|| Jai Sri Gurudev||

ADICHUNCHANAGIRI UNIVERSITY

BGS Institute of Technology

Scheme for Third Semester B.E Department of Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				Credits
				L	T	P	TL	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	22MAT31	Engineering Mathematics – III	Mathematics	3	2	0	4	3	50	50	100	**4**
2	22ME32	Strength of Materials	ME	2	2	0	4	3	50	50	100	**4**
3	22ME33	Engineering Thermodynamics	ME	2	2	0	4	3	50	50	100	**4**
4	22ME34	Manufacturing Process	ME	2	2	0	4	3	50	50	100	**4**
5	22MEIPC35	Electric Vehicles	ME	2	0	2	4	3	50	50	100	**3**
6	22MEL36	Material Testing Lab	ME	1	0	2	3	3	50	50	100	**1**
7	22MEL37	Manufacturing Technology Lab	ME	1	0	2	3	3	50	50	100	**1**
8	22AEC 38	SSD-I	HRD	2	0	0	2	2	50	50	100	
9	22 UHV39	Design Thinking	Humanities	2	0	0	2	2	50	50	100	
10	22DIPMAT40	Additional Mathematics-I	Mathematics	3	0	0	3	----	450	450	900	
TOTAL CREDITS & CONTACT HOURS							**31**					**21**
TOTAL CREDITS (I+II+III Sem)							**20+20+21**					**61**

Scheme for IV Semester B.E Department of Mechanical Engineering

Sl. No	Course Code	Title of the Course	Teaching Department	Teaching Hours/week				Examination				Credits
				L	T	P	TL	Duration in Hours	CIE Marks	SEE Marks	Total Marks	
1	22MAT41	Engineering Mathematics – IV	Mathematics	4	1	0	5	3	50	50	100	**4**
2	22ME42	Measurements and Metallurgy	ME	2	2	0	4	3	50	50	100	**4**
3	22ME43	Theory of Machines	ME	2	2	0	4	3	50	50	100	**4**
4	22ME44	Automation and Robotics	ME	2	2	0	4	3	50	50	100	**4**
5	22MEIPC45	CAMD	ME	2	0	2	3	3	50	50	100	**3**
6	22MEL46	M&M Lab	ME	1	0	2	3	3	50	50	100	**1**
7	22MEL47	Machine Shop Practice	ME	1	0	2	3	3	50	50	100	**1**
8	22AEC 48	SSD-II	HRD	0	0	2	2	1	50	50	100	
9	22 UHV49	CIP	Humanities	0	--	2	2	1	50	50	100	
10	22DIPMAT50	Additional Mathematics-II	Mathematics	3	0	0	3	----	450	450	900	
TOTAL CREDITS & CONTACT HOURS							**31**					**21**
TOTAL CREDITS (I+II+III+IV Sem)							**20+20+21+21**					**82**

Minor Degree- One Subject in each semester of 3 credits each

Sl.No	I Sem	Cr	II Sem	Cr	III Sem	Cr	IV Sem	Cr	V Sem	Cr	VI Sem	Cr	VII Sem	Cr	VIII Sem	Cr
1	22MAT11	4	22MAT21	4	22MAT31	4	22MAT41	4	22ME51	4	22ME61	4	22ME71	4	22ME81	3
2	22PHY12	3	22CHE22	3	22ME32	4	22ME42	4	22ME52	4	22ME62	4	22ME72	4	22ME82X	3
3	22CVE13	3	22EME23	3	22ME33	4	22ME43	4	22ME53X	4	22ME63X	4	22ME73X	4	22MEINT83	5
4	22ELE14	3	22ELN24	3	22ME34	4	22ME44	4	22ME54X	4	22ME64X	4	22ME74X	4	22MEPW84	10
5	22CAED15	3	22PCD25	3	22ME35	3	22ME45	3	22MEOE55X	3	22MEOE65X	3	22MEOE75X	3		
6	22PHYL16	2	22CHEL26	2	22MEL36	1	22MEL46	1	22MEL56	1	22MEL66	1	22MEL76	1		
7	22EEL17	2	22PCDL27	2	22MEL37	1	22MEL47	1	22MEL57	1	22MEL67	1	22MEL77	1		
8	22AEC 18	1	22AEC 28	1	22AEC38		22 AEC 48		22 AEC 58		22 AEC 68					
9	22 DS19	1	22 BIO29	1	22UHV39		22UHV49		22UHV59		22UHV69					
					NCMC		NCMC		NCMC		NCMC					
Total Credits-166		20		20		21		21		21		21		21		21

