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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

IV Semester
Scheme & Syllabus of B.E. Programme
Mechanical Engineering
(2024 Scheme)

Core Values

Spiritual, Judicious, Commitment, Integrity, Trustworthy



AICTE | NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300 | NBA | A+ NAAC | QS I-GAUGE GOLD | INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating

SJC INSTITUTE OF TECHNOLOGY, CHIKKABALLAPURA

An Autonomous institution Under VTUfrom 2024 – 2025

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SCHEME OF TEACHING AND EXAMINATION – B.E. – Mechanical Engineering

(Applicable for students admitted from the Academic Year 2024-25 and onwards)

4th Semester

Mechanical Engineering													
Sl. No.	**Course Code**	**Course Title**	**Course Type**	**TD/ PSB**	**Teaching Hours / Week**			**Examination**					
					L	**T**	**P**	**SEE Duration (Hrs)**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**
1	BME401	Engineering Thermodynamics	PCC	ME	3	0	0	**3**	**50**	**50**	**100**	**3**
2	BME402	Machining Science and Metrology	IPCC	ME	3	0	2	**3**	**50**	**50**	**100**	**4**
3	BME403	Fluid Mechanics	IPCC	ME	3	0	2	**3**	**50**	**50**	**100**	**4**
4	BBI404	Biology for Engineers	BSC	CHE	2	0	0	**3**	**50**	**50**	**100**	**2**
5	BMEL405	Mechanical measurement and Metrology Lab	PCCL	ME	0	0	2	**3**	**50**	**50**	**100**	**1**
6	BME406x	ESC/ETC/PLC	ESC	ME	If the course is a Theory: 3	0	0	**3**	**50**	**50**	**100**	**3**
					If the course is a Laboratory: 2	0	2					
7	BUH407	Universal Human Values	UHV	ANY DEPT	1	0	0	**1**	**50**	**50**	**100**	**1**
8	BCS408x	Ability Enhancement Course/Skill Enhancement Course – IV	AEC/ SEC	ME	If the course is a Theory: 1	0	0	**1**	**50**	**50**	**100**	**1**
					If the course is a Laboratory: 0	0	2	**2**				

9	BMP409	Metaphysical Science	HSSMC	ANY DEPT	1	0	0	**1**	**50**	**50**	**100**	**1**

10	BNS410	National Service Scheme (NSS)	NCMC	NSS Coordinator	0	0	2	-	**100**	-	**100**	**0**
	BPE410	Physical Education (PE) (Sports and Athletics)		Physical Education Director								
	BYO410	Yoga		Yoga Teacher								
	BMU410	Music		Music Teacher								
11	BCE411	Competency Enhancement Course-2	NCMC	CDCAC	0	2	0	-	**100**	-	**100**	**0**
									650	**450**	**1100**	**20**

ASC: Applied Science Course, 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, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Engineering Science Course (ESC/ETC/PLC) (Note- Student should opt for the course which should not be similar to the course opted in 1st Year)

Course Code	Course Name	Course Code	Course Name
BME406A	Non-Traditional Machining	BME406C	Solar Energy
BME406B	Industrial IoT	BME406D	Mechatronics

Ability Enhancement Course/Skill Enhancement Course – IV

Course Code	Course Name	Course Code	Course Name
BME408A	3D Printing	BME408C	Introduction to AI & ML
BME408B	MATLAB for Mechanical Engineers	BME408D	Introduction to Data Analytics

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's 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.) 2024-25 may please be referred.

National Service Scheme /Physical Education/Yoga/Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga and Music with the concerned coordinator / teacher of the course during the first week of 3rd semester. Activities shall be carried out between 3rd semester to the 6th 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, Yoga and Music 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.

Semester: IV						
Engineering Thermodynamics						
Course Code	**:**	BME401		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Physics, Mathematics and Chemistry**
Knowledge on Fundamental Concepts	**Control volume and mass, Calculus.**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Learn about thermodynamic system and its equilibrium, Understand various forms of energy, work and heat transfer
CLO2	understand the applications of the first and second laws of Thermodynamics to various gas processes and cycles
CLO3	understand the various Air standard and Gas power cycles and their Performance
CL04	Understand the concepts related to Refrigeration.
CL05	Know the basics of Air conditioning system.

Module – 1	**08 Hrs.**
Basics of Thermodynamic: definition and scope, Microscopic and Macroscopic approaches., intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer. Numerical on temperature scales. **Textbook-1: Chapter1,2**	
Module – 2	**08 Hrs.**
Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. No numerical. **First Law of Thermodynamics:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Extension of the First law to control volume,	

steady flow energy equation(SFEE), important applications (No numerical)
Textbook-1: Chapter 3,4,5

Module – 3	**08 Hrs.**

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine, schematic representation, importance and superiority of a reversible heat engine and irreversible processes, internal and external reversibility. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems
Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems
Textbook-1: Chapter6,7

Module – 4	**08 Hrs.**

Gas Power Cycles: Air standard cycles; Carnot, Otto, Diesel, Dual and Stirling cycles, p-v and T-s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles.
Gas turbine (Brayton**) cycle**; description and analysis. Regenerative gas turbine cycle. Inter-cooling and reheating in gas turbine cycles. Jet propulsion: Introduction to the principles of jet propulsion. Simple problems
Textbook-1: Chapter13 and Textbook-2: Chapter11

Module – 5	**08 Hrs.**

Refrigeration Cycles: Vapor compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Any one case study on cold storage or industrial refrigerator..

