

Scheme and Syllabus of
III and IV semesters
B.E. Mechanical Engineering
2025-26



Siddaganga Institute of Technology

Department of Mechanical Engineering

Our Motto: Work is Worship

Institute Vision:

To develop thoughtful and creative young minds in a learning environment of high academic ambience by synergising spiritual values and technological competence.

Institute Mission

1. To continuously strive for the total development of students by educating them in state-of-the-art technologies and managerial competencies providing best in class learning experience with emphasis on skills, values and learning outcomes and helping them imbibe professional ethics and societal commitment.
2. To create research ambience that promotes interdisciplinary research catering to the needs of industry and society.
3. To collaborate with premier academic and research institutions and industries to strengthen multidisciplinary education, applied research, innovation, entrepreneurship and consulting ecosystems.

Department Vision

To be one of the Premier Centre for technical education and applied Research in Mechanical Engineering and to bring out globally acclaimed competent engineers with innovative ideas and ethical values to fulfil the societal needs.

Department Mission

- M1-** Develop as a Centre of Excellence in Mechanical Engineering by Facilitating the state-of-the-art infrastructure, industry relevant curriculum and effective skill oriented teaching-learning -teaching process.
- M2-** Contribute to the development of Nation by preparing the younger generation to pursue research and development in the thrust areas of mechanical engineering such as thermal power engineering, Manufacturing engineering, Material science engineering, Mechanical Design, Product design and Management.
- M3-** To Prepare mechanical engineering graduates to be professionally competent with strong entrepreneurial, ethical and spiritual values to fulfil societal requirements.

Program Outcomes:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **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.
4. **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.
5. **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.
6. **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 practice.
7. **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.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** 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.
11. **Project management and finance:** Demonstrate knowledge and understanding of the 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.
12. **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 change.

Program Specific Outcomes (PSOs)

PSO1: Mechanical Engineering graduates will be able to pursue research on Advanced Materials and Manufacturing, Thermal sciences, and Advanced Management concepts.

PSO2: Mechanical Engineering graduates will be able to Design and Develop various Mechanical Equipment's for general and Advanced Applications.

PSO3: Mechanical Engineering graduates will be able to use Interdisciplinary Modern I.T tools in various applications.

Program Educational Objectives (PEOs)

PEO-1 - Graduates of mechanical engineering are working as competent technical and managerial leaders in Design, Manufacturing, Materials, Thermal, Automation and Management fields.

PEO-2 - Graduates of mechanical engineering exhibit leadership qualities with strong communication skills and able to work in team or individually with professional and ethical values which leads to improvement in the performance of the organization.

PEO-3 - Graduates of mechanical engineering program are involved in professional practices addressing societal needs, environmental issues with life-long learning.



SCHEME OF TEACHING AND EXAMINATION (2022 Scheme) (For AY 2025-26)

III Semester

Sl. No.	Course and Course Code	Course Title	Teaching / Paper setting Dept.	Teaching hrs.						Evaluation Duration hrs.			Total No. of Hours	Examination		Credits
				Lecture	Tutorial	Practical/ Drawing	Study Hour	Term Work/ Self-Study	CIE	SEE	CIE Marks	SEE Marks		Total Marks		
1.	PCC S3MAT2	Engineering Mathematics-III	Maths	42	0	0	14	27	4	3	90	50	50	100	3	
2.	IPCC S3MEI02	Engineering Materials & Metallurgy	ME	42	0	28	14	29	4	3	120	50	50	100	4	
3.	IPCC S3MEI03	Fluid Mechanics	ME	42	0	28	14	29	4	3	120	50	50	100	4	
4.	PCC S3ME01	Mechanics of Materials	ME	28	28	0	14	13	4	3	90	50	50	100	3	
5.	PCCL S3MEL01	Computer Aided Machine Drawing Lab	ME	0	0	28	0	0	3	3	34	50	50	100	1	
6.	ESC S3ME0X	ESC/ETC/PLC	ME	42	0	0	14	27	4	3	90	50	50	100	3	
7.	UHV SHS01	Social Connect and Responsibility (Board: ME)	ME	0	0	28	0	02			30	100	-	100	1	
8.	AEC/ SEC S3MEA0 X	Ability Enhancement Course (List of courses is given below)	ME	If offered as Theory Course												
				14	0	0	0	12	2.5	1.5	30	50	50	100	1	
				If offered as Integrated Course												
				0	0	28	0	0	2.5	1.5	32					
9.	NCMC SMC01	National Service Scheme (NSS)	NSS CO													
		Physical Education (PE) (Sports and Athletics)	PED	0	0	28	0	0	2	0	0	100	0	100	0	
		Yoga	PED													
		Total										550	350	900	20	
	AAP	AICTE Activity Points (Applicable for both Regular and Lateral Entry students)		40 hours community service to be documented and produced for the examination												



Note: **PCC:** Professional Core Course, **IPCC:** Integrated Professional Core Course, **PCCL:** Professional Core Course laboratory, **UHV:** Universal Human Value Course, **NCMC:** Non Credit Mandatory Course, **AEC:** Ability Enhancement Course, **SEC:** Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course, **PLC:** Programming Language Course, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.

Engineering Science Course (ESC/ETC/PLC) (Offered by the Department)

S3MEE02	Electric & Hybrid Vehicle Technology	S3MEE03	Energy Conservation & Auditing
S3MEE04	Product Lifecycle Management	S3MEE05	Mechatronics

Ability Enhancement Course – III (Offered by the Department)

S3MEA02	Introduction to Virtual Reality	S3MEA04	Computational Thinking and Problem Solving
S3MEA05	Fundamentals of Geometric Dimensioning and Tolerancing		

Integrated Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2022-23 may please be referred.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.



Note: PCC: Professional Core Course, **IPCC:** Integrated Professional Core Course, **PCCL:** Professional Core Course laboratory,

UHV: Universal Human Value Course, **NCMC:** Non Credit Mandatory Course, **AEC:** Ability Enhancement Course,

SEC: Skill Enhancement Course, **ESC:** Engineering Science Course, **ETC:** Emerging Technology Course,

PLC: Programming Language Course, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Evaluation.

Engineering Science Course (ESC/ETC/PLC) (Offered by the Department)

S4MEE02	Non-Destructive Testing	S4MEE04	Non-Traditional Machining
S4MEE05	CAD, CAM & CIM	S4MEE06	Turbomachinery

Ability Enhancement Course – IV (Offered by the Department)

S4CCA02	Advanced Technical Training Lab-C++ LAB	S4CCA03	Advanced Technical Training Lab-Python LAB
S4CCA04	Introduction to Data Analytics	S4CCA05	Introduction to Design and Manufacturing

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2022-23 may please be referred.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first Week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the Degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of Degree.

Engineering Mathematics-III (Mechanical Engineering)

Contact Hours/ Week:	3(L)	Credits:	3
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S3MAT2	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	Demonstrate the use of Laplace transform and Inverse Laplace transform.
2.	Present periodic functions as Fourier series.
3.	Develop and conduct appropriate experimentation, analyze, interpret data and use engineering judgment to draw conclusion.
4.	Understand the basic concepts and applications of probability in engineering.

UNIT I : Laplace Transform
Definition, Transforms of elementary functions, properties of Laplace Transform, Laplace Transform of $t^n f(t)$, $\frac{1}{t} f(t)$, derivatives and Integrals. Laplace Transform of Periodic functions, unit step function.
8 Hours

UNIT II : Inverse Laplace Transform
Inverse Laplace Transform, Convolution theorem (without proof) and problems. Applications – Solution of Linear differential equations using Laplace Transform.
8 Hours

UNIT III : – V:Fourier Series
Periodic functions, Fourier Expansions, Half Range Fourier Cosine Expansion and Sine Expansion, Practical Harmonic Analysis.
8 Hours

UNIT IV : Statistics
Introduction, Curve Fitting: Straight line, reducible to Linear and Quadratic form-parabola. Definition of Correlation and regression lines, formula for correlation coefficient, regression lines with proof and angle between the regression lines, Rank correlation.
7 Hours

UNIT V : Probability
Basic terminology, Definition of probability, Probability and set notations, Addition law of probability, independent events, conditional probability, multiplication law of probability, Baye's theorem.
8 Hours

TEXT BOOKS		
1	B.S.Grewal	“Higher Engineering Mathematics”, 43rd edition, Khanna Publications, 2015. ISBN:978-81-7409-195-5.
2	Ramana .B.V	“Higher Engineering Mathematics”, latest edition, Tata-McGraw Hill, 2016. ISBN;0-07-053516-7.

REFERENCE BOOKS		
1	Erwin Kreyszig	“Advanced Engineering Mathematics” , 10th edition, Wiley Publications, 2015. ISBN;978-81-7409-195-5.
2	C. Ray Wylie and Louis C. Barrett	“Advanced Engineering Mathematics”, 6th Edition, Tata-McGraw Hill 2005.
3	Louis A. Pipes and Lawrence R. Harvill	“Applied Mathematics for Engineers and Physicists”, 3rd Edition, McGraw Hill, 2014.

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Apply the concept of Laplace transform to obtain transform of periodic and unit step functions. (L2& L3)
CO2	Apply the concept of inverse Laplace transform to solve initial value problem. (L3)
CO3	Represent a periodic function as a Fourier series, also computes the Fourier coefficients numerically (L3).
CO4	Apply least square method to fit a curve for the given data and evaluate the correlation coefficient and regression lines for the data. (L3).
CO5	Analyze the nature of the events and hence determine the appropriate probabilities of the events. (L3).

Course Articulation Matrix

		POs											PSOs		
		1	2	3	4	5	6	7	8	9	10	11	1	2	
COs	CO1	3													
	CO2	3													
	CO3	3													
	CO4	3	1												
	CO5	3	1												

1: Low association, 2: Moderate association, 3: High association

Engineering Materials & Metallurgy

Contact Hours/ Week:	3+0+2 (L+T+P)	Credits:	4.0
Total Lecture Hours:	39(L) + 26 (P)	CIE Marks:	50
Sub. Code:	S3MEI02 (IPCC)	SEE Marks:	50

Course objectives: The objectives of this course are: Knowledge of Materials and Material Science is very important for all engineers. Knowledge of materials characteristics is very important for design and manufacture of a component and this forms the basic for any mechanical / manufacturing industry. The main objective of this course is to impart knowledge on materials, material science and its characterization. It is useful in mechanical design, analysis, development, research, process planning, production planning and controlling activities of an industry. From this course student will learn

At the end of this course, the students will be able to:

1.	To distinguish between various types of deformation / fracture occurs in materials.
2.	The mechanical properties of materials.
3.	Mechanism and type of solidification in metals.
4.	Heat treatment of materials and various characteristics obtained due to heat treatment.
5.	Conventional and advanced materials with its characteristics and applications

UNIT I

Mechanical Behavior Materials: Stress- strain diagrams to show ductile and brittle behavior of materials, linear and non-linear elastic behavior, Mechanical properties in plastic range, yield strength, offset yield strength, ductility, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip, dislocation and twinning, deformation of polycrystalline metals. Numerals on Evaluation of Mechanical Properties of Metals using Stress-Strain Diagram.

8 Hours

UNIT II

Fracture: Types of fracture, Griffith theory of Brittle fracture, Theoretical Cohesive strength. **Creep:** Phenomenon with examples, three stages of creep, creep properties, Creep test, stress relaxation. **Fatigue:** Types of fatigue loading with example, Mechanism of fatigue, fatigue properties, fatigue testing and SN diagram.

7 Hours

UNIT III

Solidification: Mechanism of solidification, Homogenous and Heterogeneous Nucleation, crystal growth. Cast metal structures.

Phase diagram: Solid solutions, Hume Rothary rules, substitution, and interstitial solid solutions, construction of equilibrium diagrams, Interpretation of equilibrium diagram. Numericals on phase diagrams.

Iron Carbon system: Iron carbon equilibrium diagram description of phases, Solidification of steels and cast irons and invariant reactions.

8 Hours

UNIT IV

TTT Diagrams: TTT curves, continuous cooling curves, Effect of cooling rate on TTT diagram, effect of carbon and alloying elements on TTT diagram.