Course Code	22ME32	Course Title	Strength of materials	Semester	3
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**

CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: To impart basic knowledge on evaluation response of materials for physical structuresunder static load.	**Teaching Hr**
Module-1 **Simple Stress and Strain:** Introduction. Properties of material, Concept of Stress and Strain, Hook's Law, Stress Strain Diagram for structural steel and Non-ferrous materials. Poisson's Ratio & principles of superposition, Total elongation of tapering bars of circular and rectangular cross-sections. Elongation due to self-weight, Problems on deformations of member. Composite section, Volumetric strain. Expression for Volumetric strain, Elastic constants, relationship among elastic constants, Thermal stresses including compound bars.	**12**
Module-2 **Compound Stresses:** Introduction. Stress components on inclined planes. General two-dimensional stress system,Principal planes and stresses, Problems on principle plane stresses. Mohr's circle for biaxial stresses. **Thin and Thick Cylinders:** Introduction. Thin and thick cylinders subjected to pressure. Hoop stresses and longitudinal stresses. Problems on change in length, diameter and volume. Lame's equations. Problems on thickcylinder**.**	**12**

Module-3 **Bending Moment and Shear Force in Beams:** Introduction, Types of beams loadings and supports. Shearing force in beam. Bending moment, Sign convention. Relationship between loading shear force and bending moment. Expression for shear and bending moment equations. SFD and BMD for cantilever beams, simply supported beams & overhanging beams considering point load, UDL, UVL and Couple.	**12**
Module-4 **Bending Stress and Shear Stress in Beams:** Introduction, Bending stress in beam. Assumptions in simple bending theory. Pure bending derivation of Flexure equation. Modulus of rupture, Section modulus, Flexural rigidity. Assumptions in theory of shear stresses in beams, Expression for horizontal shear stress in beam, Shear stress diagram for solid rectangular section and circular section. **Deflection of Beams:** Introduction, Elastic curve-Derivation of differential equation of deflection curve. Signconvention, slope and deflection standard loading using Macaulay's method, Problems on simply supported and overhanging beams to point load, UDL & Couple.	**12**
Module-5 **Torsion of Circular Shafts:** Introduction. Pure torsion- General torsion equation. Strength and stiffness, Torsional rigidity, Torsional flexibility and polar modulus. Power transmitted by solid shaft. Power transmitted by hollow shaft. **Elastic stability of columns:** Introduction. Euler's theory on columns. Effective length, slenderness ratio. Short and long columns, Radius of gyration, Buckling load. Assumptions, derivations of Euler's Buckling load for different end conditions. Limitations of Euler's theory, Rankine's formula, related problems.	**12**

Activity/Assignment	Details
Activity 1:	CAM Module and Gear profile module generation using **MechAnalyser** (**MechAnalyzer** isa 3D model based open-source software developed by IIT Delhi) (http://www.roboanalyzer.com/mechanalyzer.html)
Activity 2:	Conduct experiments to determine equilibrium speed, sensitiveness, power and effort of centrifugalgovernors in design lab.

