber security, and other legal issues.

Startup Registration in India/Maharashtra: Overview of the process, required documents, and benefits.

Unit 4 Funding and Growth 5hrs.

Funding Options for Tech Startups: Bootstrapping, angel investors, venture capital, crowd funding, government grants. Government Schemes and Support for Startups in India/Maharashtra: Overview of available programs, incentives, and incubation centers. Pitching to Investors, Scaling, Tech Business Digital Marketing for Tech Products: Social media marketing, content marketing, SEO, and online advertising.

Unit 5 Sales - Marketing & Supports 6hrs.

Introduction, Digital Sales Platforms: E-commerce platforms, app stores, and online marketplaces. Marketing Tech Products: Developing effective marketing campaigns for tech-savvy audiences. Examples:(Analyzing the marketing strategies of successful tech companies) **Customer Support for Tech Products:** Government Incubation Support & Other agencies.

Textbooks

1. Made In India 75 Years of Business and Enterprise by Amitabh Kant
2. Introduction to Entrepreneurship by Katherine Carpenter, University of Victoria.
3. By IIBF's - Micro, Small and Medium Enterprises.
4. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko and Richard M. Hodgetts.

Reference books

1. Entrepreneurship" by William D. Bygrave and Andrew Zacharakis.
2. Business Model Generation" by Alexander Osterwalder and Yves Pigneur.
3. "Entrepreneurship: Successfully Launching New Ventures" by Bruce R. Barringer and R. Duane Ireland.

E-content Links:

1. https://www.freebookcentre.net/Business/E-Business-Books.html.
2. https://www.freebookcentre.net/Business/Marketing-and-Sales-Books.html
3. https://onlinecourses.nptel.ac.in/noc21_mg70/preview

E-books:

1. https://www.free-ebooks.net/business.
2. https://www.hubspot.com/resources/ebook.

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SE Mechanical Curriculum									
Course	**Environment Studies**			**Code**	24UMEP408				
Credits	Th	Tut	Pr	**Scheme**	TAE	CAE	ESE	INT	EXT
Teaching hrs.	-	-	04	**Marks**	-	-	-	25	-
Total Credits	-	-	02	**Total Marks**	25				

Course Outcomes:
On successful completion of the course the learner will be able to:
CO1 Associate the role of environment in man-environment relationship and critically analyse the necessity of environment awareness in society.
CO2 Create awareness about the environmental issue and the role of pollution act in the conservation of resources.

List of Laboratory Assignments

1 Environment and Ecosystem:
   a) Environment –Meaning of Environment, Types of Environment, Components of Environment,
   b) Man- Environment relationship, importance of environment,
   c) Need for Public Awareness
   d) Ecosystem-Meaning, Major Components of Ecosystem
   e) Case studies of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem
   f) Stability of Ecosystem in Sustainable Environment
2 Environment Pollution
   a) Definition of Pollution, Types of Pollution
   b) Air Pollution-Meaning, Sources, effects of air pollution, Air Pollution Act
   c) Water Pollution – Meaning, Sources, Effects of Water pollution, Water Pollution Act
   d) Noise Pollution – Meaning, Sources, Effect of Noise Pollution
   e) Solid Waste Pollution – Meaning, sources, Effect of Waste Pollution
   f) Environment Protection Act – Air (Prevention and control of Pollution)Act, Water Act (Prevention and control of Pollution) Act , Solid waste Pollution Act in India

Learning Resources:
Text Book:
1. Agarwal, D.P. (1992): Man and Environment in India through Ages, Books & Books, New Delhi
2. Arthur N. Strahler and Alan H. Strahler (1973 1st Ed): “Environmental Geoscience Interaction between natural systems and man”, Wiley International Ed.
3. Balakrishnan, M., 1998: Environmental Problems and Prospects in India, Oxford & IBH Pub., New Delhi.

Journal Articles:

1 Barrow, C. J. (2003): Environmental Change and Human Development. Arnold Publication.

2 Bhaduri, S., and Basu, R. (2006):Society Development and Environment. Progressive Publishers.

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