Heat treatment of metals: Annealing and its types, Normalizing, Hardening, Tempering, Martempering, Austempering, Hardenability, surface hardening methods like Carburizing cyaniding, nitriding flame hardening and induction hardening.
8 Hours

UNIT V
Advanced Materials: Composite materials, definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP's and MMC's, advantages and application of composites. Smart Materials: Introduction, Classification, definition of each type of smart material.
Ferrous and non-ferrous materials: Properties, composition and uses of Grey cast Iron, malleable iron, S.G. iron and steel, Copper alloys- Brasses and Bronzes. Aluminium alloys- Cast Alloys and Wrought alloys, AISI & BIS designation of steels.
8 Hours

LABORATORY EXPERIMENTS : Material Testing Laboratory	
Part A	
1	Tensile test for mild steel (0.2% Carbon steel)
2	Compression test for mild steel.
3	Torsion test for mild steel.
4	Bending test for rectangular section of wood.
Part B	
1	Shear test for mild steel.
2	Rockwell hardness test for mild steel, C.I., Tool Steel.
3	Brinell hardness test for mild steel & Aluminum.
4	Izod Impact tests mild steel.
5	Charpy Impact tests mild steel
6	Preparation of Specimen for Metallographic Examination and microstructural evaluation. i. For Aluminum, Mild Steel and Medium Carbon Steel Metal. ii. Microstructure observation of prepared specimen.
7	Hardening Heat treatment of Medium Carbon Steel and evaluation of Microstructure before and after treatment.
8	Die penetrant test – (Demo).
9	Magnetic particle inspection test – (Demo).
26 Hours	

TEXT BOOKS		
1	William D.Callister Jr.	Materials Science & Engineering An Introduction., John Wiley & Sons Inc., 8th Edition, 2009.
	Robert L Norton	Machine Design: An Integrated approach, Prentice Hall 4th Edition, 2010

REFERENCE BOOKS		
1	V.Raghavan	Materials Science and Engineering- V.Raghavan, PHI, 2006
2	H. VanVlack Addison	Elements of materials science & Engg.- H. VanVlack Addison – Wesley Edition, 1998.

3	Donald R. Askeland	The science and Engineering of Materials - Donald R. Askeland, 4th edition, Thomson Asia Pvt. Ltd.,Singapore, 2007.
---	--------------------	---------------------------------------------------------------------------------------------------------------------

ONLINE RESOURCES

1	NPTEL COURSE: Basics of Materials Engineering, By Prof. Ratna Kumar Annabattula, IIT Madras	
---	---------------------------------------------------------------------------------------------	--

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Determine and distinguish the various types of deformation in materials and the mechanism of deformation and qualitatively determine standard mechanical properties and types of failures of materials under different loading conditions like tensile, compression, bending, shear, impact and torsion.
CO2	Explain the various types of solidification occurring during the phase transformation and its effects on the properties of the materials.
CO3	Interpret the phase transformations occurring in the materials through various alloy phase diagrams and study the microstructure of metallic materials through metallographic examination.
CO4	Analyse the requirement of various heat treatment methods and also to suggest the appropriate heat treatment method which can be used for various materials and applications.
CO5	Analyse and evaluate the use of various advanced materials to various applications depending on the requirement and able to determine the flaws in materials by using nondestructive testing techniques.

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3	3		2									3		
	CO2	3	2	1					2					3	2	
	CO3	2	2		3					2	3		2	3		
	CO4	2	2	1	2					2	3		3	3	2	1
	CO5	2				1							3	3	2	

Fluid Mechanics

Contact Hours/ Week:	: 3(L) + 0(T) + 2(P)	Credits:	3
Total Lecture Hours:	: 39	CIE Marks:	50
Total Practical Hours:	: 26	SEE Marks:	50
Course Code	: S3MEI03		

Course objectives:

This course will enable students to:

1	Understand of the basic properties of fluids and understand the continuum approximation
2	Learn the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.
3	Know how velocity, acceleration changes in fluid flow.
4	Understand the flow characteristic and dynamics of flow field for various Engineering applications.
5	Discuss the main properties of laminar and turbulent pipe flow and appreciate their differences

UNIT I

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

8 Hours

UNIT II

Fluid Statics: Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Introduction, Total pressure, Center of pressure on horizontal, vertical and inclined surfaces. Buoyancy, center of buoyancy, Metacenter, metacentric height, Conditions of stability of floating bodies and submerged bodies. Determination of metacentric height- Analytical and experimental method. numerical problems.

8 Hours

UNIT III

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

8 Hours

UNIT IV

Fluid Dynamics: Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numericals. Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals.

Loss of head due to friction in pipes, Major and minor losses, pipes in series and parallel. numerical problems
Self study: Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control.
8 Hours

UNIT V
Laminar and Turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation. Dimensional Analysis: Derived quantities, dimensions of physical quantities, dimensional homogeneity, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude. numerical problems
7 Hours

TEXT BOOKS		
1	Frank M. White and Henry Xue	Fluid Mechanics 9th Edition, McGraw Hill; Standard Edition (16 June 2022); McGraw Hill Education (India) Private Limited

REFERENCE BOOKS		
1	S K Som, Gautam Biswas, S Chakraborty	Introduction to Fluid Mechanics and Fluid Machines McGraw Hill Education; 3rd edition (1 July 2017)
2	Yunus A. Çengel and John M. Cimbala's	"Fluid Mechanics: Fundamentals and Applications, McGraw-Hill; 4th edition (16 April 2017)

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Explain fundamental fluid properties, pressure concepts in static fluids, and methods of pressure measurement using manometers and gauges
CO2	Analyze pressure distribution on submerged surfaces and assess buoyancy and stability of floating and submerged bodies using metacentric height concepts.
CO3	Describe fluid motion through types of flow, velocity components, and apply continuity equation, velocity potential, and stream function to solve fluid kinematics problems.
CO4	Apply momentum and energy principles, including Bernoulli's theorem and Euler's equation, to solve practical fluid dynamics problems involving jets, pipe flows, and head loss calculations
CO5	Differentiate between laminar and turbulent flow, analyze viscous flow in pipes and bearings, and use dimensional analysis and similitude for modeling fluid flow problems.

Course Articulation Matrix:

	POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3							1		1			3		
	CO2	2	3						1		1			3		
	CO3	2	3						1		1			3		
	CO4	2	3						1		1			3		
	CO5	2	3						1		1			3		

List of Experiment

Exp.No.	Part A
1	Determination of coefficient of friction of flow in a pipe.
2	Determination of minor losses in flow through pipes.
3	Determination of force developed by impact of jets on vanes i) for 90 ⁰ flat ii) circular
4	Calibration of flow measuring devices 1. Orifice plate 2. Venturimeter 3. V notch for 90 ⁰
	Part B
5	Performance testing of Turbines. 1. Pelton wheel Francis Turbine
6	Performance testing of pumps 1. Centrifugal pumps 2. Reciprocating pump

Mechanics of Materials

Contact Hours/ Week:	2+2+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	26 (L) + 26 (T)	CIE Marks:	50
Sub. Code:	S3ME01 (PCC)	SEE Marks:	50

UNIT I

Simple stress and strain: Introduction, Stress, Strain, Axially loaded members, Hooke's Law and Poisson's ratio, Extension /Shortening of a bar, bars with cross sections varying in steps, Problems on bars with continuously varying cross sections (circular and rectangular), Principle of super position, Compatibility Equation, Statically Indeterminate Members, Elongation due to self-weight, Volumetric strain, Elastic constants, Thermal stresses

6L + 6T Hours

UNIT II

Compound stresses: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.

Applications of Plane stress: Introduction, Cylindrical pressure vessels/cylinders, Stresses in thin cylinders, changes in dimensions of a cylinder, Thick cylinders: Lamé's equation (no derivation), Stresses and pressure across section.

5L + 5T Hours

UNIT III

Shear force and bending moment diagrams

Introduction, Types of beams, loads and reactions, shear forces and bending moments, Relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniform distributed load (UDL) and couple.

5L + 5T Hours

UNIT IV

Stresses in beams: Bending Stresses in beams: Introduction, theory of simple bending, assumptions in simple bending, Bending Equation, Problems. Shear stresses in beams: Shear Stress Equation, Shear stresses in built up sections – I section (symmetric) and T section, Problems.

Deflection of beams: Introduction, differential equation for deflection, Double integration method, Macaulay's method.

5L + 5T Hours

UNIT V

Torsion of circular shafts and Elastic stability of columns:

Introduction, Derivation of torsional equation, Power transmitted by solid and hollow circular shafts.

Introduction to columns: Euler's theory for axially loaded elastic long columns, derivation of Euler's load for both ends pinned or hinged, end conditions for other cases, effective length, limitations of Euler's theory.

5L + 5T Hours

TEXT BOOKS		
1	S Ramamrutham	Strength of Materials, 20th edition, 2020, Dhanpat Rai Publishing Company Ltd, New Delhi.

REFERENCE BOOKS		
1	Ferdinand Beer & Russell Johnston	Mechanics of Materials, Tata MaGraw Hill, 2003.
2	Nash W.A.	Strength of Materials, Ed 4. Schaum's Outline Series. 2007.
3	Egor P. Popov	Engineering Mechanics of Solids, Second Edition, Pearson Education

ONLINE RESOURCES	
1	http://rtlabs.nitk.ac.in/?q=page/strength-materials-lab

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Apply engineering fundamentals to determine axial and thermal stresses in simple and compound bars.
CO2	Determine the compound stresses on an inclined plane by analytical and graphical method and to analyze the stresses in thick and thin cylinders.
CO3	Draw shear force and bending moment diagrams for statically determinate beams.
CO4	Calculate shear and bending stresses and evaluate the deflection of beams.
CO5	Determine the shear stresses in circular shafts subjected to torsion. Calculate buckling load in columns with various end conditions and interpret the results.

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	3	1														
	CO2		2														
	CO3		2														
	CO4		2														
	CO5		2														

3-Strong, 2-Medium, 1-Low

SCHEME END EXAMINATION:

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Computer Aided Machine Drawing Lab

Contact Hours/ Week:	0+0+2 (L+T+P)	Credits:	1.0
Total Lecture Hours:	26 (P)	CIE Marks:	50
Sub. Code:	S3MEL01 (PCCL)	SEE Marks:	50

PART A

Introduction to CAD software and 3D modelling from Isometric views (in CAD software only):

Review of graphic user interface of the software and review of basic sketching commands and navigational commands. Conversion of isometric views of simple machine parts into 3D model and use it for the preparation of draft sheet by generation of orthographic views and sectional views. (Bureau of Indian Standards conventions are to be followed)

Riveted and pin Joints: Drawing of snap head rivet, single riveted lap joint and butt joint with single cover plate only (Chain type only).

4 + 2 Hours

PART B

3D modelling, assembly and generation of draft sheet for assembly only (in CAD software only):

1. Flanged Coupling
2. Screw Jack
3. Tool Head of a Shaper (Assignment)

20 Hours

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Draw orthographic views from the given pictorial view of simple machine parts.
CO2	Draw sectional views of different types of riveted joints.
CO3	Modeling of various machine components using modern tools and to generate 2D & 3D assembled view.

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3				3					2		2		3	
	CO2	3								2		2		3		
	CO3	3				3				2		2		3		

Scheme of Examination:

Two questions from Part-A	:10 +15 Marks
ONE question from Part-B	:25 Marks
Total	:50 Marks

Electric & Hybrid Vehicle Technology

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S3MEE02	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	To help students be thorough with the concepts of Electric vehicles (EVs) and its advantages to traditional ICE vehicles in the longer run.
2.	To allow students to learn the basic structure of an EV and Hybrid Vehicles
3.	To provide insights into the electric motors and allied accessories that are essential for proper functioning of an EV system.
4.	To enable students to learn to synthesize and characterize high performance nanomaterials for Li battery application. To enable students to design and assemble battery components and test them for proper functioning of an EV system.
5.	To help students understand the challenges and opportunities present in Battery thermal Management systems

UNIT I

Conventional IC engine vehicle – Its Limitations and environmental impact

Introduction to Electric Vehicles: EV System, EV History, Electric Vehicles and the Environment, EV Advantages, EV Market, Usage Patterns for Electric Road Vehicle Types of Electric Vehicles – EV Architecture: Battery Electric Vehicles, The IC Engine/Electric Hybrid Vehicle, Fuelled EVs, EVs using Supply Lines, EVs which use Flywheels or Supercapacitors, Solar-Powered Vehicles, Vehicles using Linear Motors, EVs for the Future.