Course outcomes: By the end of the course the student shall be able to
CO1: Apply the basic concepts and principles of stress analysis on members subjected to uniaxial load.
CO2: Draw shear force, bending moment diagrams subjected to different types of loads..
CO3: Evaluate the bending, shear stresses & deflection in beams..CO4: Evaluate the torsional moment of shafts & elastic stability of columns.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. James G.Gere, *Mechanics of Materials,* 5th Edition, 2004.Thomson Publishers. ISBN-0534417930
2. S.Ramamrutham, R. Narayanan, *Strength of Materials,* Dhanphatrai publishing Co.Ltd.2003.ISBN-818743354X, 978818743354

REFERENCE BOOKS:

1. Egor.P. Popov, *Engineering Mechanics of solids,* Pearson education India, 2nd edition, 1998. ISBN-8120321073, 9788120321076
2. Strength of Materials by S. S. Bhavikatti, Vikas publications House – Pvt. Ltd., Third edition.
3. Ferdinand Beer & Russell Jhonstan, *Mechanics of Materials*, TMH 3rd Edition, 2003. ISBN – 0070535108, 97800705351071.

Course Code	22ME33	Course Title	Engineering Thermodynamics	Semester	3
Credits	4	L – T – P –TL*	4 – 0 – 0 – 4	Teaching Hrs	56
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: To impart basic knowledge on evaluation response of materials for physical structuresunder static load.	**Teaching Hr**
Module-1 **Fundamental Concepts of Thermodynamics:** Introduction, scope, microscopic and macroscopic approaches. Types of System and types of Properties. Thermodynamic state, path and process and its types, thermodynamic equilibrium, and its types, diathermal wall, zeroth law of thermodynamics. Concept of Temperature measurement- Numericals. **Work and Heat:** Definition of Thermodynamic work and its types. Expression for displacement workdone in different processes through p-v diagrams. Heat-definition, comparison of work and heat, sign convention- Numericals.	**12**
Module-2 **First Law of Thermodynamics:** First law for cyclic and non-cyclic processes, concept of total energy and energy as the property of a system, variousmodes of energy, internal energy and enthalpy. Steady Flow Energy Equation (SFEE),Application of steady flow process for compressor, Turbine, and Nozzle. Numericals	**12**

Module-3 **Second Law of Thermodynamics:** Direct and reversed heat engine (Refrigerator and heat pump), thermal efficiency and COP, Kelvin-Planck and Clausius statements, Equivalence of Kelvin-Planck and Clausius statements. Definition of perpetual motion machines of I & II kind, Reversible and irreversible processes, factors that make a process irreversible, reversible heat engine. Numerical Problems. **Entropy:** Limitations of II law of thermodynamics Clausius inequality; statement, proof, path. Entropy: definition, principle of increase of entropy, entropy as a quantitative test for irreversibility, calculation of entropy in various quasi- static processes using Tds relations. Numericals.	**12**
Module-4 **Refrigeration:** Introduction to refrigeration, and classification. Refrigerating effect, ton of refrigeration and COP, Desirable properties of refrigerant, Bell Coleman cycle, and analysis of ideal vapor compression refrigerator. Numericals. **Air-conditioning**: Introduction- Properties of atmospheric air- Psychometric properties- Psychometric chart- Psychometric processes and their representation on Psychometric chart- Types of air conditioning systems – Numericals.	**10**
Module-5 **Air Standard Cycles:** Air standard assumptions - Otto cycle - Diesel and Dual cycles - Comparison of Otto, Dieseland Dual combustion cycles. Sterling cycles - Numericals. **Vapor Power Cycles:** Introduction to vapor power cycle, Carnot vapor power cycle, Simple Rankin cycle. Rankinreheat and regenerative cycles- Numericals. .	**12**
Course outcomes: At the end of the course students will be able to: **CO1:** Apply the basic concepts of thermodynamics on different thermodynamic processes and solve the problems withwork and heat interactions. **CO2:** Apply the concepts of laws of thermodynamics and entropy for the analysis of thermodynamic processes andthermal systems. **CO3:** Evaluate the performance of refrigeration and air-conditioning systems and finding their application in theEngineering field. **CO4:** Apply the knowledge of applied thermodynamics to comprehend and analyze gas power cycles and vapor powercycles.	