Psychometrics and Air-conditioning Systems: Properties of Atmospheric air, and Psychometric properties of Air, Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.

Textbook-2: Chapter11 and Textbook-1: Chapter15

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore the fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems.
CO2	Evaluate the feasibility of cyclic and non-cyclic processes using First and second law of thermodynamics
CO3	Apply the knowledge of entropy, to solve numerical problems related to thermal devices.
CO4	Analyze the performance of Air standard cycles and gas turbine cycles.
CO5	Interpret the principles, applications of refrigeration and air conditioning systems.

Text Books	
1	Basic and Applied Thermodynamics, P K Nag, 2nd Ed., Tata McGraw Hill Publications, 2017.
2	A textbook of Engineering Thermodynamics, R K Rajput, Fifth edition, Laxmi Publications, 2019.
3	Fundamentals of Thermodynamics by Claus Borgnakke and Richard E Sonntag, 8th edition, Wiley India Edition, 2020
4	Thermodynamics, An Engineering Approach, by Yunus A Cenegal, Michael A Boles, and Mehmet Kanoglu, 9th Edition, Tata McGraw Hill publications, 2019

Reference Books	
1	Engineering Thermodynamics, J B Jones and G A Hawkins, John Wiley and sons, 1986.
2	An Introduction to Thermodynamics, Y V C Rao, Wiley Eastern, 2003
3	Applications of Thermodynamics, Dr V Kadambi and Dr T R Seetharam, Wiley Publications, 2018

Web links and Video Lectures (e-Resources)	
1	https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
2	https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne
3	https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QISf55zy2Nlqr5F09oO2qcIwNNfrZ&index=3
4	https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUry7
5	https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2								1		
CO2	3	3	1								1		
CO3	3	3	2								1		
CO4	3	3	2		2		2		1		1	2	2
CO5	3	3	2		2		2		1		1	2	2

Semester: IV						
Machining Science & Metrology						
Course Code	**:**	BME402		**Credits**	**:**	04
Hours/Week(L:T:P)	**:**	3:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	40L + 12P Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	IPCC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**ELEMENTS OF MECHANICAL ENGINEERING**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**YES**

Course Learning Objectives: This course will enable the students	
CLO1	Enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
CLO2	Exploit the basic principles of measurements.
CLO3	Develop the knowledge on mechanics of machining process and effect of various parameters on machining.
CLO4	Knowledge about different machine tools to produce components having different shape sand sizes.
CLO5	Enhance the knowledge pertaining to gauge, comparator and angular measurement.

Module – 1	**08 Hrs**
Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation. Cutting tool materials and applications. **Introduction to basic metal cutting machine tools: Lathe-** Parts of lathe machine, accessories of lathe Machine and various operations carried out on lathe. Kinematics of lathe. Turret and Capstan lathe. **Text Book 1 :Ch 1 Text Book 2 :Ch 1 Text Book 5 :Ch 1**	
Module – 2	**08 Hrs**
Introduction: Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wave length standard, sub division of standards, numerical problems on length calibration. **Line & End Standards:** Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges. **Systems of Limits, Fits & Tolerance:** Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation. **Text Book 1 :Ch 2 Text Book 2 :Ch 2 Text Book 4 :Ch 2**	

Module – 3	08 Hrs
Thermal aspects, Tool wear, and Machinability **Temperature in Metal Cutting**: Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures Tool life and tool Wear: progressive tool wear; **Forms of wear in metal cutting:** crater wear, flank wear, tool-life criteria, cutting tool materials: basic requirements of tool materials, major classes of tool materials: high-speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings; the work material and its machinability **Cutting fluids:** Action of coolants and application of cutting fluids. **Text Book 1 :Ch 3 Text Book 2 :Ch 3 Text Book 3 :Ch 3**	
Module – 4	**08 Hrs**
Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), milling cutter nomenclature, various milling operations, calculation of machining time. **Indexing:** Need of indexing Simple, compound and differential indexing calculations. Simple numerical on indexing. **Shaping, Slotting and Planning Machines Tools:** Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter Difference between shaping and planning operations. **Drilling Machines:** Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time. **Grinding**: Grinding operation, classification of grinding processes: cylindrical, surface & centerless grinding **Text Book 1 :Ch 4 Text Book 2 :Ch 4 Text Book3 :Ch 4**	
Module – 5	**08 Hrs**
Gauges: Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems. **Comparators:** Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra-optimeter, Solex air gauge, ultrasonic gauges, LVDT. **Angular Measurements:** Bevel protractor, sine bar, angular gauges, numerical on building of angles. **Text Book 1 :Ch 5 Text Book 2 :Ch 5 Text Book 5 :Ch 5**	

PRACTICAL COMPONENT OF IPCC

Sl No.	Experiments
1	Preparation of one model on lathe involving - Plain turning, Facing, Knurling, Drilling, Boring, Internal Thread cuts and Eccentric turning.
2	Preparation of One model on lathe involving - Plain turning, Facing , Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
3	One Job, Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
4	Cutting of Gear Teeth using Milling Machine.
5	Simple operations and One Job on the drilling and grinding machine.
6	Experiment on anyone advanced machining process

Course Outcomes: After completing the course, the students will be able	
CO1	Analyze various cutting parameters in metal cutting.
CO2	Differentiate the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design.
CO3	Identify the concept of Temperature in Metal Cutting, forms of wear in metal cutting and Cutting fluids.
CO4	Illustrate the construction of machines & machine tools and compute the machining time of various operations.
CO5	Interpret the working principle of different types of comparators, gauges, angular Measurements.