8 Hours

UNIT II

Introduction to Hybrid Vehicles: Types of hybrid vehicles, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains. Hybrid electric vehicle, series and parallel HEV's, merits and Demerits of hybrid electric vehicles. Energy consumption Concept of Hybrid Electric Drive Trains, Performance of Electric vehicles, Tractive effort and energy consumption in normal driving, regenerative braking, drive cycles: simple and standard.

Design of Electric and Hybrid Electric Vehicles: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator

8 Hours

UNIT III

Electric vehicle power train – Brief outline of electric motor, battery pack, inverter, charger and converter, Electric Motors- AC/DC Motors/ Generators, Brushed DC Motor/ Brushless DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles.

DC Motor – Torque Characteristics, motor layout, torque vectoring, switched reluctance motors, induction motors, Basics of EV suspension. Configuration and control of Drives.

8 Hours

UNIT IV

Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Batteries: Types, Lithium-ion battery-materials, current trend, battery charging and discharging cycles, use of batteries in powertrain. Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors. Charging methods for battery, Termination methods, charging from grid.

8 Hours

UNIT V

Battery management system (BMS): Introduction, Illustration of BMS, battery pack capacity and range, Battery state evaluation. Battery thermal Management systems: Thermal Issues of Li-ion battery, Operating Requirements, Overall Heat Transfer Co-efficient, Phase Change Material (PCM), Technologies of BTMS, Evaluation of Different Technologies, Modelling of BTMS.

7 Hours**TEXT BOOKS**

1	James Larminie and John Lowry	Electric Vehicle Technology Explained, John Wiley & Sons Ltd, 2nd ed., 2012.
2	K. T. Chau	Electric Vehicle Machines and Drives Design, Analysis and Application-Wiley-IEEE Press (2015).
3	G A Goodarzi and John G Hayes	Electric powertrain _ energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles (2018, John Wiley & Sons).
4	Christopher D. Rahn and Chao Yang Wang	Battery Systems Engineering, 2013 edition, John Wiley, and Sons Ltd.

REFERENCE BOOKS :

1	C.C. Chan and K.T. Chau	Modern Electric Vehicle Technology, Oxford University Press, 2001.
2	Ali Emadi	Handbook of Automotive Power Electronics and Motor Drives, CRC Press Taylor & Francis Group, 2005.
3	Iqbal Hussein	Electric and Hybrid Vehicles: Design Fundamentals, CRC Press Taylor & Francis Group, 2003.
4	Chris Mi, M. Abul Masrur, David Wenzhong Gao	Hybrid Electric Vehicles Principles and Applications with Practical Perspectives Wiley Publication 2011

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	To help students be thorough with the concepts of Electric vehicles (EVs) and its advantages to traditional ICE vehicles in the longer run.
CO2	To allow students to learn the basic structure of an EV and Hybrid Vehicles
CO3	To provide insights into the electric motors and allied accessories that are essential for proper functioning of an EV system.
CO4	To enable students to learn to synthesize and characterize high performance nanomaterials for Li battery application. To enable students to design and assemble battery components and test them.
CO5	To help students understand the challenges and opportunities present in Battery thermal Management systems

Course Articulation Matrix

	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	2	1										2		2
	CO2	2	1										2		2
	CO3	2	1										2		2
	CO4	2	1										2		2
	CO5	2	1										2		2

Scheme of SE Examination:

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Energy Conservation & Auditing

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S3MEE03	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	Understand the present energy Scenario and the issues that are related to energy management.
2.	Recognize the significance of energy conservation and being aware of energy conservation concepts and approaches.
3.	Understand efficient heat & electricity utilization, saving and recovery in different thermal and electrical system.
4.	Provide awareness of the Energy Economics Evaluation.
5.	Provide awareness of the Energy Conservation methods and policy associated with environmental sustainability.

UNIT I

Energy Scenario: Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future.

Energy conservation: Principles of energy conservation, Energy Conservation Act 2001 and its features, Electricity Act-2003 & its features, Energy consumption pattern, Resource availability, Energy pricing, Estimation of energy use in a building. Standards for thermal performance of building envelope, Evaluation of the overall thermal transfer, ECBC code for Building Construction.

8 Hours

UNIT II

Energy efficiency in thermal utilities: Energy efficiency in boilers, furnaces, steam systems, cogeneration utilities, waste heat recovery, compressed air systems, HVAC & R systems, fans and blowers, pumps, cooling tower, Thermal insulation.

Energy efficiency in electrical utilities: Energy efficiency for electric motors, lighting systems, Characteristics of Light, Types of Lighting, Incandescent Lighting, Fluorescent Lighting, Vapor Lighting, Street Lighting, LED Lighting, Tips for Energy Conservation, Products for Energy Conservation in lighting system.

8 Hours

UNIT III

Energy Audit: Definition, objective and principles of Energy Management, Need of Energy Audit and Management, types of energy audit, audit process, Guidelines for writing energy audit report, impact of renewable energy on energy audit recommendations and energy audit report, energy audit of building system, lighting system, cooling tower, HVAC system, Water heating system, waste heat recovery opportunities during energy audit, Industrial audit opportunities, Instruments for Audit and Monitoring Energy and Energy Savings. Numericals

8 Hours

UNIT IV

Energy Economics: Simple Payback Period, Time Value of Money, Internal Rate of Return, Net Present Value, Life Cycle Costing, Equivalent uniform annual cost (EUAC), Life cycle cost, Discounting factor, Capital recovery, Depreciation, taxes and tax credit, Impact of fuel inflation on life cycle cost, Cost of saved energy, cost of energy generated, Energy performance contracts and role of Energy Service Companies. Case study Flue gas heat recovery from boiler

by installing economizer, Case study by reviewing energy bills, Annual energy saving of building lighting items, Numericals.
8 Hours

UNIT V

Energy Policy and Environment: Climate policy, United Nations Framework Convention on Climate Change (UNFCCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF), Carbon credit Market .
7 Hours

TEXT BOOKS

1	Dale R Patrick, Stephen W Fardo	Energy Conservation Guidebook, 2nd Edition, CRC Press
2	Albert Thumann	Handbook of Energy Audits, , 6th Edition, The Fairmont Press

REFERENCE BOOKS

1	Bureau of Energy	Bureau of Energy Efficiency Reference book: No.1, 2, 3 4
2	W.C. Turner	Energy Management Handbook, John Wiley and Sons
3	E J Wilson and D Gerard	Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation, Blackwell Publishing
4	J. Krieder and A.Rabl,	Heating and Cooling of Buildings - Design for Efficiency, McGraw Hill Publication, 1994.
5	SK Soni & Manoj Nair	Energy Management, Tech India Publication, 2010

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Apply the knowledge of Energy scenario to understand the basic energy conservation principles.
CO2	To Evaluate the energy saving & conservation in different mechanical utilities.
CO3	To prepare energy audit report for different energy conservation instances.
CO4	Evaluate the cost effectiveness and Energy performance through energy economics study.
CO5	Understanding energy policy as well as the environmental sustainability challenges associated with energy management.

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	H-3		-	-	-	-	-	-	-	-	-	-	H-3		
	CO2	H-3		-	-	-	-	-	-	-	-	M-2	-	H-3		
	CO3	H-3	M-2	-	-	-	-	-	-	-	-	-	-	H-3		
	CO4	H-3	H-3	-	-	-	-	-	-	-	-	M-2	-	H-3		
	CO5	H-3			-	-	-	M-2	-	-	-	M-2	-	H-3		

Scheme of SE Examination:

Question paper contains 10 questions. Students have to answer 5 full questions selecting one full question from each unit.

Product Lifecycle Management

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S3MEE04	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	To familiarize the students with the need, benefits and components of PLM.
2.	To acquaint students with Product Data Management & PLM strategies
3.	To give insights into new product development program and guidelines for designing and developing a product and Virtual Product Development.
4.	To familiarize the students with environmental aspects in Product Design.
5.	To acquaint students with Digital manufacturing and PLM strategy.

UNIT I

<p>Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, PLM Applications</p> <p>PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM.</p>
8 Hours

UNIT II

<p>Product Design: Product Design and Development Process, Engineering Design, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System.</p>
12 Hours

UNIT III

<p>Product Data Management (PDM): Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.</p> <p>Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.</p>
8 Hours

UNIT IV

<p>Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design</p>
5 Hours

UNIT V

<p>Digital Manufacturing</p> <p>Digital manufacturing, benefits of digital manufacturing, manufacturing the first-one, Ramp up, virtual learning curve, production planning.</p>

Developing a PLM strategy and conducting a PLM assessment Strategy, Impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives. Infrastructure assessment, assessment of current systems and applications.
6 Hours

TEXT BOOKS		
1	John Stark	“Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer.
	Fabio Giudice, Guido La Rosa, Antonino Risitano,	“Product Design for the environment”

REFERENCE BOOKS		
1	Saaksvuori Antti, Immonen Anselmie,	“Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
2	Michael Grieve	“Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

ONLINE RESOURCES	
1	https://onlinecourses.swyam2.ac.in/imb19_mg01/preview
2	

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
CO2	Illustrate various approaches and techniques for designing and developing products.
CO3	Apply product engineering guidelines / thumb rules in designing products.
CO4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant.
CO5	Acquire knowledge in Digital manufacturing and PLM strategy.

SCHEME OF END EXAMINATION:

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit

Mechatronics

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S3MEE05	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	This Subject covers the basic concepts of the various devices used for the automated machine tools and manufacturing systems to increase the productivity with accuracy.
2.	The important devices covered include the applications of hydraulic and Pneumatic, sensors and feed back devices, Electronics.
3.	This Subject also covers the topics like controls systems, condition monitoring.

UNIT I

Introduction: Definition of Mechatronics, Multi-disciplinary scenario, origins. Evolution of Mechatronics, An over view of mechatronics. Design of mechatronics system. Measurement system and function of main elements of measurement systems. Objectives, advantages and disadvantages of mechatronics. Microprocessor based controllers. Principle of working of machines like CNC, automatic camera, engine management system, automatic washing machine.

Reviews of Transducers and Sensors

Definition and classification of transducers – with a simple sketches, Principle. (No detailed discussions on different type of transducers), Working of transducer with a simple Example, Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.

10 Hours

UNIT II

Electrical Actuators

Actuator and actuator system. Classifications of actuator system with examples. Mechanical switches. Concept of bouncing Methods of Preventing bouncing of mechanical switches. Solenoids, Relays. Solid state switches - Diodes, Thyristors, Triacs, Transistors, Darlington pair. Electrical actuator. Principle, construction and working of AC, DC motors. Stepper motors, permanent magnet motors, servomotors, Servo systems and control.

8 Hours

UNIT III

Hydraulic Actuators

Valves -Classifications, Pressure Control Valves -Pressure relief valves, Pressure regulating/reducing valves, Pressure sequence valve. Flow control valves -Principle, needle valve, globe valve. Direction control valve -Sliding spool valve. Solenoid operated. Symbols of hydraulic elements. Hydraulic cylinders - constructional features, classification and application Hydraulic motors -Types, vane motors and piston motors, applications.

8 Hours

UNIT IV

Digital logic & Microprocessor

Digital logic, Number systems, Logic gates, Boolean algebra, Karnaugh maps, Applications of logic gates, Sequential logic gates.

Introduction to Microprocessor, 8085A processor architecture Terminology- such as, CPU, Memory and address, ALU, assembler. Data, registers, Fetch cycle, write cycle, state, bus,

interrupts. Micro controllers -difference between microprocessor and micro controllers. Requirements for control and their implementation in micro controllers.
9 Hours

UNIT V
Concept, necessity, op-amps, protection, filtering, wheat stone bridge -Digital Signals - Multiplexer. Data acquisition -Introduction to digital signal processing -Concepts and different methods.
5 Hours

TEXT BOOKS		
1	W. Bolton	Mechatronics, Pearson Education Asia -2nd ED. 2001
2	Nitaigour and Premchand Mahilik	Mechatronics, Principles, Concepts and applications - Tata McGraw Hill -2003

REFERENCE BOOKS		
1	David G. Alciatore & Michel BiHiland	Introduction to mechatronics and measurement systems, -Tata McGraw Hill -2000.
2	HMT Ltd	Mechatronics Tata McGrawHill -2000.