Text Books: 1. Basic and applied thermodynamics: P K Nag, Tata Mc Graw Hill Co. Ltd, New Delhi 2. Thermodynamics- An engineering approach: Yunus A Cengel and Michael Boles, Tata McGraw Hill Publishing Co.Ltd, New Delhi **Reference Books:1.**Thermal engineering By R K Rajput, Laxmi publication Pvt, Ltd, New Delhi. 2.Thermodynamics :S C Gupta, Pearson Education PP (Singapore) Pvt. Ltd, Delhi. 3.Thermodynamics: Basic and Applied: V Ganesan, McGraw Hill Education (India) Pvt. Ltd, Chennai.	

Course Code	22ME34	Course Title	Manufacturing Process	Semester	3
Credits	3	L – T – P –TL*	3 – 0 – 0 – 3	Teaching Hrs	42
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives:	**Teaching Hr**
1. Understanding of the concept of casting processes and to introduce theconcept of dependent and independentvariables which control materials casting. 2. To know the concept of selection of appropriate production processesfora specific application. 3. Understand students to good foundry practices and product designconsiderations. Understanding of the fundamentals of joining processes.	
Module-1 Manufacturing process: Introduction to basic manufacturing, Classification ofmanufacturing process, Applications.Casting: Introduction, steps involved in making casting, Terminologies of casting. Pattern making: Functions of pattern, Classification of pattern, Differentpatternmaterials, various patternallowances in design of pattern. Mould making: Types of moulds, Mould making, Desirable properties ofSand Mould. Core making: Functions of cores, important factors in core design andmaking.Self study component: Applications of Manufacturing process.	**08**

Module-2 Gating system: Concept of gating system, different types of gating systems, gating system design, risering design,8umerical on gating and risering design.Defects in casting: Introduction causes and remedies. Solidification: Solidification of pure metal and alloy, Mechanisms of solidification,types of nucleation, grain structures. Progressive and directional solidification, solidification variables. Methods of achieving directional solidification. Casting defects: shrinkage and porosity Self study component: Solidification defects	**08**
Module-3 Special casting processes: Shell molding, investment casting, Gravity diecasting, Pressure die casting, Centrifugalcasting, Slush casting, Continuous casting, Injectionmolding. CO_2 moulding. Melting Furnaces: Classification, constructional features and working principleof coke fired and Gas fired pit furnace,Resistance furnace, Electric arc furnace,Cupola furnace. Self study component: Application of furnace	**08**
Module-4 Unconventional machining: Classification, USM, EDM, ECM, LBM, AJMtechniques.Lapping and Honing Machines: Lapping-Principle of Lapping-Lapping methods- Advantages and limitations oflapping Honing- Principle of honing- Types of honing machines-Advantages,limitations and application of honing	**09**
Module-5 Welding: Classification of welding, TIG & MIG Welding, FSMAW, oxyacetylene welding, types of flamesand gas welding type characteristics Special welding technique: Laser Beam Welding, Explosive welding, Resistance welding, Thermit welding. Self study component: Inspection method	**09**

Course outcomes: By the end of the course, the student shall be able to know CO1: Importance of casting process, steps involved in casting, patterns, binders, additives andmolding machines. CO2: Describe the types of cores, types of metallic mold castings and melting furnaces.CO3: Develop agating system for a given metal casting component CO4: Discuss the basic principles of different welding processes and their applications	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of three sub- questions) from eachmodule. • Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question fromeach module.	
Textbooks: 1. Foundry Technology, O.P. Khanna, Dhanpatrai publications (P)-2003 reprint. 2. Manufacturing Technology: Foundry, Forming and Welding, P N Rao, 2 nd Edition TataMcGraw-Hillpublishing company Limited. **Reference Books:** 1. S.K. HajraChoudhury (2001), Elements of Workshop Technology, Vol-I, MediaPromoters Pvt Ltd.,Mumbai. 2. S. Kalpakjian and S.R. Schmid, "Manufacturing Engineering and Technology", 7 thEdition, Prentice-Hall, 2013 3. Roy A. Lindberg (2004), Processes and Materials of Manufacture, 4th Edition, Prentice-Hall of India, NewDelhi. Banga T.R; and Agrawal R.L, "Foundry Engineering", Khanna Publishers, 1992.	