Text Books	
1	Metal Cutting Principles, Oxford University Press. Shaw, M C, (2014)
2	Advanced Methods of Machining, Springer. McGeough, J A, (1988),
3	Fundamentals of Machining and Machine Tools, CRC Press. Boothroyd, G., and Knight, W. A.
4	Machining and Machine Tools, Wiley India. Chattopadhyay, A B, (2013)
5	Manufacturing Technology II, Tata McGraw Hill. Rao P. N.

Web links and Video Lectures (e-Resources)	
1	V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: http://nptel.ac.in/courses/112104028/
2	U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: http://nptel.ac.in/courses/112103248/
3	A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, https://nptel.ac.in/courses/112/105/112105126/

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2				1			1	1		3	
CO2	3	2										3	
CO3	3	2										3	
CO4	2				1							2	
CO5	2											2	

Semester: IV						
Fluid Mechanics						
Course Code	:	BME403		**Credits**	:	04
Hours/Week(L:T:P)	:	3:0:2		**CIE**	:	50 Marks
Total Hours	:	40T+12P Hrs		**SEE**	:	50 Marks
Course Type	:	IPCC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	**Physics and Mathematics**
Knowledge on Fundamental Concepts	**Integration and differentiation.**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Have a knowledge of the basic properties of fluids and understand the continuum approximation.
CLO2	Calculate the forces exerted by a fluid at rest on submerged surfaces
CLO3	Understand the flow characteristic and dynamics of flow field for various engineering applications.
CL04	Know how velocity changes and energy transfers in fluid flows are related to forces and to understand why designing for minimum loss of energy in fluid flows is so important.
CL05	Discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.

Module – 1	**08 Hrs.**
Basics of fluids: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapor pressure, compressibility and bulk modulus. Concept of continuum, types of fluids, 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 **Fluid Statics:** Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. No numerical **Textbook-1: Chapter 1,2,3**	
Module – 2	**08 Hrs.**
Fluid Kinematics: Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates, simple Problems. **Textbook-1: Chapter 5**	

Module – 3	08 Hrs.
Fluid Dynamics: 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, pitot tube, rectangular and triangular notch, orifices etc., related numerical. **Loss of head due to friction in pipes:** Major and minor losses, pipes in series and parallel. **Textbook-1: Chapter 6,8,11**	
Module – 4	**08 Hrs.**
Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aero foils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control. **Dimensional Analysis:** Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude. **Textbook-1: Chapter 12,13,14**	
Module – 5	**08 Hrs.**
Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks. **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, applications **Textbook-1: Chapter 15 and Textbook-4: Chapter 1**	

PRACTICAL COMPONENT OF IPCC (May cover all / major modules)

Sl.NO	Experiments
1	Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer.
2	Measurement of pressure using different Manometers for high and low pressure measurements (Manometers using different monomeric fluids).
3	Determination of head loss in pipes and pipe fittings having different diameters, different materials and different roughness
4	Reynolds apparatus to measure critical Reynolds number for pipe flows
5	Determine co-efficient of discharge of venture meter, orifice meter and notches by the principle of Bernoulli equation.
6	Impact of jet on flat and curved plates
7	Determination of drag and lift co-efficient of standard objects using wind tunnel. **Can be Demo experiments for CIE**
8	Use any CFD package to study the flow over aero foil/cylinder **Can be Demo experiments for CIE**

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore the properties of fluids and hydrostatics forces acting on immersed body.
CO2	Formulate and solve equations of the control volume for fluid flow systems without considering forces.
CO3	Analyze the fluid flow in various flow measuring devices and Calculate resistance to flow of incompressible fluids through closed conduits
CO4	Develop basic knowledge of dimensional analysis, similitude and boundary layer concept.
CO5	Illustrate and explain the basic concept of compressible fluid flow and CFD

Text Books	
1	Fluid Mechanics and Hydraulic Machines, 2017,Dr. R K Bansal, Laxmi publishers,ISBN:978-81-318-0815-3
2	Fluid Mechanics,2015, Yunus A Cengel, McGraw- Hill,Third Edition, ISBN:978933920468
3	Fluid Mechanics, Frank M White., (2016), 8thEdition , McGraw-Hill
4	Computational fluid dynamics,2015 ,Anderson, Third edition,yes dee publishing pvt.Ltd,

Reference Books	
1	Introduction to Fluid Mechanics, Fox, R. W., Pitchard,P.J.,and McDonald, A. T.(2010), 7thEdition, John Wiley & Sons Inc.
2	Fundamentals of Fluid Mechanics, Munson, Young, Okiishi & Hebsch, , 7th Edition John Wiley Publications.

Web links and Video Lectures (e-Resources)	
1	Web links and Video Lectures (e-Resources): • Nptel.ac.in • VTU, E- learning • MOOCS • Open courseware
2	http://www.mhhe.com/cengel/fm3
3	http://www.mhhe.com/white/fm8/sie

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2								1		
CO2	3	3	2								1		
CO3	3	3	2		1					1	1	2	2
CO4	3	3	2		1					1	1		
CO5	3	3	2		2					1	1	2	2

Semester: IV						
Mechanical Measurements and Metrology Lab						
Course Code	**:**	BMEL405		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:2:0		**CIE**	**:**	50 Marks
Total Hours	**:**	30 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	PCCL		**SEE Duration**	**:**	2 Hours

Prerequisites:	
Courses	**Measurements and Metrology**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**Yes**

Course Learning Objectives: This course will enable the students to	
CLO1	*Calibrate* pressure gauges, thermocouples, LVDTs, and load cells using standard procedures to *verify* measurement accuracy and error analysis.
CLO2	*Determine* material properties (e.g., modulus of elasticity) and geometric parameters (angles, screw threads) using strain gauges, optical projectors, and precision tools (sine bar, bevel protractor).
CLO3	*Compare* the accuracy of different measurement techniques (e.g., gear tooth vernier vs. micrometer) and *justify* the selection of methods for specific applications.
CLO4	*Design* a calibration protocol for an instrument (e.g., LVDT or thermocouple) and *document* uncertainty sources in measurements.
CLO5	*Enumarate* the working principles of mechanical comparators, optical tools, and strain gauges in metrology applications.