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Describe the basic concepts of Mechatronics and discuss the advantages of Mechatronics system. Analyse the working principle of various sensors and transducers.
CO2	Describe construction and working of various Electrical actuators.
CO3	Explain various hydraulic actuators to design hydraulic circuits for automation.
CO4	Analyze different logic gates and its application with 8085 microprocessor architecture.
CO5	Interpret and compare the digital filters for processing of discrete time in Signal conditioning.

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	3															2
	CO2	3															2
	CO3	3															2
	CO4	3	1														2
	CO5	3															2

Scheme of Examination: There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Social Connect & Responsibilities

Contact Hours/ Week:	0:0:2:0	Credits:	01
Total Lecture Hours:	26	CIE Marks:	50
Sub. Code:	SHS01	SEE Marks:	

Course objectives:	
This course will enable students to:	
1.	Enable the student to do a deep drive into societal challenges being addressed by NGO(s), social enterprises & The government and build solutions to alleviate these complex social problems through immersion, design & technology.
2.	Provide a formal platform for students to communicate and connect with their surroundings.
3.	Enable to create of a responsible connection with society.
Learning Outcomes: The students are expected to have the ability to:	
1	Understand social responsibility
2	Practice sustainability and creativity
3	Showcase planning and organizational skills
Contents:	
The course is mainly activity-based that will offer a set of activities for the student that enables them to connect with fellow human beings, nature, society, and the world at large. The course will engage students in interactive sessions, reading groups and semester-long activities conducted by faculty mentors. In the following a set of activities planned for the course have been listed:	

UNIT I

Plantation and adoption of a tree: Plantation of a tree by Miyawaki Method that will be adopted by entire semester by a group of students. They will also make an excerpt either as a documentary or a photoblog describing the plant's origin, its usage in daily life, and its appearance in folklore and literature.
6 Hours

UNIT II

Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photoblog and documentary on evolution and practice of various craft forms.
6 Hours

UNIT III

Organic farming: Definition of organic farming, Organically grown crops in India, Differentiate between conventional farming and organic farming, Necessity of organic farming, Key characteristics of organic farming, Four principles of organic farming(principle of Health, principle of ecology, principle of fairness and principle of care),Types of organic farming: 1) Pure organic farming, 2) Integrated farming (Integrated nutrient management and Integrated pest management), objectives of organic farming, benefits of organic farming, Basic steps in organic farming and limitations of organic farming.
4 Hours

UNIT IV	
Water Conservation: Global Water Scarcity - Global water crisis and its implications; Rainwater Harvesting - Concept and benefits of rainwater harvesting; Water Audit – An approach to water conservation; Efficient Water Use - Optimizing water consumption in daily life	
6 Hours	

UNIT V	
Food Walk City's culinary practices, food lore, and indigenous materials of the region used in cooking.	
4 Hours	

Activities :	
1	Plantation and adoption of a tree: Select suitable species in consultation with horticulture, forest or agriculture department. Interact with NGO/Industry and community to plant Tag the plant for continuous monitoring
2	Heritage walk and crafts corner: Survey in the form of questioner by connecting to the people and asking. Questions during survey can be asked in local language but report language is English
3	Organic farming: Collect data on organic farming in the vicinity. Like types of crop, methodology etc
4	Water Conservation: Report on traditional water conservation practices (to minimize wastage)
5	Food Walk: Survey local food centres and identify its specialty, Identify and study the food ingredients, Report on the regional foods, Report on Medicinal values of the local food grains, and plants.

PEDAGOGY

The pedagogy will include interactive lectures, inspiring talks by various departments, field visits, social immersion. Applying and synthesizing information from these sources to define the social problem with your group. Social immersion with NGOs/social sections will be a key part of the course.

COURSE TOPICS:

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

A total of 26 hrs engagement per semester for this course in 3rd semester of the B.E. program. The students will be divided into 1 group of 60 each. Each group will be handled by one faculty mentor.

Guideline for Assessment Process:**Continuous Internal Evaluation (CIE)**

1	Student shall keep a separate dairy and prepare report in consultation with the mentor/s to indicate what he has observed and learned in the social connect period
2	Report shall be handwritten or blog with paintings, sketches, poster, video and/or photograph with Geo tag.
3	The report should be signed by the mentor.
4	The report shall be evaluated on the basis of the following criteria (see Table below) and/or other relevant criteria pertaining to the activity completed.

5	Each module is evaluated for 35 Marks and final presentation will be for 15 marks.		
	Sl. No.	Particulars (for each module)	Maximum Marks
	1	Planning and scheduling the social connect	10
	2	Information/Da ta collected during the social connect	10
	3	Report writing	15
	4	Final Presentation from the group	15
Total		50	

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1															
	CO2															
	CO3															
	CO4															
	CO5															

Introduction to Virtual Reality

Contact Hours/ Week:	1+0+0 (L+T+P)	Credits:	1.0
Total Lecture Hours:	13	CIE Marks:	50
Sub. Code:	S3MEA02	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	Describe how VR systems work and list the applications of VR.
2.	Develop the knowledge and skills needed to create immersive virtual reality experiences.
3.	Ability to apply geometric models and viewing transformations to create and manipulate virtual worlds, while also understanding the physiological aspects of human vision, eye movements.
4.	Understand the system of human vision and its implication on perception and rendering.
5.	Explain the concepts of motion and tracking in VR systems.

UNIT I

Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.
Hours

UNIT II

Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR
Hours

UNIT III

The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Modeling, Homogeneous Transformations-Rotation, Translation, Scaling
Hours

UNIT IV

Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information. Visual Rendering -Ray Tracing and Shading Models, Rasterization.
Hours

UNIT V

Motion & Tracking: Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Tracking- Tracking 2D & 3D Orientation.
Hours

TEXT BOOKS

1	Steven M. LaValle,	Virtual Reality, Cambridge University Press, 2016, ISBN 1107198933 / 9781107198937.
2	William R Sherman and Alan B Craig,	Understanding Virtual Reality: Interface, Application and Design, (The Morgan Kaufmann Series in Computer Graphics)”. Morgan Kaufmann Publishers, San Francisco, CA, 2002. ISBN- 1558603530 / 9781558603530.
	Alan B Craig, William R Sherman and Jeffrey D Will	Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann Publishers In, 2009, ISBN-13 978-0123749437.

REFERENCE BOOKS		
1	Gerard Jounghyun Kim	“Designing Virtual Systems: The Structured Approach”, Springer, 2005, ISBN 1107198933 / 9781107198937.
2	Doug A Bowman, Ernest Kujiff, Joseph J LaViola, Jr and Ivan Poupyrev	“3D User Interfaces, Theory and Practice”, Addison Wesley, Professional, 2005, ISBN 9780201758672.
3	Oliver Bimber and Ramesh Raskar,	“Spatial Augmented Reality: Merging Real and Virtual Worlds”, CRC Press, 2005, ISBN -13-978-15668812304.
4	Burdea, Grigore C and Philippe Coiffet	“Virtual Reality Technology”, Wiley IEEE Press, 2ND Edition 2003, ISBN-13:978-0471360896.

ONLINE RESOURCES	
1	http://lavalle.pl/vr/book.html
2	https://nptel.ac.in/courses/106/106/106106138/
3	https://www.coursera.org/learn/introduction-virtual-reality.

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Describe how VR systems work and list the applications of VR.
CO2	Demonstrate the design and implementation of the hardware that enables VR systems to be built.
CO3	Understand the system of human vision and its implication on perception and rendering.
CO4	Explain the concepts of motion and tracking in VR systems.
CO5	Describe the importance of interaction and audio in VR systems.

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	3															
	CO2	3															
	CO3	3															
	CO4	3															
	CO5	3															

SCHEME END EXAMINATION: There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Introduction to Computational Thinking

Contact Hours/ Week:	1+0+0 (L+T+P)	Credits:	1.0
Total Lecture Hours:	13	CIE Marks:	50
Sub. Code:	S3MEA04	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Develop a basic understanding of historical computing developments, including hardware devices and software languages
2.	Solve problems by deconstructing them into smaller Modules using a systematic approach in an iterative fashion
3.	Develop the skills necessary to translate algorithms into software instructions in a high-level language in order to solve problems using a computer

UNIT I

Information and data, Number Systems-Binary, Hexadecimal, Octal, Conversion, BCD, Data encoding. Boolean Algebra, Simplification of Boolean expression.

2 Hours

UNIT II

Problem Solving, Top-down design, Problem definition, Problem decomposition, Abstraction, Greedy Method, Divide and Conquer.

2 Hours

UNIT III

Algorithmic Thinking, Algorithm and Flowcharting, Efficiency of algorithms, The analysis of algorithms, Fundamental Algorithms-exchange values of two variables, factorial computation, Sine function computation.

3 Hours

UNIT IV

Data organization: List and Arrays, Problem Solving: Factoring and Recursion Techniques.

3 Hours

UNIT V

Searching and Sorting Techniques, Text processing and Pattern matching.

3 Hours

TEXT BOOKS

1	David Riley and Kenny Hunt	Computational thinking for modern solver, Chapman & Hall/CRC, 2014
2	R.G. Dromey	“How to solve it by Computer”, PHI, 2008

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Define and convert from different number systems and simplify Boolean operations.
-----	-----------------------------------------------------------------------------------

CO2	Describe different problem decomposition techniques.
CO3	Design algorithms using fundamental programming constructs.
CO4	Understand different data structures and factoring techniques.
CO5	Identify and apply searching and sorting techniques.

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	3				2											2
	CO2	3				2											2
	CO3	3				2											2
	CO4	3				2											2
	CO5	3				2											2

Fundamentals of Geometric Dimensioning And Tolerancing

Contact Hours/ Week:	1(L)+0(T)+0(P)	Credits:	1.0
Total Lecture Hours:	13	CIE Marks:	50
Sub. Code:	S3MEA05	SEE Marks:	50

Course objectives:

The main objective of this course is to provide a comprehensive understanding of Geometric Dimensioning and Tolerancing (GD&T) based on the ASME Y14.5 standards. Students will learn to accurately interpret and apply GD&T symbols and rules, establish reliable datum systems and reference frames, and effectively use various form, orientation, profile, location, and runout tolerances to enhance the precision and functionality of engineering designs and manufacturing processes. From this course student will be able to:

1.	Apply the principles of Geometric Dimensioning and Tolerancing (GD&T) in accordance with the ASME Y14.5 standard.
2.	Define features, datums, tolerances, and geometric requirements on engineering drawings.
3.	Interpret Datum Reference Frames to ensure proper location and orientation of features on a part.
4.	Apply form tolerances, orientation tolerances, to control the geometry of parts.
5.	Apply location tolerances, profile tolerances, and runout tolerances, to control the geometry of parts.

UNIT I

Introduction to GD&T, ASME and History of Y14.5, GD&T and Standardization. GD&T symbols, GD&T in manufacturing and inspection.

2 Hours

UNIT II

Features and Rules of GD&T: Introduction to Features and Material Conditions - Maximum Material Condition, Least Material Condition. The Feature Control Frame. Introduction to Virtual Condition and Boundary Condition, Bonus Tolerance.

3 Hours

UNIT III

Datum's Control: Introduction to Datum's, The Datum Reference Frame, Primary Datum Controls, Datum Targets.

Datum Reference Frame: Theory & Interpretation, Datum Elements, View Oriented Datum's.

3 Hours

UNIT IV

Tolerances: Definition, Different types of tolerances.

Form Tolerances: Straightness (Surface), Straightness (Derived Median Line), Flatness (Surface), Flatness (Derived Median Line), Circularity, Cylindricity.

Orientation Tolerances: Parallelism (Surface), Parallelism (Axis), Perpendicularity (Surface), Perpendicularity (Axis), Angularity (Surface and Axis).

3 Hours

UNIT V

Profile Tolerances: Profile of a Surface, Profile of a Line.

Location Tolerances: Concentricity, Symmetry.

Runout Tolerances: Runout/Circular Runout, Total Runout.