Course Code	22MEIPC35	Course Title	ELECTRIC VEHICLES	Semester	III
Credits	3	L–T–P–TL*	3–1–0-4	Teaching Hrs.	40
Total Marks	100	CIE*	50	SEE*	50

***NOTE:L–Lecture; T– Tutorial; P–Practical; TL–Total; CIE–Continuous Internal Evaluation; SEE–Semester End Examination**

Course Learning Objectives: **The course will enable the students to** **1.** To understand the concept of electric vehicles. **2.** To understand the concept of hybrid vehicles. **3.** To study about fuel cell for electric vehicles. **4.** To understand the different types of energy storage system. **5.** To know the concepts of battery management system.	Teaching Hr.
Module-1 **Introduction to Electric Vehicle**: History of electric vehicles, social and environmental importance of electric vehicles, Types of Electric Vehicle and components, Electrical vehicles Indian & International standards & test. Batteries – overviewand its types. Battery plug-in and life. Charging – Methods and Standards, Alternate charging sources – Wireless & Solar.	**8**
Module-2 **Hybrid Vehicles**: Introduction, Hybrid Electric vehicles classification – Micro, Mild, Full, Plug-in, EV, Hybrid layout &Architecture – Series, Parallel and Series-Parallel, Propulsion systems and components, Comparison of ICE v/s Electric Vehicle v/s Hybrid Electric Vehicles, Hybrid vehicle standard & test.	**8**

Module-3 **Fuel Cells for Electric vehicles:** Introduction, Fuel cell types & components, Operation principles, Energy Consumption,Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity, Fuel Cell vehicle standard & test.	**8**
Module-4 **Energy storage system**: Batteries: Lead Acid Battery, Nickel based batteries, Sodium based batteries, Lithium basedbatteries – Li-ion & Li-poly, Metal Air Battery, Zinc Chloride battery; Ultra capacitors; Flywheel Energy Storage System; Hydraulic Energy Storage System, Comparison of different Energy Storage System. Battery performance, Regenerative Braking System.	**8**
Module-5 **Battery Pack and Battery Management System**: Battery pack design, Battery Management System, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, thermal control, and protection interface, SOC Estimation, Energy& Power estimation, Battery thermal management system, Battery Pack Safety, Battery Standards &Test.	**8**
Course Outcomes: At the end of the course, the student will be able to: **CO 1.** Describe about working principle of electric and hybrid vehicles. **CO 2.** Illustrate the various types and working principle of fuel cells. **CO 3.** Discuss about the different types of energy storage system. **CO 4:** Apply the concepts of battery management system.	

Suggested Learning Resources:

Books:

1. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2020.
2. Electric and Hybrid Vehicles: Design and fundamentals, Eqbal Husain, CSR press 3rd edition., 2021
3. Hybrid, Electric and Fuel Cell Vehicles, Jack Erjavec and Jeff Arias, Cengage Learning, 2012.
4. Guangjin Zhao, "Reuse and Recycling of Lithium-Ion Power Batteries", John Wiley & Sons. 2017.

References:

Battery Management system for future electric vehicles, Bathala Neeraj, Dr.G. Raghvendra, Vijay Dattatray Chudahri, Scientific International Publication House 1st Ed., 2022.

Course Code	22MEL36A	Course Title	Materials Testing Lab	Semester	III
Credits	2	L – T – P – TL*	1 –0 – 2 – 3	Teaching Hrs	42
Total Marks	100	CIE*	50	SEE*	50

***NOTE:L–Lecture; T– Tutorial; P–Practical; TL–Total; CIE–Continuous Internal Evaluation; SEE–Semester End Examination**