PRACTICAL COMPONENT OF IPCC

Sl No.	**Experiments**
	MECHANICAL MEASUREMENTS
1	Calibration of i) Pressure Gauge
	ii) Thermocouple
	iii) LVDT
	iv) Load cell
2	Determination of modulus of elasticity of a mild steel specimen using strain gauges.
	METROLOGY
1	Measurements using i) Optical Projector
	ii) Toolmaker Microscope.

2	Measurement of angle using i) Sine Center
	ii) Sine bar
	iii) bevel protractor.
Demonstration Experiments (For CIE)	
1	Measurements of Screw thread Parameters using i) two wire method.
	ii) Three-wire method.
2	Measurement of gear tooth profile using i) Gear tooth Vernier.
	ii) Gear tooth micrometer.
3	Measurements of Surface roughness using Mechanical Comparator.

Course Outcomes: After completing the course, the students will be able to	
CO1	Perform calibration of instruments (pressure gauge, thermocouple, etc.) and analyze measurement errors against standard references.
CO2	Compare angle measurement methods (Sine Bar vs. Bevel Protractor) and justify the optimal technique for a given tolerance requirement.
CO3	Operate optical measurement tools (projector, microscope) to evaluate dimensional accuracy of engineering components.
CO4	Design a measurement protocol for screw threads/gear teeth and critique the impact of wire selection on measurement uncertainty.
CO5	Interpret surface roughness data and correlate it with manufacturing process parameters (e.g., machining speed).

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
3	3	2										2	
3	3	2	1									2	
CO3	3	1										2	
CO4	3											2	
CO5	3											2	

Semester:IV						
Non Traditional Machining						
Course Code	**:**	BME406A		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	ESC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Machining Science**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Compare modern machining processes (e.g., ECM, EDM) and classify their industrial applications based on material, precision, and cost.
CLO2	Analyze the limitations of conventional machining and justify the use of non-conventional methods for specific materials (e.g., composites, ceramics).
CLO3	Operate simulation tools/Virtual Labs to demonstrate the working principle of non-traditional machines (e.g., laser cutter, waterjet).
CLO4	Optimize process parameters (e.g., feed rate, power) for non-traditional machining and predict their impact on surface finish/material removal rate.
CLO5	Design a comparative chart contrasting energy types (thermal, electrical, chemical) used in different processes and their efficiency.

Module – 1	**08 Hrs**

Introduction to Non-traditional machining

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Textbook-1: Chapter1 Textbook-2: Chapter1

Module – 2	**08 Hrs**

Ultrasonic Machining (USM):

Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM):

Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics- Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Textbook-1: Chapter2 Textbook-2: Chapter2

Module – 3	**08 Hrs**

Electrochemical machining (ECM):

Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH. **Chemical Machining (CHM):**

Elements of the process, Resists (maskants), Etchants. Types of chemical machining process- chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Textbook-1: Chapter3 Textbook-2: Chapter3

Module – 4	**08 Hrs**

Electrical Discharge Machining (EDM):

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

Plasma Arc Machining (PAM):

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

Textbook-1: Chapter4 Textbook-2: Chapter4 Textbook-3: Chapter4

Module – 5	**08 Hrs**

Laser Beam Machining (LBM):

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

Electron Beam Machining (EBM):

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Textbook-1: Chapter5

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe non-traditional machining process and compare with Traditional machining process. Recognize the need for Non-traditional machining process.
CO2	Describe the constructional features, performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.
CO3	Characterize the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.
CO4	Illustrate the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM.
CO5	Identify industrial applications of LBM and EBM in fields like aerospace, medical, and micro-machining.

Text Books	
1	Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000.
2	Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd Edition, Michigan, 1984.
3	Non Traditional Manufacturing Processes, by Gary F Benedict, Taylor & Francis.

Reference Books	
1	Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001
2	New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
3	Modern Machining process, Aditya, 2002.
4	Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
5	Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM)
6	Gary F. Benedict, ―Nontraditional manufacturing processes‖, Marcel Dekker, Inc. 1987.

Web links and Video Lectures (e-Resources)	
1	https://nptel.ac.in/courses/112105127

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1			1							1	
CO2	3	1		1			1				2	1	
CO3	2	2										1	
CO4	3	1	2	1	2		1				1	1	
CO5	2	2		1	2						1	1	

Semester: IV						
Industrial IoT						
Course Code	**:**	BME406B		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	ESC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Internet of Things**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	*Differentiate* between IoT and IIoT architectures by *comparing* their technological stacks, security requirements, and industrial use cases, and *explain* how IIoT enables Industry 4.0.
CLO2	*Map* data flows in an IIoT-enabled factory by *designing* a schematic of edge-to-cloud data pipelines and *evaluating* the roles of controllers (PLC, SCADA, microcontrollers) in process automation.
CLO3	*Propose* a business model for an IIoT solution in a target industry (e.g., mining or automotive) by *assessing* the I-IRA framework and *justifying* its alignment with industry-specific challenges.
CLO4	*Develop* a predictive maintenance solution for a manufacturing plant by *integrating* IIoT sensors, analytics, and AI, and *critique* its impact on operational efficiency.
CLO5	*Troubleshoot* a simulated IIoT network failure by *diagnosing* issues in the CIM pyramid layers (field, control, enterprise) and *recommending* resilience strategies.