2 Hours

TEXT BOOKS		
1	N. D. Bhatt	Engineering Drawing, Charotar Publishing House Pvt. Ltd., Fifty fourth Edition, 2023, ISBN: 9789385039706.
2	P.S. Gill	Geometric Dimensioning & Tolerancing, S.K. Kataria & Sons, Third Edition, 2022, ISBN: 978-93-5014-378-0.
3	Gene R. Cogorno	Geometric Dimensioning and Tolerancing for Mechanical Design, Third Edition, McGraw Hill, 2020, ISBN: 9781260453782.
4	Alex Krulikowski	Fundamentals of Geometric Dimensioning and Tolerancing, Third Edition, Delmar Cengage Learning, 2013, ISBN: 9781111129828.

REFERENCE BOOKS		
1	Brian Griffiths	Engineering Drawing for Manufacture, Elsevier Science & Technology, First Edition, 2003, ISBN: 9781857180336.
2	James D. Meadows	Geometric Dimensioning and Tolerancing-Applications, Analysis & Measurement [Per ASME Y14.5-2009], Second Edition, James D Meadows & Assoc Inc, 2010, ISBN-13: 9780971440166.
3	Paul J. Drake, Jr.	Dimensioning and Tolerancing Handbook (MECHANICAL ENGINEERING), First Edition, McGraw-Hill Professional, 1999, ISBN: 9780070181311.

ONLINE RESOURCES :		
1	Understanding Engineering Drawings	https://www.youtube.com/watch?v=ht9GwXQMgpo
2	Understanding GD&T	https://www.youtube.com/watch?v=G7wnGeR_69k&t=1035s

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Understand core GD&T principles (ASME Y14.5) and its role in standardization, manufacturing, and inspection.
CO2	Define features, datums, tolerances, and geometric requirements in GD&T, explaining MMC, LMC, and the Feature Control Frame.
CO3	Interpret Datum Reference Frames based on theory and identify various datum elements, including view-oriented ones.
CO4	Apply form and orientation tolerances to control desired part geometry.
CO5	Apply location, profile, and runout tolerances for proper part geometry control.

Course Articulation Matrix

	POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3									2				2	
	CO2	2													2	
	CO3		2												2	
	CO4			2											1	
	CO5			2											1	

IV Semester

Machine Tools, Metrology and Measurements

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3.0
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S4ME01	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	About the fundamental knowledge and principles of metal cutting, cutting tool materials, cutting fluids and machine tools.
2.	About standards used for measurement and its importance
3.	About methods of modern manufacturing like interchangeability and selective manufacturing.
4.	Concept of measurement and measurement system.
5.	About transducers and its use in measurement systems.
6.	Various instruments used in measurement of various parameters like force, pressure, temperature etc.

UNIT I

Theory of Metal Cutting: Single point cutting tool nomenclature, Chip formation, Orthogonal and Oblique cutting, Merchants circle diagram, analysis. Shear angle relationship, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation, cutting tool materials and cutting fluids, numerical problems.

Milling Machines: Indexing- Simple, compound, indexing calculations, numerical on indexing.

Shaper: Introduction, Driving mechanisms, operations.

Grinding: Types of abrasives, bonding process, classification, constructional features and applications, cylindrical, surface, and center less grinding.

8 Hours

UNIT II

Standards of measurement:

Definition and Objectives of metrology, Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, comparison, Slip gauges, Wringing, Indian Standards (M-81, M-112), Numerical problems on building of slip gauges.

System of limits, Fits, Tolerances and gauging:

Definition of tolerance, limits, deviation etc., Principle of interchangeability and selective assembly, Indian standards, concept of limits of size and tolerances, definition of fits, types of fits and their designation, hole basis system, shaft basis of system, classification of gauges, brief concept of design of gauges (Taylor's principle), Wear allowance and machining allowance on gauges, Types of gauges -plain plug gauge, ring Gauge, snap gauge, limit gauge, Numerical problems on gauges.

8 Hours

UNIT III

Comparators

Introduction to Comparator, Characteristics, classification of comparators. mechanical comparators, Reed type, Dial gauge LVDT, Pneumatic Comparators, Solex Comparators.

<p>Angular measurements</p> <p>Bevel Protractor, Sine Principle and. use of Sine bars, Sine centre, use of angle gauges, (numerical on building of angles)</p> <p>Introduction to Nano and Laser Metrology: Introduction, nanotechnology and engineering, Scanning Probe Microscope, 3 D measurements, Co-ordinate Measuring Machine (CMM).</p>	8 Hours
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------

UNIT IV	
<p>Measurements and Measurement systems</p> <p>Definition, Significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-times delay. Errors in Measurements, Classification of Errors.</p> <p>Transducers (Sensors):</p> <p>Primary and Secondary transducers, Classification, Electrical, Mechanical, Electronic transducers.</p> <p>Intermediate modifying and Terminating Devices:</p> <p>Mechanical systems, inherent problems, introduction to mechanical and electrical amplification, input circuitry and telemetry. Mechanical counters, Cathode Ray Oscilloscope, Oscillographs, X-Y Plotters.</p>	8 Hours

UNIT V	
<p>Force Measurement</p> <p>Force Measurements: Principle, analytical balance, platform balance, proving ring.</p> <p>Pressure Measurement:</p> <p>Principle, use of elastic members, Bridgeman gauge, McLeod gage.</p> <p>Temperature measurement Resistance thermometers, thermocouple, law of thermocouples, materials used for construction, Pyrometers.</p>	7 Hours

TEXT BOOKS		
1	P. N Rao	Manufacturing Technology, Volume 1, 4th Edition, McGraw Hill (India) Pvt. Ltd. 2014
2	R.K Jain	Metrology and Measurements, Khanna Publications, 2003.
3	NV Raghavendra, L Krishna murthy	Engineering Metrology and Measurements, Oxford publishers. 2013
4	Beckwith Marangoni and Lienhard Buck	Mechanical measurements, Pearson Education Asia, 5th Ed., 2001

REFERENCE BOOKS		
1	Holman	Mechanical measurements
2	Sirohi and Radhakrishna	Mechanical measurements
3	Doblin	Mechanical measurements
4	J.F. Gayler and C.R. Shotbolt	Metrology for Engineers
5	Alsutko, Jerry.D.Faulk	Industrial Instrumentation- Thompson Asia Pvt. Ltd.2002

6	R.K.Jain	Engineering Metrology
---	----------	-----------------------

ONLINE RESOURCES	
1	NPTEL course on Engineering Metrology Link: https://nptel.ac.in/courses/112104250
2	NPTEL course on Metrology & Measurements Link: http://nptel.ac.in/courses/112106138/

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Explain the basic concepts of mechanics of metal cutting and the parameters affecting the tool life. Analyze the use of various standards and to determine the use of tolerance and fits in manufacturing.
CO2	Interpret the various comparators, limit gauges and angle measuring instruments for various engineering applications.
CO3	Explain the generalized measurement system, characteristics of measuring Instruments, errors in measurements and transducers and its applications.
CO4	Select and analyse the measuring instruments to measure the temperature, pressure, force and its applications.
CO5	Apply measurement of various parameters (like Temperature, Force, Pressure etc.) and concept of standardization in every walk of their life effectively.

Course Articulation Matrix

	POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	2		1										3		
	CO2	3	2										2	3	2	
	CO3	2	2											3	2	
	CO4	3												3	2	
	CO5	3	2								3		3	3	2	

SCHEME END EXAMINATION:

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Theory of Machines

Contact Hours/ Week:	3+0+2 (L+T+P)	Credits:	4.0
Total Lecture Hours:	39 (T) + 26 (p)	CIE Marks:	50
Sub. Code:	S4MEI01 (1PCC)	SEE Marks:	50

UNIT I

Introduction

Definitions: Link or element, pairing of elements with degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Mobility of Mechanism, Inversion, Machine. Kinematic chain with Four bar chain; Single slider crank chain & Double slider crank chain and their inversions.

- i) Quick return motion mechanisms - Whitworth mechanism
- ii) Intermittent Motion mechanisms - Geneva mechanism and Ratchet & Pawl mechanism.

Cams: Types of cams, Types of followers, Displacement diagrams. Cam profile for roller follower.

8 Hours

UNIT II

Velocity and Acceleration Analysis of Mechanisms (Graphical Methods):

Velocity and acceleration analysis of Four Bar mechanism and Slider crank mechanism by vector polygons, Relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident Particles on separate links,

Static Force Analysis:

Reaction between members without friction. Analysis of engine mechanism, four bar mechanism (without friction).

8 Hours

UNIT III

Dynamics of Engine Mechanism:

Design of Flywheel and Turning Moment Diagrams for single cylinder and multi cylinder IC Engines.

Gyroscope:

Vectorial representation of angular motion, Gyroscopic couple, Effect of gyroscopic couple on ship, plane, two wheeler and four wheeler.

9 Hours

UNIT IV

Spur Gear: Law of gearing, Definitions, Path of contact, Arc of contact, Contact ratio, Backlash and Interference in involute gears (No Problems).

Gear Trains: Simple gear trains, Compound gear trains for large speed reduction, Reverted gear trains, Epicyclic gear trains, and tabular methods of finding velocity ratio of epicyclic gear trains.

7 Hours

UNIT V

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

Balancing of Reciprocating masses: Balancing of reciprocating masses. single cylinder engine, balancing of multi cylinder-inline Engine.	
7 Hours	
List Of Experiments	
1	Kinematic Mechanisms
2	Static and Dynamic analysis of mechanisms
3	Gyroscopic behaviour of rotating masses
4	Balancing of rotating masses in a single plane
5	Balancing the rotating masses in different planes
6	Frictional and centrifugal forces in porter governor
7	Frictional and centrifugal forces in proell governor

TEXT BOOKS		
1	Rattan S.S.	Theory of Machines. Ed 4. Tata McGraw-Hill. New Delhi. 2017. ISBN: 978-9351343479, 9351343472

REFERENCE BOOKS		
1	Sadhu Singh.	Theory of Machines. Ed 2. Pearson Education (Singapore), Indian Branch. New Delhi. 2012. ISBN-10: 8177581279, ISBN-13: 978-8177581270
2	Shigley J.V. and Uickers J.J.	Theory of Machines & Mechanisms. Ed 2. McGraw Hill International. 1995. ISBN-10: 0070569304

ONLINE RESOURCES	
1	https://nptel.ac.in/courses/112104114

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Apply the knowledge of mechanisms for engineering applications
CO2	To identify and analyse the motion transmitted in planar mechanisms and to find the velocity and acceleration in different links by graphical approach
CO3	To design a flywheel using turning moment diagram and to determine and analyse the effect of gyroscopic couple in vehicles.
CO4	To Identify and determine the gear parameters for analysing the velocity ratio in different gear trains
CO5	To Identify and determine static and Dynamic balancing systems involving rotating and partial balancing of reciprocating masses.

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	2													2		
	CO2		2												2		
	CO3		2												2		
	CO4		1												2		
	CO5		2												2		

SCHEME END EXAMINATION:

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit

Engineering Thermodynamics

Contact Hours/ Week:	2+2+2 (L+T+P)	Credits:	4.0
Total Lecture Hours:	26(L) + 26(T) + 26 (P)	CIE Marks:	50
Sub. Code:	S4MEI02	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	Understand the basic concepts of thermodynamics, energy interaction and application of first law of thermodynamics.
2.	Understand the application of second law of thermodynamics and entropy concept.
3.	Learn air standard cycles principles, working and its applications
4.	Understand the various properties of pure substances and working of reciprocating compressor and its performance parameters.
5.	Learn the basic thermodynamic concepts and analysis of refrigeration system, and psychrometry.