	Teaching Hr.
Course Learning Objectives: This course will enable students to; • To study the tensile , compressive and shear prosperities of metals and non-metals • To evaluate Brinel, Vicker's and Rockwell's hardness of the materials • To find impact strength of the given material • To prepare the specimen for metallographic examination (Demonstration) **6.** To study the wear & density characteristics of the given specimen (Demonstration)	
List of Experiments 1. To determine the tensile strength using Universal Testing Machine. 2. To determine the compression strength using Universal Testing Machine. 3. To determine the shear strength using Universal Testing Machine. 4. To determine the modulus of rigidity using Torsion Tester. 5. To determine the Bending strength using Universal Testing Machine. 6. To determine the impact strength of a specimen by Izod impact method. 7. To determine the impact strength of a specimen by Charpy impact method. 8. To determine the Brinell, Rockwell and Vickers's Hardness Number using hardness testing equipment. **Activity:** 1. Demonstration of wear characteristics of ferrous, non-ferrous and composite materials for different parameters. 2. Demonstration of Sample preparation and etching of ferrous metal specimen for metallographic observation Demonstration of determination of density of Metals.	**8**

Course outcomes: By the end of the course the student shall be able to CO1: Determine tensile, compressive properties of the given material using UTM. CO2: Determine torsional ,bending and Shear properties of the given material using UTM.CO3: Determine impact strength of the given material CO4: Determine hardness of the given material & impact strength of the given materialCO5: Prepare the document based on the experiment/test conducted.	

Question paper pattern:

The students will have to conduct ONE Experiment
Activity (Demonstration only)

Scheme of Examination:

ONE question: 80 Marks

Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 50 Marks)

CourseCode	22MEL37	Course Title	Manufacturing Technology Lab	Semester	III
Credits	2	L – T – P –TL*	1 – 0 – 2 – 3	Teaching Period	42 Hours
ToatalMark	100	CIE	50	SEE	50

***NOTE:L–Lecture; T– Tutorial; P–Practical; TL–Total; CIE–Continuous Internal Evaluation; SEE–Semester End Examination**

Course Learning Objectives:	**Teaching Hr**
1. The course will introduce desirable properties of molding sand and establish its relevance inpreparing the sand mold. 2. To introduce the experimental procedure in determining the GFN, Permeability, Strength ofmold, moisture & clay content in sand sample, corehardness & mold hardness. 3. To bring in the effect of clay & water content on the various properties of molding sand. 4. To give students hands on practice in preparing the sand moulds (Cope & Drag box) usingsingle piece, split pattern and without using pattern. 5. To give students hands on practice in preparing forging models using open - hearth furnaceby performing upsetting, drawing & bending operation.	
List of Experiments PART – A **1. Testing of Moulding Sand and Core Sand:** Preparation of sand specimens and conduction of the following tests: a. Compression and Shear test using Universal Sand Testing Machine. b. Permeability test c. Sieve analysis to find grain fineness number of base sand d. Determination of clay content in base sand e. Moisture content test in base sand	14

PART – B **2. Foundry Practice** a. Preparation of moulds with or without patterns.(Single piecepattern and Split pin pattern)	14
PART – C **3. Forging Practice:** Preparing minimum three forged models involving upsetting,drawing and bending operations. **PART – 4** **Visit to Foundry Industries**	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module. Scheme of Examination: ONE question from part -A: 30 Marks ONE question from part –B/Part-C: 50 Marks Viva -Voice: 20 Marks Total: 100 Marks (To Be reduced to 60 Marks)	

CourseCode	**22ME42**	**Course Title**	**Measurements and Metallurgy**	**Semester**	**IV**
Credits	**3**	**L – T – P –TL**	**3 – 0 – 0 – 3**	**TeachingHrs**	**42**
Total Marks	**100**	**SEE**	**50 Marks**	**CIE**	**50 Mark**

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**

CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives:	**Teaching Hr**
1. To impart the knowledge of importance of standards & conversion. 2. To introduce the fundamental concepts & derive the relations for the design of gauges, types of gauges, concepts involving comparators, angular measurements, 3. To incorporate the knowledge in various class of materials and their applications. To develop the knowledge about the heat treatment process required for the metals	
Module-1 **Linear and Angular measurement** Definition, objectives and concept of metrology, Classification of standards, MaterialStandard, Wavelength Standards, Line and End standards, calibration of End bars (Numerical). Slip gauges-Indian standards on slip gauge, wringing of slip gauge, types of slip gauges, Numerical on building of slip gauges (M87,M112),Sine Bar and Sine center, Bevel protractor, Numerical on angle gauge.	**08**