Module – 1	**08 Hrs**
Introduction to Industrial IoT ; IoT background, History and definition, IoT enabling factors, IoT use cases, IoT key technologies, I-IoT – Fourth industrial revolution, use cases of the I-IoT, Similarities and differences of IoT and I-IoT, IoT analytics and Artificial Intelligence. **Textbook-1: Chapter1 Textbook-2: Chapter1**	
Module – 2	**08 Hrs**
Industrial process and devices: Industrial process, automation in the industrial process, control and measurement systems, types of industrial process, The CIM pyramid, CIM pyramid architecture – devices and networks, CIM network. **Textbook-1: Chapter2 Textbook-2: Chapter2**	

Module – 3	08 Hrs
Industrial data flow and devices: The I-IoT data flow, The Industrial IoT data flow in a factory, The edge device, and The Industrial IoT data flow in the cloud. Industrial data flow and devices, The I-IoT data flow in the factory, I-IoT data flow measurement and actuator chain, controllers: Introduction to microcontroller, PLC and SCADA. **Textbook-1: Chapter3 Textbook-2: Chapter3**	
Module – 4	**08 Hrs**
Business models and reference architecture of I-IOT: Business models of IOT and IIOT, Business opportunities in I-IOT, categorization of business opportunities in I-IOT, reference architecture of IOT and I-IOT, categorization of reference architecture in I-IOT, I-IRA framework, categorization of I-IRA frame works. **Textbook-1: Chapter4**	
Module – 5	**08 Hrs**
Industrial IoT- Applications: The manufacturing industry, Automotive industry and Mining industry: Background of the industries, challenges, Industrial IoT as a solution, Benefits. **Textbook-1: Chapter5 Textbook-2: Chapter5**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Exploit the evolution of IoT to IIoT, differentiate their architectures, and justify IIoT's role in Industry 4.0 with use cases.
CO2	Model industrial data flows (edge-to-cloud) and evaluate the roles of devices (PLCs, SCADA) in automation systems.
CO3	Design an IIoT reference architecture (e.g., I-IRA) for a given industry scenario and categorize business opportunities.
CO4	Propose IIoT solutions to industry-specific challenges (e.g., predictive maintenance in mining) and assess their benefits.
CO5	Integrate AI/analytics into IIoT systems to optimize process efficiency and predict failures using real-time data.

Text Books	
1	Hands on Industrial Internet of Things by GiacomoVeneri and Antonio Capasso, Packt publisher. 2018 edition..
2	Introduction to Industrial internet of things and industry 4.0, Sudeep Mishra, Chandana Roy and Anandarup Mukherjee, CRC press, 2021.

Reference Books	
1	Internet of Things (A Hands-on-Approach) 1st Edition by ArshdeepBahga and Vijay Madisetti, VPT publisher 2014,.
2	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications by Daniel Minoli, Wiley; 1st edition (10 July 2013).
3	Getting Started for internet of things with launch pad and ESP8266, River Publishers; 1st edition (31 March 2019), ISBN-13 : 978-8770220682.

Web links and Video Lectures (e-Resources)	
1	Introduction to Industry 4.0 and Industrial IOT **https://archive.nptel.ac.in/courses/106/105/106105195/**

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2											2	
CO2	1	2										1	2
CO3	1			2								1	
CO4	1	2										1	
CO5	1											1	

Semester: IV						
Solar Energy						
Course Code	**:**	BME406C		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	ESC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Elements of Mechanical Engineering
Knowledge on Fundamental Concepts	Energy, Types and Forms of Energy
Knowledge on Connected Tools (If any)	NIL

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the Energy and its sources, importance, utilizations and production and consumption of energy resources.
CLO2	Introduce the concepts and principles of solar energy, its radiation, collection, storage and application
CLO3	Analyze performance of flat plate collector by considering the thermodynamic properties.
CLO4	Study the photovoltaic effect and working principle of the system.
CL05	Economic analysis of the Solar plants.

Module – 1	**08 Hrs**
Introduction: Energy, Power, Types of Energy, Forms of Energy, Sources of Energy, Law of Conservation of energy, Energy conversion Technologies (Direct and Indirect), World's Production and reserves of commercial energy sources, India's production and reserves and Energy alternatives. Solar, thermal, photovoltaic. Water power, wind biomass, ocean temperature difference, tidal and waves, geothermal, tar sands and oil shale, nuclear (Brief descriptions); advantages and disadvantages, comparison (Qualitative and Quantitative). **Text Book 1: Ch 1 and Text Book 3: Ch 1**	
Module – 2	**08 Hrs**
Solar Radiation: Extra Terrestrial radiation, spectral distribution of extraterrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation. **Measurement of Solar Radiation:** Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. Solar radiation data. **Text Book 3: Ch 3**	
Module – 3	**08 Hrs**
Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expressions for the angle between the	

incident beam and the normal to a plane surface (No derivation) local apparent time, apparent motion of sun, day length, numerical problems.

Radiation Flux on a Tilted Surface: Beam, diffuse and reflected radiation, expression for flux on tilted surface (no derivations) numerical examples.