UNIT I

Introduction to Engineering Thermodynamics, Basic concepts, and definitions: Microscopic and macroscopic approaches, thermodynamic system, surrounding and boundary, types of systems with examples, intensive and extensive properties with examples, quasi-static process, cyclic and non-cyclic processes. thermodynamic equilibrium. Zeroth Law of Thermodynamics, Temperature, construction of thermometers. Definition of thermodynamic work and heat, Joule's experiments (equivalence of heat and work). First Law of Thermodynamics: derivation of work done and heat transfer for different processes, application of First law to closed and open system, derivation of steady flow energy equation and its application for various devices. Problems.
6 + 6 Hours

UNIT II

Limitations of First law of thermodynamics, heat engine: schematic representation and efficiency, reversed heat engine, schematic representation and Co-efficient of Performance. Statements of the Second law of Thermodynamics, equivalence of the Kelvin-Planck and Clausius statements, reversible and irreversible processes, factors that make a process irreversible, Carnot cycle, derivation of the efficiency of Carnot cycle and its limitations, Inequality of Clausius, Concept of entropy, derivation of entropy change for various process. concept of available energy and unavailable energy.
5 + 5 Hours

UNIT III

Air-Standard Cycles: Otto Cycle and Diesel Cycle (P-V and T-s diagrams), derivation of efficiency and mean effective pressure. Problems for finding efficiency and mean effective pressure. Brayton cycle: P-V and T-S diagram, Derivation for thermal efficiency, work ratio, and Pressure ratio for maximum power output. Problems.
IC- Engines: definitions of Brake Power, Indicated Power, Thermal efficiencies etc. Problems on performance of two-stroke and four-stroke SI and CI engines, heat balance, Morse test
5 + 5 Hours

UNIT IV

Pure substances and Vapour Power Cycle
Introduction to pure substance: properties, phase equilibrium diagram, (P-T-V and h-S diagrams), dryness fraction (quality), Steam tables and its use. Simple Rankine cycle; T-s diagram, performance analysis. Problems

Reciprocating air Compressor Working principle of single stage reciprocating air compressors, derivation of work input, volumetric efficiency and isothermal efficiency, multistage air compressor, derivation of intermediate pressure for a two stage air compressor, Problems.
5 + 5 Hours

UNIT V
Introduction to Refrigeration: unit of refrigeration, Vapour compression refrigeration system(VCR), derivation of COP of VCR. Air refrigeration system: derivation of COP of Air refrigeration system, Problems Psychrometry: Dry bulb temperature, wet bulb, temperature, dew point temperature, partial pressures, specific and relative humidity, humidification and dehumidification, Use of Psychrometric chart, Problems
5 + 5 Hours

Lab Experiments
<ol style="list-style-type: none"> 1. Find the viscosity of the given lubricating oil. 2. Find the flash and fire point of the given lubricating oil. 3. Draw the valve time diagram for a 4 stoke diesel engine. 4. Find the percentage error of the planimeter. 5. Conduct the performance on a two-stroke petrol engine. 6. Conduct the performance on a four-stroke petrol engine. 7. Conduct the performance on a four stroke Diesel engine. 8. Conduct the performance on a reciprocating air compressor. 9. Conduct the test on vapour compression refrigeration. 10. Conduct the test on air conditioning system.
26 Hours

TEXT BOOKS		
1	Rajput R.K	Engineering Thermodynamics, Third Edition, Lakshmi publications(P) LTD.
2	Sonntag, Borgnakke and Van Wylen	Fundamentals of Thermodynamics, Sixth Edition, Wiley-India Edition.

REFERENCE BOOKS		
1	P.K. Nag	Basic and Applied Thermodynamics. Fifth Edition McGraw Hill Education(India) Private Limited.
2	Yunus A. Cengel, Michael A. Boles and Mehmet Konoglu	Thermodynamics - An Engineering Approach. Ninth Edition, McGraw Hill

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Identify, formulate, and analyze Thermodynamic system using first law of thermodynamics and steady flow energy equation.
CO2	Apply the concepts of second law of thermodynamics for the analysis of heat engines and reverse heat engines.

CO3	Apply the concepts of air standard cycles to analyze and solve problems on power cycles and performance of IC engines.
CO4	Apply the concepts of pure substance to analyze Rankine cycle and to solve problems on vapour power cycles by using Mollier diagram.
CO5	Identify and analyze different power absorbing devices like compressors, refrigeration and Air-conditioning equipment.

Course Articulation Matrix

		POs												PSOs		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3	2											3		
	CO2	3	2											3		
	CO3	3	2										2	3		
	CO4	3	2										2	3		
	CO5	3	2										2	3		

Scheme of SE Examination:

There will be 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

Machine Tools, Metrology & Measurements Lab

Contact Hours/ Week:	0+0+2(L+T+P)	Credits:	1.0
Total Lecture Hours:	26	CIE Marks:	50
Sub. Code:	S4MEL01 (PCCL)	SEE Marks:	50

Course objectives:

This course will enable students to:

1.	Provide the necessary skills to imparting the required shape and size on the given work piece using the different machine tools.
2.	Provide the necessary skills to measure the various linear dimensions, angular dimensions, strain, tool force and other physical variables.
3.	Perform the calibration of instruments used in measurement of pressure, temperature displacement and weight
4.	Estimation of surface roughness using optical flat.

PART A: MACHINE TOOLS

Turning Practice:

Preparing a model involving the turning operations like Facing, Countersinking, Plain Turning, Step Turning, forming turning (Convex & Concave), Chamfering, Taper turning by swivelling of compound rest method, Thread cutting (V-Thread), Knurling.

10 Hours

Shaping & Milling operations

- i. One model prepared on shaper containing V-groove /dovetail/ rectangular groove
- ii. Spur gear teeth cutting on Horizontal milling machine.

6 Hours

PART B: MEASUREMENTS

1. Calibration of Pressure Gauge and Load Cell
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Determination of modulus of elasticity of mild steel specimen using strain gauges
5. Measurements using Profile Projector
6. Measurements of angle using Sine bar
7. Measurements of cutting tool forces using Lathe Tool Dynamometer
8. Measurements of gear tooth profile using gear tooth Vernier.
9. Calibration of micrometre using slip gauges
10. Measurement of the flatness using Optical Flats

10 Hours

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Impart the shape and size on the work piece as required by the engineering drawing using various machining operations.
CO2	Calibrate measuring instruments and to measure the physical variables such as pressure, weight, temperature, and displacement.
CO3	Determine the modulus of elasticity using strain gauges. Able to determine the cutting tool forces and surface roughness.
CO4	Use various machine tools and measuring instruments.

Course Articulation Matrix:

The Course Outcomes of the course Engineering Materials helps to the achievement of the Programme Outcomes as summarized in the following Table.

	POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	3								2			2	3	2	2
	CO2	3							2	3			2	3	2	2
	CO3	3				3			2	3			3	3	2	2
	CO4	3							2	3			2	3	2	2
	CO5															

SCHEME OF EXAMINATION:

ONE question from Machine tools (Part-A):	25Marks
ONE question from Measurements (Part-B):	15Marks
<u>Viva-Voce:</u>	<u>10Marks</u>
	Total:50

Non-Destructive Testing

Contact Hours/Week	:	3+0+0 (L+T+P)	Credits	:	3.0
Total Lecture Hours	:	39	CIE Marks	:	50
Course Code	:	S4MEE02	SEE Marks	:	50

Course Objectives: From this course student will:

1. understand the Principles of NDT, explore and compare NDT Methods
2. understand NDT Equipment and Safety
3. learn to assess the size of the defects in any manufactured part/component
4. select appropriate NDT technique to be used for a given component for defect detection. .
5. gain knowledge about how AI can be used in NDT to automate defect detection.

Unit I
<p>Introduction: Need for Inspection, Types of inspection Techniques, Benefits of Non-destructive examination, selection of NDT methods, Reliability in NDT.</p> <p>Visual Examination: Defects in Materials, Basic Principles, Defects detected by unaided eye, optical aids used for visual inspection.</p>
08 Hours
Unit II
<p>Liquid Dye Penetrant Inspection (LPI): Introduction, Principles, Characteristics of penetrants, Inspection Procedure, Penetrant testing materials and methods, Applications and Limitations.</p> <p>Magnetic Particle Inspection (MPI): Basic definitions and principles, Magnetization methods, Procedure, continuous and residual methods, sensitivities, demagnetization, Magnetic Particles, Applications, Advantages and Limitations.</p> <p>Eddy Current Testing (ECT): Introduction and principles, Instrumentation for ECT, Techniques of ECT, sensitivity, Applications and Limitations</p>
8 hours
Unit III
<p>Radiography: Introduction, Uses and limitations of radiography, Basic Principles, Electromagnetic Radiation Sources, Production of X-rays, X-ray Spectra-radiation sources, Attenuation of radiation, Effect of radiation in the film, Radiographic imaging.</p> <p>Inspection Techniques (Single wall single image, Double wall penetration, latitude and special) Applications, Viewing and interpretation of radiographs, Radiation hazard, Protection against radiation, Introduction to Digital Radiography and its benefits compared to conventional radiography.</p>
8 Hours
Unit IV
<p>Ultrasonic Testing (UT): Introduction, Nature of sound, Piezoelectric Transducers, Characteristics of Piezoelectric Transducers, Characteristics of Ultrasonic Beam, Sound waves at Interfaces, Sound attenuation, Types of Display-A, B, C-scan, Inspection methods, Defect identification, Immersion testing, sensitivity, surface condition and some applications, Working principle of Phased array transducers and Electromagnetic Acoustic Transducers</p>
8 hours

Unit V
Other NDT Methods: Acoustic Emission Testing (AET), Instrumentation, Acoustic Emission Signal features, Applications. Thermography-Principle of Thermography, Working Process of Infrared Thermography, Infrared Thermography Testing Techniques, Applications.
AI in NDT: Probability of Detection, True Positive, False Positive Automatic Defect Recognition.
08 Hours

TEXT BOOKS:

1.	Barry Hull and Veron John	Non-Destructive Testing – ELBS Edition 1989.
2.	American society of Metals	Metals hand book- for non-destructive evaluation & quality control, V 01-17, 9U1 Edition, 2001.
3.	Handbooks of American Society	Non-Destructive Testing, 2002.

REFERENCE BOOKS:

1.	Baldev Raj, T. Jayakumar and M. Thavasimuthu	Practical Non Destructive Testing, Third Edition, 2011, Narosa Publishers. ISBN: 8173197970
2.	J. Prasad and C. G. Krishnadas Nair	Non-Destructive test and Evaluation of Materials, 2008, Tata Mc Graw Hill, 2008. ISBN: 0070620849

Course Outcomes: After attending this course student will be able to
CO1 Explain the fundamentals of non-destructive testing and demonstrate the principles, techniques, and limitations of visual inspection.
CO2 Describe NDT techniques for detecting surface and near-surface defects in ferrous and non-ferrous materials.
CO3 Interpret radiographic images and assess internal defects in materials using radiographic testing techniques, considering safety and image quality principles.
CO4 Analyze ultrasonic signals and perform ultrasonic testing (UT) for evaluating internal flaws and thickness measurements in engineering components
CO5 Discuss advanced NDT methods and integration of AI in inspection systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	3	1			1			1							
CO3	3	1			1	1		1							
CO4	3	1			1			1							
CO5	3														

Non-Traditional Machining

Contact Hours/ Week:	3	Credits:	3
Total Lecture Hours:	39	CIE Marks:	50
Sub. Code:	S4MEE04	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	To Learn modern machining practice for high strength, hardness & thermally resistive materials.
2.	To learn capabilities of different types energies for machining
3.	To learn effects of different parameters on machining process
4.	To communicate understanding of machining technique effectively

UNIT I
<p>Introduction History, Classification, comparison between Traditional and Non Traditional Machining, process selections. Mechanical Process: Ultrasonic machining (USM) Introduction, Equipment, tool materials & tool Size, Abrasive slurry, Cutting tool system Magnetostriction assembly. Mechanics of cutting, Effect of parameter:-Effect of amplitude and frequency, Initial vibration, Effect of grain diameter, Effect of applied static, Effect of slurry, Tool & work material, Applications.</p> <p>Water jet and Abrasive water jet Machining: Introduction, Cutting Equipment, machining Process, advantages and applications</p> <p>Abrasive Jet Machining: Introduction, Equipment, Variables in AJM: - Carrier Gas, Type of abrasive, Size or abrasive grain, velocity of the abrasive jet, Mean No. abrasive particles per unit volume of the carrier gas, Work material standoff distance(SOD), nozzle design, Shape of cut. Process characteristics- Material removal rate, Nozzle wear, Accuracy (surface finish. Applications, Advantages & Disadvantages of AJM</p>
9 Hours