Module-2 **System of Limits, Fits, Tolerence and Guaging** Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fitsand their designation (IS 919- 1963). Classification of gauges, brief concept ofdesign of gauges (Taylor's principles), Numerical on design of Gauges.	**08**
Module-3 **Measurement systems and Comparators** Block diagram of generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability,linearity, loading effect, Errors in measurement, classification of errors. Functional requirements of comparators, classification, mechanical - dial indicator, Johnson Mikrokator, sigma comparators, Electrical Comparator, LVDT, Pneumatic comparator -back pressure, solex comparators and optical Comparators-Zeiss ultraoptimeter	**08**
Module-4 **Solidification and Phase Diagrams** Mechanism of solidification, homogeneous and heterogeneous solidification,Hume Rothary rules, substitution and interstitial solid solutions. Construction of phase diagram for binary systems, types of phase diagrams,Gibbs phase rule. lever rule. Iron carbon equilibrium diagram and invariant reactions. Numerical on lever rule.	**08**
Module-5 **Heat Treatment of Metals and Alloys** CCT and TTT diagrams, heat treatment of metals: Annealing method and itstypes. Normalizing, hardening, tempering, mar tempering, austempering. Hardenability-Jominy-end quench test surface hardening methods:carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys., Radius of gyration, Buckling load. Assumptions, derivations of Euler's Buckling load for different end conditions. Limitations of Euler's theory, Rankine's formula, related problems.	**08**

Course outcomes: By the end of the course students shall be able toCO1: Distinguish between linear and angular measurements CO2: Design of limit gauges for hole and shaft. CO3: Illustrate the mechanism of solidification for various alloys CO4: Describe various types of heat treatment process require for strengthening of materials	
Question paper pattern: •The question paper will have ten full questions carrying equal marks. •Each full question will be for 20 marks. •There will be two full questions (with a maximum of three sub- questions) from each module. •Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question from eachmodule.	
Textbooks: 1. R.K. Jain, **Engineering Metrology**, Khanna Publishers, 1994. 2. I.C.Gupta, **Engineering Metrology**Dhanpatrai publications. 3. James F Shackleford.& Madanapalli K Muralidhara, **Material science forEngineers,** Sixthedition, Pearson Publications - 2007 4. Smith, **Foundations of Materials Science and Engineering,** 4th Edition McGrawHill,2009. **Reference Books:** 1. Beckwith Marangoni and Lienhard, **Mechanical Measurements**,PearsonEducation, 6th Ed., 2006. 2. Alan Cottrell **An Introduction to Metallurgy** Universities Press IndiaOrientalLongman Pvt. Ltd., 1974. W.C.Richards **Engineering Materials Science**, PHI, 1965	

Course Code	22ME43	Course Title	Theory of Machines	Semester	IV
Credits	4	L – T – P –TL*	4 – 1 – 0 – 5	Teaching Hrs	56
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**

CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To teach the students to gain the Knowledge of Mechanisms, and their mobility and velocity and accelerationfor different mechanisms. • To understand the fundamentals of gear teeth, types of gear, gear mesh and its arrangements. • To teach the kinematics of cam- follower motion. • To understand the fundamentals of TM diagram and governor characteristics.	
Module-1 **Definitions:** Introduction to Link, Kinematic Pairs, Degrees of freedom. Kinematic chain, Mechanism, Inversion, Machine, Grubler's criterion. **Linkages:** Four bar chain and its inversions, Single slider chain and its inversions, Double slider chain and its inversions, Kinematic chain with three lower pairs, Quick return motion mechanisms. **Static Force Analysis:** Introduction, Static equilibrium, Equilibrium of two and three force members. Member with two forces and torque, Free-body diagrams, Static force analysis of simple mechanisms. **Activity:** Demonstrate the following Mechanisms using **The Virtual Lab;** Hart Straight Line Mechanism, Peaucellier Straight Line Mechanism. Elliptical Cam Mechanism, Eccentric Cam Mechanism, Whitworth Mechanism, Crank and Slotted Mechanism, Universal Joint.(http://www.vlab.co.in/broad-area-mechanical-engineering)	**12**