Text Book 1 : Ch 3 and Text Book 3: Ch 3 Ch 4

Module – 4	**08 Hrs**

Solar Thermal Systems: Flat plate collector, Evacuated Tubular Collector, Solar air collector, Solar concentrator, Solar distillation, Solar cooker, Thermal energy storage systems, Solar Pond, Solar Chimney (Tower).

Performance Analysis of Liquid Flat Plate Collectors: General description, collector geometry, selective surface (qualitative discussion) basic energy-balance equation, stagnation temperature, transmissivity of the cover system, transmissivity – absorptivity product, numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided). Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided). Effect of various parameters on the collector performance; collector orientation, selective surface, fluid inlet temperature, number covers, dust.

Text Book 1 : Ch 4 and Text Book 3: Ch 4

Module – 5	**08 Hrs**

Solar Photovoltaic Systems: Introduction, Solar cell Fundamentals, Characteristics and classification, Solar cell: Module, panel and array construction.

Types of solar power plants: grid tied, offgrid, and hybrid systems, Design considerations for solar power plants: site selection, orientation, and shading analysis, PV system components and their functionalities, Operation, maintenance, and performance monitoring of solar power plants.

Economic Analysis: Initial and Annual costs, Definitions, Present worth calculations, Repayment of loan in equal annual installments, Annual solar savings, Cumulative solar savings and life cycle savings, Payback period, concluding remarks and Problems.

Text Book 3: Ch 6 and Ch 14

Course Outcomes: After completing the course, the students will be able to	
CO1	Elucidate the basics of Energy and their sources, Conversion technologies, solar radiation and devices used in solar radiation measurement.
CO2	Illustrate the working principle of solar energy conversion devices.
CO3	Determine the intensity of solar radiation and efficiency on Flat and Tilted surfaces.
CO4	Analyze the transformation of solar energy sources into usable form by using different energy conversion system.
CO5	Evaluate the performance and economic analysis of solar energy conversion devices

Text Books	
1	Solar Energy -Principles, Thermal Collection & Storage, S.P.Sukhatme: Tata McGraw Hill Pub., New Delhi 1996..
2	Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, NewDelhi. 2003.
3	Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.

Reference Books	
1	Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016
2	Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
3	Renewable Energy Sources and Conversion Technology, N.K.Bansal, Manfred Kleeman&MechaelMeliss, Tata McGraw Hill, 2004
4	Non-Conventional Energy, Ashok V Desai, Wiley Estern Ltd, New Delhi, 2003.

Web links and Video Lectures (e-Resources)	
1	https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=2
2	https://www.youtube.com/watch?v=Og4LEc7SpdQ&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=3
3	https://www.youtube.com/watch?v=L3AEXdvtIkk&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=19
4	https://www.youtube.com/watch?v=TUu40kDqcEc&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=24
5	https://www.youtube.com/watch?v=k7LX0a67V8A&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=37

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3					2		3	2		2	3	
CO2	3					2		3	2			2	
CO3	2	3	3					2	2			2	
CO4	2	3	3	3				2	2	2		2	
CO5	2	3	3	3				2	2	3		2	

Semester: IV						
Mechatronics						
Course Code	**:**	BME406D		**Credits**	**:**	03
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	ESC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies
CLO2	To understand the evolution and development of Mechatronics as a discipline.
CLO3	To substantiate the need for interdisciplinary study in technology education
CLO4	To understand the applications of microprocessors in various systems and to know the functions of each element.
CLO5	To demonstrate the integration philosophy in view of Mechatronics technology and work efficiently in multidisciplinary teams.

Module – 1	**08 Hrs**
Introduction: Scope and elements of Mechatronics, Mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine. **Transducers and sensors:** Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors **Text book 1: Ch1, Ch2**	
Module – 2	**08 Hrs**
Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods. **Electro Mechanical Drives:** Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4quadrant servo drives, PWM's – Pulse Width Modulation **Text book 1: Ch3**	
Module – 3	**08 Hrs**

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

Text book 2: Ch3

Module – 4

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application. Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

Text book 1- Ch 4

Module – 5

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines – Machine Elements: Different types of guide ways, Linear Motion guide ways. Bearings: antifriction bearings, hydrostatic bearing and hydrodynamic bearing. Recirculating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

Text book 1- Ch 6, Ch7

Course Outcomes: After completing the course, the students will be able to	
CO1	**Illustrate** various Components of Mechatronic systems.
CO2	**Describe** the various control systems used in automation.
CO3	**Elucidate** the Fundamentals of Microprocessor, microprocessor, PLCs and their applications.
CO4	**Apply** the Principles of mechatronic system design to product design
CO5	**Build** simple mechatronic system through project-based learning and asses the team work of students.

Text Books:	
1	Mechatronics-Principles Concepts and Applications, Nitaigour Premchand Mahalik, Tata McGraw Hill, 1st Edition 2003.
2	Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education, 1st Edition 2005.

Reference Books:	
1	Mechatronics System Design, Devdas Shetty, Richard A. Kolk, Cengage publishers, Second edition.
2	Mechatronics: Integrated Mechanical Electronic Systems, K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram, Wiley Pvt. Ltd, New Delhi, 2008.

Web links and Video Lectures (e-Resources)	
1	https://onlinecourses.nptel.ac.in/noc21_me27/

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2								3	3	
CO2	2	2	2								3	3	
CO3	2	2	2								3	3	
CO4	2	2	2		2						3	3	2
CO5	2	2	2		2				2	2	3	3	2

Semester: IV						
3-D Printing						
Course Code	**:**	BME408A		**Credits**	**:**	1
Hours/Week(L:T:P)	**:**	1:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	15 Hrs.		**SEE**	**:**	50 Marks
Course Type	**:**	AEC		**SEE Duration**	**:**	1 Hour.