UNIT II
<p>Electrochemical Removal Process Introduction, Study of ECM machine, Elements of ECM process:- Cathode tool, Anode work piece, source of DC power, Electrolyte. Chemistry of the process, ECM process characteristics-Material removal rate, Accuracy. Surface finish., ECM Tooling:-ECM tooling technique, example, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug., Economics of ECM, Applications such as Electrochemical turning, Electrochemical Grinding. Electrochemical Honing, debarring, Advantages, Limitations.</p> <p>ii) Chemical Machining(CHM) Introduction, Elements of process, Chemical blanking Process:- Preparation of work piece preparation of masters, masking with photo resists, etching blanking, Accuracy of chemical blanking, Application of chemical blanking, process characteristics of CHM material removal rate accuracy, surface finish, Hydrogen embitterment, Advantages & application of CHM.</p>
7 Hours

UNIT III**Thermal Metal Removal Processes :**

Electrical discharge machining(EDM)-introduction, machine, mechanism of removal, dielectric fluid, spark generator, EDM tool design Electrode feed control, Electrode manufacture, electrode material selection, under sizing and length of electrode Machining time. Flushing-Pressure flushing, suction side flushing, pulsed flushing synchronized with movement, EDM process characteristics: Metal removal rate. Accuracy surface finish, Heat affected Zone. Machine tool selection, Application: EDM accessories applications, discharge grinding, Traveling wire EDM

7 Hours**UNIT IV****i) Plasma Arc Machining (PAM)**

Introduction. Equipment thermal generation of plasma, selection of gas, Metal removal, PAM parameters, Process characteristics precautions, Applications, Advantages and limitations.

ii) Electron Beam Machining

Generation and control of Electron beam, electron beam machining theory, process Capabilities & limitations

iii) Laser Beam Machining

Introduction, Apparatus, Material Removal, cutting speed and accuracy of cut, advantages and limitations.

8 Hours**UNIT V****Micromachining Processes:** Micro-turning, Micro-drilling and Micro-milling

Introduction, Micro-turning, Micro-drilling, Micro-milling, Micro-grinding and Ultra-precision Processes

Laser Micromachining:

Introduction, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication.

8 Hours**TEXT BOOKS**

1	Pandey & Shah	Modern Machining Process, TATA McGraw Hill
2	Vijay K Jain	Advanced Machining Processes, Allied Publishers.
3	V.K.Jain	Micro-manufacturing Processes, CRC Press, 2012

REFERENCE BOOKS

1	J. Paulo Davim, Mark J. Jackson	Nano and Micromachining, John Wiley & Sons, 2013
2	Kapil Gupta	Micro and Precision Manufacturing, Springer, 2017

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	Identify and describe salient features in NTM processes and types of energies used in NTM methods and describe the modern manufacturing processes such as AJM and AWJM with its advantages, disadvantages and applications
CO2	Explain advanced chemical and electrochemical machining processes for material removal with its advantages, disadvantages and applications.
CO3	Explain thermal metal removal processes with process characteristics, its advantages, disadvantages and applications.
CO4	Describe the advantages, limitations and applications of the thermal machining processes.
CO5	Explain working of micromachining methods

Course Articulation Matrix

	POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
COs	CO1	2	1											1		
	CO2	2	1											1		
	CO3	2	1											1		
	CO4	2	1											1		
	CO5	2	1											1		

Scheme of SE Examination:

End Semester – There are 10 questions, two from each unit and the students have to answer 5 full questions choosing one question from each unit.

CAD/CAM & CIM

Contact Hours/ Week:	: 3+0+0(L+T+P)	Credits:	3.0
Total Lecture Hours:	: 39	CIE Marks:	50
Sub. Code:	: S4MEE05	SEE Marks:	50

UNIT I

Computer Aided Design: Definition of CAD/CAM, product life cycle, Introduction to CAD and CAM. Advantages and disadvantages of CAD and CAM.

Software configuration of a graphic system: functions of graphics package, construction of geometry, wire frame and solid modelling, 2D transformations. Introduction to exchange of modelling data -Basic features of IGES, STEP, DXF, and DMIS.

08 Hours

UNIT II

Computer Aided Manufacturing: Introduction to NC, CNC and DNC. Basic Components of NC machine, NC Coordinate System, fixed zero and Floating zero, Absolute positioning and incremental positioning, NC Motion Control System, NC Part Programming, Problems with Conventional NC.

Computer Numerical Control: Basic components, Functions of CNC, tool pre-setting, ATC, Tool Magazine, Modular tooling system, work holding devices, Steps involved in development of a part program.

08 Hours

UNIT III

Automation: Definition, types of automation, reasons for automation, Production Concepts & Mathematical Models, Types of Plant Layouts.

High Volume Production System: Automated flow lines, Transfer Mechanisms, methods of work part transport, Production/ Manufacturing Costs, Manufacturing Overhead Costs, break even analysis, Buffer Storage.

Line Balancing: Methods of Line balancing with examples, Computerized Line Balancing.

08 Hours

UNIT IV

Computerized Manufacturing Planning System: Process Planning, Requirements for Process Planner, Computer-Aided Process Planning, Parts of Computer-Aided Process Planning, Materials Requirements Planning (MRP), Fundamental Concepts of MRP, Input and outputs of MRP,

Shop Floor Control & Computer Aided Quality Control: Introduction to Shop Floor Control, Functions of Shop Floor Control, Phases of Shop Floor Control, Factory data Collection System and types, Automatic identification system. Contact and Non-Contact inspection methods, Co-ordinate measuring machine.

08 Hours

UNIT V

AI Enabled CAD: Introduction to AI concepts, Types of AI, Key AI technologies, AI Applications in CAD: Generative design, Parametric modeling and AI, Predictive modeling in design processes, Basic AI integration with CAD tools.

AI Enabled CAM: Role of AI in CNC machining and automation, Predictive maintenance and quality control, AI for process optimization, Role of AI in robotics.

07 Hours

TEXT BOOKS		
1	P .N. Rao	A text book on CAD/CAM Principles and Application by P .N. Rao, Tata McGraw Hill.2018.ISBN:0-07-058373-0\
2	M P Groover	A text book on CAD/CAM by Groover, Tata McGraw Hill.2018. ISBN: 978-81-775-8416-5
3	Web resources	"Artificial Intelligence for Design: A comprehensive Guide"

REFERENCE BOOKS		
1	D.T.Pham & S.S.Dimov	"Rapid Manufacturing" Springer-Verlag London, 2000
		Academic journals

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Summarize the concepts of CAD and CAM in production system. Outline the software configurations and types of modeling in CAD. Develop programs for creating graphic elements and perform 2D transformations. Illustrate exchange of modeling data and various types of formats.
CO2	Apply fundamentals of NC, CNC and DNC for automation. Explain the process of high speed machine tools and its accessories. Develop part program for turning, milling and drilling operations.
CO3	Illustrate different types of automation. Explain and analyze various production concepts and solve problems on various parameters of manufacturing to improve productivity. Explain and analyze types of automated flow lines to balance the process of manufacturing.
CO4	Summarize types of computerized process planning, MRP, capacity planning, group technology . Illustrate shop floor control and computerized inspection methods for quality assurance .
CO5	Summarize the applications of AI in CAD/CAM and Explain role of AI in CNC, Automation and robotics

Course Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	1										1	3		
CO 2	3	1										1	3		
CO 3	3	1										1	3		
CO 4	3											1	3		
CO 5	3											1	3		

Turbo Machinery

Contact Hours/ Week:	: 3	Credits :	3.0
Total Lecture Hours:	: 39	CIE Marks :	50
Sub. Code:	: S4MEE06	SEE Marks :	50

Course objectives:	
This course will enable students to:	
1.	Student should be able to understand different positive displacement machines like Pelton wheel, Francis and Kaplan turbines operation and applications.
2.	Learn energy transfer in Turbo machines, velocity triangles and Euler turbine equation.
3.	Learn energy transfer in power absorbing machines, velocity triangles and relation between utilization factor and degree of reaction.
4.	Learn Steam turbine velocity triangles, Compounding, degree of reaction, Utilization factor.
5.	Learn general analysis of Centrifugal compressor and Pumps, Concept of Axial compressor and Pumps.

UNIT I

Introduction: Definition of a turbo machine, Parts of a Turbo machine, Comparison with positive displacement machine; Classification of hydraulic turbines, discussions on various efficiencies of Pelton wheel, Francis turbines and Kaplan turbines. Specific speed of turbine. UNIT quantities. Problems concerned to these turbines (Numerical Problems).
08 Hours

UNIT II

Energy Transfer in power producing machines: Euler Turbine equation; Alternate form of Euler turbine equation -components of energy transfer; Degree of reaction; Effect of blade discharge angle on energy transfer and degree of reaction; velocity triangles for different values of degree of reaction; Utilization factor; Vane efficiency; Relation between utilization factor and degree of reaction; condition for maximum utilization factor -optimum blade speed ratio for different types of turbines (Numerical Problems).
08 Hours

UNIT III

Energy Transfer in Power absorbing machines: components of energy transfer; Degree of reaction; velocity triangles for different values of degree of reaction; Utilization factor; Vane efficiency; Relation between utilization factor and degree of reaction; General analysis of centrifugal and axial flow compressors. Effect of blade discharge angle on the performance. Theoretical head capacity relationship. Concept of centrifugal pumps and compressors. Concepts of axial flow compressors and pumps (Numerical Problems).
08 Hours

UNIT IV

Steam and Gas Turbines: Impulse Staging and need for compounding; Velocity and pressure compounding- condition for maximum utilization factor for multi stage turbine with equiangular blades; Condition for maximum blade efficiency, stage efficiency. Effects of Blade and Nozzle losses; Reaction staging; Reheat factor in turbine. (Numerical Problems)
08 Hours

UNIT V

Centrifugal Compressors and Pumps: Centrifugal Compressors- Classification; Expression for overall pressure ratio developed; Blade angles at impeller eye root and eye tip; Slip factor and power input factor; Width of the impeller channel; Compressibility effects-need for pre-whirl vanes; Diffuser design, Flow in the diffuser passage, determination of diffuser inlet vane angle, width and length of the diffuser passages; Surging of centrifugal compressors; Centrifugal Pumps, definition of terms used in the design of centrifugal pumps like manometric head, suction head,

delivery head, manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency, multistage centrifugal pumps design procedure (Numerical Problems).
07 Hours

Text Books:

1	V.Kadambi	An Introduction to Energy Conversion : Turbomachinery Vol. III Paperback – 1 January 2011, Publisher : New Age International Private Limited. ISBN-10 : 8122431895
2	S.M. Yahya	Turbines, Compressors & Fans, Publisher: McGraw Hill Education (1 July 2017), ISBN : 9780070707023
3	B K Venkanna	Fundamentals of Turbomachinery Publisher: Prentice Hall India Learning Private Limited (1 January 2009) ISBN: 9788120337756

Reference Books:

1	D. G. Shepherd	Principles of Turbo Machinery, The Macmillan Company (1964).
2	V. Ganesan	Gas Turbines, Tata McGraw-Hill Company Limited, 2 nd Edition (2002).
3	Fluid dynamics and turbo machines (Video lecture)	http://nptel.ac.in/courses/112106200
4	Basic principles of turbo machines (PPT NOTES)	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-1.html

Course Outcomes:

Upon completion of this course the student will be able to:

CO1	apply the knowledge of mathematics and engineering fundamentals to solve numericals on hydraulic turbines
CO2	Deduce the the Euler's turbine equation and solve numericals on power producing machine.
CO3	Deduce the Euler's turbine equation and solve numericals on power absorbing machine
CO4	Analyse the effects of factors affecting steam turbines turbine efficiency.
CO5	Able to analyse the performance of centrifugal pumps and compressors

Course Articulation Matrix:

POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSOs	
													I	II
CO1	2	1					1				2		2	2
CO2	2	1											1	2
CO3	2	1					1				2		1	2
CO4	2	1			2						2		1	2
CO5	2	1			2						2		2	2
CO6	2	1											1	2

Biology for Engineers

Contact Hours/ Week:	3+0+0 (L+T+P)	Credits:	3
Total Lecture Hours:	40	CIE Marks:	50
Sub. Code:	S4CCA01	SEE Marks:	50

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

Teaching-Learning Process (General Instructions)	
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.	
1	Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
2	Instructions with interactions in classroom lectures (physical/hybrid).
3	Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
4	Flipped classroom sessions (~10% of the classes).
5	Industrial visits, Guests talks and competitions for learning beyond the syllabus.
6	Students' participation through audio-video based content creation for the syllabus (as assignments).
7	Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.
8	Students' seminars (in solo or group) /oral presentations.

UNIT I

INTRODUCTION TO BIOLOGY: The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each), Properties and functions), vitamins and hormones.
8 Hours

UNIT II

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE): Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/ detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).
8 Hours

UNIT III

HUMAN ORGAN SYSTEMS AND BIO DESIGNS (QUALITATIVE): Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials,

bionic eye). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems).
8 Hours

UNIT IV

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE): Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes-hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).
8 Hours

UNIT V

TRENDS IN BIOENGINEERING (QUALITATIVE): Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self- healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).
8 Hours

TEXT BOOKS

1	Rajendra Singh C and Rathnakar Rao N	Biology for Engineers, Rajendra Singh C and Rathnakar Rao N Publishing, Bengaluru, 2023.
2	Krista Rompolski	Human Physiology, Stuart Fox, McGraw-Hill eBook. 16th Edition, 2022
3	Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K.,	Biology for Engineers, Tata McGraw-Hill, New Delhi, 2012.
4	Arthur T. Johnson	Biology for Engineers, CRC Press, Taylor and Francis, 2011
5	Leslie Cromwell	Biomedical Instrumentation, Prentice Hall 2011.
6	Sohini Singh and Tanu Allen	Biology for Engineers, Vayu Education of India, New Delhi, 2014.
7	Yoseph Bar-Cohen	Biomimetics: Nature-Based Innovation, 1st edition, 2012, CRC Press.
8	D. Floreano and C. Mattiussi	Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, MIT Press, 2008.
9	C R Sunilkumar, N Geetha A C Udayashankar	Bioremediation of heavy metals: bacterial participation, Lambert Academic Publishing, 2019.
10	Ibrahim Ozbolat	3D Bioprinting: Fundamentals, Principles and Applications, Academic Press, 2016.
11	Maria Rodriguez Mende	Electronic Noses and Tongues in Food Science, Academic Press, 2016

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

Course Outcomes:	
Upon completion of this course the student will be able to:	
CO1	Elucidate the basic biological concepts via relevant industrial applications and case studies.
CO2	Evaluate the principles of design and development, for exploring novel bioengineering projects.
CO3	Corroborate the concepts of biomimetics for specific requirements.
CO4	Think critically towards exploring innovative biobased solutions for socially relevant problems.
CO5	

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	2	2														3
	CO2	2	2	3													3
	CO3	2	2	3													3
	CO4	2	2														3
	CO5	2	2				2	2									3

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum

total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.
- Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks

Universal Human Values

Contact Hours/ Week:	1+0+0+0 (LTPS)	Credits:	1.0
Total Lecture Hours:	13	CIE Marks:	50
Sub. Code:	SHS02	SEE Marks:	50

Course objectives: This course will enable students to: Universal Human Values (conducted during induction programme)	
1.	.Understanding of self-exploration about themselves (human beings), family, society and nature/existence.
2.	Appreciating the harmony in the human being, family, society and nature/existence
3.	Strengthening holistic perception of co-existence and mutual fulfilment among the four orders of nature.

UNIT I

Understanding Harmony in the Human Being - Harmony in self

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'; Understanding the needs of Self ('I') and 'Body' - happiness and physical facility; Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer); Understanding the characteristics and activities of 'I' and harmony in 'I'.

3 Hours

UNIT II

Understanding Harmony in self and body

Understanding the harmony of 'I' with the Body: Sanyam and Health, correct appraisal of Physical needs, meaning of Prosperity in detail, Include discussions to differentiate between i) Prosperity and accumulation. ii) Ensuring health vs dealing with disease.

2 Hours

UNIT III

Understanding Harmony in the Family - Harmony in Human-Human Relationship

Understanding values in human - human relationship, meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness, Trust and Respect as the foundational values of relationship; Understanding the meaning of Trust, Difference between intention and competence; Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.

3 Hours

UNIT IV

Understanding Harmony in Society and Nature

Understanding the harmony in the society (society being an extension of family)- Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Understanding the harmony in the Nature; Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.

2 Hours

UNIT V

Understanding Harmony in all levels of Existence

Understanding Existence as Co-existence of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence. Include discussions on-human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

3 Hours

TEXT BOOKS

1	Gaur, R.R. & Sangal R	'Foundation Course in Human Values and Professional Ethics; Presenting a universal approach to value education through self-exploration', Excel Books, Bangalore, 2016, ISBN: 978-8-174-46781-2
---	-----------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

REFERENCE BOOKS:		
1	Tripathi A.N.	'Human Values', New Age International Publisher, 2003, ISBN: 81-224-1426-5

ONLINE RESOURCES	
1	http://www.storyofstuff.com
2	https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
3	https://fdp-si.aicte-india.org/8dayUHV_download.php
4	https://www.youtube.com/watch?v=8ovkLRYXijE
5	https://www.youtube.com/watch?v=OgdNx0X923I

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Become more aware of themselves, and their surroundings (family, society, nature)
CO2	Become more responsible in life, and value human relationships and human society
CO3	Have better critical ability in handling problems and in finding sustainable solutions

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1						1		3								
	CO2						1		3								
	CO3						1		3								
	Overall level						1		3								

Evaluation Pattern:

Two Tests of 25 marks each and 45 minutes duration

SEE for 50 marks and examination duration is 90 minutes

Description	Schedule	Duration (min)	Conducted for	Reduced to
Test-1	7 th Week	45	25 marks	25 marks
Test-2	14 th Week	45	25 marks	25 marks
CIE			50 marks	50 marks
SEE		90	50 marks	50 marks
Total			100 marks	100 marks

Question Paper Pattern

CIE: CIE pattern may be hybrid type with MCQs and descriptive questions.

- 10 Marks MCQs
- 3 descriptive questions of 5 marks each
- All the questions are compulsory

SEE: SEE pattern may also be hybrid type with MCQs and descriptive questions.

- 20 Marks MCQs
- 1 descriptive question of 10 marks from each of the units (total 3 questions)
or
2 questions of 5 marks from each of the units (total 6 questions)
- All the questions are compulsory

Introduction to Data Analytics

Contact Hours/ Week:	0+0+2 (L+T+P)	Credits:	1.0
Total Lecture Hours:	26	CIE Marks:	50
Sub. Code:	S4CCA04 (AEC)	SEE Marks:	50

Course objectives: This course will enable students to:	
1.	To understand Numpy, Pandas and Matplot library
2.	To understand basics of statistics
3.	To learn the basic of decision tree algorithm.
4.	To understand random forest algorithm and Anova
5.	To use Python data structures.
6.	To use excel in data analytics

Experiments	
1	Use Numpy to create single and multi-dimensional array and perform various operations using Python.
2	Use Pandas to access dataset, cleaning, manipulate data and analyze using Python
3	Use matplotlib library to plot graph for data visualization using Python
4	Determine probability, sampling and sampling distribution using Python
5	Determine frequency distributions, variability, average, and standard deviation using Python
6	Draw normal curves, correlation, correlation coefficient and scatter plots using Python
7	Implement and analyze Linear regression in Python (Single variable & Multivariable)
8	Implement and analyze Logistic regression in Python
9	Implement and analyze Decision tree algorithm in Python
10	Implement and analyze Random Forest algorithm in Python
26 Hours	

TEXT BOOKS		
1	McKinney	W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc."
2	Swaroop, C. H.	(2003). A Byte of Python. Python Tutorial.
3	Ken Black	Sixth Editing. Business Statistics for Contemporary Decision Making. "John Wiley & Sons, Inc"

ONLINE RESOURCES:	
1	https://www.simplilearn.com/tutorials/data-analytics-tutorial/data-analytics-with-python
2	https://www.youtube.com/watch?v=GPVsHOIRBBI&ab_channel=freeCodeCamp.org

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Analyze data using tools and represent for visualization
CO2	: Implement various statistical methods.
CO3	Understand and use decision tree and random forest algorithm
CO4	Understand and Implement T test and Anova

Course Articulation Matrix

		POs											PSOs				
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1	3	2			2											
	CO2	3	2			2											
	CO3	3	2			2											
	CO4	3	2			2											
	CO5	3	2			2											

Introduction to Design & Manufacturing

Contact Hours/ Week:	1+0+0 (L+T+P)	Credits:	1.0
Total Lecture Hours:	13	CIE Marks:	50
Sub. Code:	S4CCA05 (AEC)	SEE Marks:	50

Course objectives:	
This course will enable students to:	
1.	To improve the visualisation skills and understand the conventions used in engineering drawing.
2.	To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.
3.	To impart fundamental knowledge of drawing of different machine parts.
4.	To enable the students with concepts of dimensioning and standards related to drawings.
5.	To enable the students to draw the assembly of various machine components.
6.	To enable the students on limits, tolerance and fits and indicate them on machine drawings.

UNIT I

<p>Introduction to Computer Aided Sketching Review of graphic interface of the software. Review of 2D Sketching, Parametric Solid Modeling, Assembly creation and product rendering.</p> <p>Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. (<i>Above topics to be studied as a review</i>)</p> <p>Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.</p> <p>The basics of sketching and modelling:</p> <p>Create a basic sketch - Profile Tools, Curve Tools, Editing Tools, Operation Tools, Constraints, construction geometries and adding dimensions. Part- Solid from sketches, Solid from surfaces, modify Tools, Operation Tools.</p>	2 Hours
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------

UNIT II

<p>Exploring design tools for production:</p> <p>Create draft during a feature - Create draft as a feature - Add ribs and plastic supports - Analyze draft on a design - Create holes and threads - Use a coil feature - Mirrors and patterns - Surface creation for complex geometry - Use surfaces to replace faces - Use surfaces to split bodies and faces - Practice exercise</p>	2 Hours
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------

UNIT III

<p>The Basics of Assemblies</p> <p>The different ways to create components - Use scripts to create gears - Component color swatch and color cycling - Use McMaster-Carr parts in a design - Copy, paste, and paste new.</p> <p>Distributed designs - Create as-built joints - Create joints - Joint origins and midplane joints - Drive joints and motion studies - Interference detection and contact sets - Isolation and opacity control - Create groups and organize a timeline - Practice exercise.</p>	3 Hours
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------

UNIT IV	
Assembly Drawings: (Part drawings shall be given)	
Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views, Add geometry and dimensions to a drawing, Add GD & T text, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats.	
<ol style="list-style-type: none"> 1. Innovated bottle design for sustainability 2. Engine Piston 3. Design for Injection Molding <ol style="list-style-type: none"> 1. Plummer block (Pedestal Bearing) I.C. Engine connecting rod 	
6 Hours	

TEXT BOOKS		
1	N.D.Bhat & V.M.Panchal	‘Machine Drawing’, Published by Charotar Publishing House, 1999.
2	K.R. Gopala Krishna	‘Machine Drawing’, Subhash publication.

REFERENCE BOOKS		
1	S. Trymbakaa Murthy	“A Text Book of Computer Aided Machine Drawing”, CBS Publishers, New Delhi, 2007.
2	N.Siddeshwar, P.Kannaih, V.V.S.	‘Machine Drawing’, Sastri, published by Tata Mc.Grawhill, 2006.
3	K L Narayana, P Kannaiah, K Venkata Reddy,	“Machine Drawing”, New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
4	Ajeet Singh,	“MACHINE DRAWING”, Tata McGraw-Hill Education,, ISBN: 9781259084607, 2012

ONLINE RESOURCES	
1	https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
2	https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional

Course Outcomes: Upon completion of this course the student will be able to:	
CO1	Demonstrate their visualization skills
CO2	Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies. Make component drawings.
CO3	Produce the assembly drawings using part drawings.
CO4	Engage in lifelong learning using sketching and drawing as communication tool.

Course Articulation Matrix

		POs												PSOs			
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
COs	CO1																
	CO2																
	CO3																
	CO4																
	CO5																