Prerequisites:	
Courses	Computer Aided Engineering Drawing
Knowledge on Fundamental Concepts	Drawing
Knowledge on Connected Tools (If any)	Solid edge, Solid work

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the basics of 3D printing
CLO2	Interpret the principles of 3D printing technique
CLO3	Summarize the applications of 3D printing
CLO4	Explore the types of 3D Printing and material for suitable applications
CLO5	Identify the working principles of Stereolithography, Selective Laser Sintering and FDM

Module – 1	**03 Hrs**
Introduction: Design considerations – Material, Size, Resolution, Process; Modelling and viewing - 3D; Scanning; Model preparation – Digital; Slicing; Software; File formats. **Text Book 1: Ch 1, Reference Book 1: Ch 1, Ch 2, Ch 3**	
Module – 2	**03 Hrs**
PRINCIPLE: Processes – Extrusion, Wire, Granular, Lamination, Photopolymerisation; Materials - Paper, Plastics, Metals, Ceramics, Wood, Fiber, Material Selection - Processes, applications, limitations. **Text Book 1: Ch 2, Reference Book 1: Ch 1, Ch 2**	
Module – 3	**03 Hrs**
INKJET TECHNOLOGY: Printer - Working Principle, Positioning System, Print head, Print bed, Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand; Material Formulation for jetting; Liquid based fabrication – Continous jet, Mulitjet; Powder based fabrication – Colourjet. **Text Book 2: Ch 1, Ch 2**	
Module – 4	**03 Hrs**
LASER TECHNOLOGY: Light Sources – Types, Characteristics; Optics – Deflection, Modulation; Material feeding and flow – Liquid, powder; Printing machines – Types, Working Principle, Build Platform, Print bed Movement, Support structures. **Text Book 1: Ch 3, Reference Book 1: Ch 3, Ch 5**	

Module – 5	03 Hrs
INDUSTRIAL APPLICATIONS: Product Models, manufacturing – Printed electronics, Biopolymers, Packaging, Healthcare, Food, Medical, Biotechnology, Displays; Future trends. **Reference Book 1: Ch 7**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explore the key terminology related to 3D printing.
CO2	Interpret technical specifications for 3D printers and materials.
CO3	Apply the concepts of inkjet technique and laser technique to design 3D models.
CO4	Compare different 3D printing techniques for a specific application.
CO5	Evaluate the suitable 3D printing technique for industrial applications.

Text Books	
1	3D Printing: The Next Industrial Revolution, Christopher Barnatt, CreateSpace Independent Publishing Platform, 2013.
2	Inkjet Technology for Digital Fabrication, Ian M. Hutchings, Graham D. Martin, John Wiley & Sons, 2013, ISBN 978-0-470-68198-5.

Reference Books	
1	Chua, C.K., Leong K.F. and Lim C.S., Rapid prototyping: Principles and applications, second edition, World Scientific Publishers, 2010.
2	Joan Horvath, Mastering 3D Printing, APress, 2014.

Web links and Video Lectures (e-Resources)	
1	https://www.youtube.com/watch?v=FOW17t6HqfU
2	https://www.youtube.com/watch?v=sGntt6eInis

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				2							3	
CO2	3	2	2									3	
CO3	3	2	2									3	
CO4	3	2	2									3	
CO5	3	2										3	

Semester: IV						
MATLAB for Mechanical Engineers						
Course Code	**:**	BME408B		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	24 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	AEC		**SEE Duration**	**:**	2Hours

Prerequisites:	
Courses	Mechanics of Materials, Kinematics of Machines, Fluid Mechanics, Machine Design, Mechanical Vibration, Heat Transfer and Control systems
Knowledge on Fundamental Concepts	Understanding of concepts in mechanical engineering, Basic math concepts, Programming fundamentals
Knowledge on Connected Tools (If any)	**Nil**

Course Learning Objectives: This course will enable the students to	
CLO1	Know the fundamentals and importance of MATLAB and Application of MATLAB in Solving Engineering problems.
CLO2	Provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
CLO3	Write the MATLAB programs on Mechanics, Machine Design, Fluid Mechanics, Thermal Science, Heat Transfer, Vibrations etc
CLO4	Review how to make plots and interactive plots, analyze test data.
CLO5	Gain knowledge about MATLAB Simulink & solve engineering problems

Sl. No.	**Experiments**
1	Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.
2	Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.
3	Numerical Integration and Differentiation: Trapezoidal method, Simpson method.
4	Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using GaussSiedal and NewtonRaphson method.
5	Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order Runga Kutta method, MATLAB ode 45 algorithm in single variable and multivariable. Transforms: Discrete Fourier Transforms,
6	Application of MATLAB to analyses problems in basic engineering mechanics, mechanical

	vibrations, control system, statistics and dynamics of different circuits.
7	MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the basics of MATLAB and Application of MATLAB in Solving Engineering problems.
CO2	Write the MATLAB programs on Mechanics, Machine Design, Fluid Mechanics, Thermal Science, Heat Transfer, Vibrations and Control Systems.
CO3	Exploit the Data's, Charts, Graphs and Plots
CO4	Analyze the plots, interactive plots and test data.
CO5	Explore MATLAB Simulink & solve engineering problems

Text Books	
1	"MATLAB for Mechanical Engineers" Rao V Dukkipati, New Age Science Limited 2009, ISBN: 978-1-906574-13-0
2	"MATLAB and Simulink for Engineers", Agam Kumar Tyagi, OXFORD Higher Education.
3	"Modelling & Simulation using MATLAB – Simulink", Dr. Shailendra Jain, Wiley – India.
4	"Applied Numerical Methods Using MATLAB", Won Y.Tang, Wemun Cao, TaeSang Ching and John Morris, A John Wiley & Sons.
5	"Introduction to Simulink with Engineering Applications", Steven T. Karris, Orchard Publications.

Web links and Video Lectures (e-Resources)	
1	https://www.youtube.com/watch?v=IuEOMyGuuIg&list=PLRWKj4sFG7-6_Xr9yqg6SMr_F80KdFVhN
2	https://skill-lync.com/mechanical-engineering-courses/matlab-mechanical-engineers
3	https://www.udemy.com/course/matlab-basics-for-mechanical-engineers/?srsltid=AfmBOorKdIuXDt1k2xpVi1Cj300isb6UwSfRhGF2X9vD1fuwPvK7bC24
4	https://www.youtube.com/watch?v=5A9sEaEt3Z4&list=PLcgIaTuuWp3kWI8d1C1wZDl0SfQDxm-CK

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3					2		3	3
CO2	2	3	2	1	3					2		2	3
CO3	2	3	2		3					3			3
CO4	2	3	2		3					2			3
CO5	2				3					2			3

Semester: IV						
INTRODUCTION TO AI & ML						
Course Code	**:**	BME408C		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	15 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	AEC		**SEE Duration**	**:**	03 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**NIL**
Knowledge on Connected Tools (If any)	**NIL**

Course Learning Objectives: This course will enable the students to	
CLO1	Make use of Data sets in implementing the machine learning algorithms
CLO2	Implement the machine learning concepts and algorithms in any suitable language of choice.
CLO3	Analyse the working of various documents like PDF, Word file

Sl. No	**Experiments**
1	Implement A* Search algorithm.
2	Implement AO* Search algorithm.
3	Write a program to implement Water jug program using AI.
4	The probability that it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is Friday is 20 %. What is the probability that a student is absent given that today is Friday? Apply Baye's rule in python to get the result.
5	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
6	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
7	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.
8	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API

	Demonstration Experiments (For CIE)
9	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the implementation procedures for the machine learning algorithms
CO2	Design Java/Python programs for various Learning algorithms.
CO3	Apply appropriate data sets to the Machine Learning algorithms
CO4	Identify and apply Machine Learning algorithms to solve real world problems
CO5	Examine working of PDF and word file formats

Web links and Video Lectures (e-Resources)	
1	Tom M Mitchell,"Machine Lerning",1 st Edition, McGraw Hill Education, 2017.
2	Elaine Rich, Kevin K and S B Nair, "Artificial Inteligence", 3rd Edition, McGraw Hill Education, 2017.

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	-		-	-	-	-		-	2	-
CO2	2	2	1	-		-	-	-	-		-	2	-
CO3	2	2	1	-		-	-	-	-		-	2	-
CO4	2	2	1	-		-	-	-	-		-	2	-
CO5	2	2	1									2	

Semester: IV						
Introduction to Data Analytics						
Course Code	**:**	BME408D		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	12 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	AEC		**SEE Duration**	**:**	2 Hours

Prerequisites:	
Courses	**NIL**
Knowledge on Fundamental Concepts	**YES**
Knowledge on Connected Tools (If any)	**YES**

Course Learning Objectives: This course will enable the students	
CLO1	Utilize NumPy in Python for creating single and multi-dimensional arrays and to perform various array operations
CLO2	Apply Pandas in Python for accessing, cleaning, manipulating, and analyzing datasets efficiently.
CLO3	Understand Matplotlib in Python for plotting and visualizing data effectively.
CLO4	Compute frequency distribution, variability, mean, and standard deviation using Python.
CL05	Implement and analyze single-variable and multi-variable linear regression in Python for predictive modeling and data analysis.

Sl. No	**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 matplot library to plot graph for data visualization using Python
4	Determine frequency distributions, variability, average, and standard deviation using Python
5	Implement and analyze Linear regression in Python (Single variable & Multivariable)

Course Outcomes: After completing the course, the students will be able to	
CO1	Create and manipulate single and multi-dimensional arrays using NumPy.
CO2	Implement various statistical methods.
CO3	Analyze data using tools and represent for visualization.
CO4	Understand and use python data structures
CO5	Implement and analyze linear regression using python.

CO – PO MAPPING

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PS01	PSO2
CO1	3	3	2	3	3							3	
CO2	3	3	2	3	3							3	
CO3	3	3	2	3	3							3	
CO4	3	3	2	3	3							3	
CO4	3	3	2	3	3							3	

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.
- Promoting Excellence in Teaching, Training, Research and Consultancy.
- Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.
- Developing Entrepreneurial acumen to venture into Innovative areas.
- Imparting Value based Professional Education with a sense of Social Responsibility.

Department Vision

Building Technically Competent Engineers to Serve the Society

Department Mission

- Imparting strong fundamental knowledge in Mechanical Engineering and allied fields.
- Fostering a culture of collaboration and propagating Industry institute interactions to enhance advances in latest technologies.
- Creating State-of-Art facilities benefitting students and faculty to carryout Research, Innovation and Consultancy.
- Providing conducive environment for both students and faculty to engage in lifelong learning activities.
- Inculcating Professional ethics, Leadership qualities and Entrepreneurial skills among students.

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

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