Module-2 **Velocity and Acceleration Analysis of Mechanisms (Graphical Method):** Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **Fly wheel**: Engine output torque, turning moment diagrams of I.C. Engines and multi cylinderEngine, Fluctuation of Energy, Fly wheel design for I.C. Engine and size for punching press.	**12**
Module-3 **Dynamic Force Analysis**: Inertia force, inertia torque, Determination of inertia force- engine mechanism, Engine force analysis. **Balancing of Rotating Masses:** Static Balancing, Dynamic Balancing of rotating masses-effect of single rotating mass, effect of two rotating masses not in the same plane of rotation; several masses rotating in a single and different transverse plane, Graphical and analytical methods.	**12**
Module-4 **Spur Gears:** Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference., Back lash, comparison of involute & cycloidal teeth. Problems on Gears, **Gear Trains:** Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.	**12**
Module-5 **Cams:** Types of cams, Types of followers, Displacement - constant velocity, Simple Harmonic Motion, Uniform Acceleration & Retardation Motion, Cycloidal motion. Cam with knife edge follower and roller follower. **Governors**: Principle of Governors, Types, force analysis of Porter, Proell and Hartnell governors,Controllingforce, stability, sensitiveness, effort and power of governors, governor characteristics. **Activity 1:** CAM Module and Gear profile module generation using **MechAnalyser** (**MechAnalyzer** isa 3D modelbased	**12**

open-source software developed by IIT Delhi) (http://www.roboanalyzer.com/mechanalyzer.html) **Activity 2:** Conduct experiments to determine equilibrium speed, sensitiveness, power and effort ofcentrifugal governors in design lab. .	
Course outcomes: By the end of the course the student shall be able to CO1: Analyze various mechanisms through degrees of freedom and carry out graphical analysis of static and dynamic forces onmechanisms and machines CO2: Analyse the performance of gear trains and spur gear for power transmission. CO3: Draw turning moment diagrams of mechanisms and analyze characteristics of flywheels and governors.CO4: Draw various types of cams and follower based on motion. CO5: Resolve the rotating balancing problems using graphical and analytical method.	
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.	
TEXT BOOKS: 1. Thomas Bevan., Theory of Machines, C.B.S Publishers, 2005. ISBN-8123908741. 2. Rattan S.S., Theory of Machines, TMH , Third Edition, 2011. ISBN-13:978-0-07-0144774. **REFERENCE BOOKS:** 1. Shigley. J. V. and Uickers, J. Theory of Machines & Mechanisms TMH, 6th Edition, 2003. ISBN-04718-0237-9, ISBN-019515598X. 2. Theory of Machines by Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd. 2nd edition 2007. Mechanism and Machine Theory, A.G.Ambekar, PHI, 2007	

Course Code	22ME44	Course Title	Automation and Robotics	Semester	IV
Credits	4	L – T – P –TL*	3 – 1 – 0 - 4	Teaching Hrs	56
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • Develop knowledge in different types of robots and their working procedure. • Exposed to the basics of Sensors and Control system. • Develop skills in knowing automation and material handling systems in industry. • Awareness about safety in industry and AID Technologies.	**Teaching Hrs**
Module – 1 **Introduction to Robotics:** Definition and origin of robotics, different types of robotics, Various generations ofrobots, Degrees of freedom, Asimov's laws of robotics, Robot applications. **Sensors**; Sensors, Specifications of sensor, Sensors for common engineering measurements – Proximity, Tactile, Range, Miscellaneous Sensor etc.; Analog to digital converters, Digital to analog converters,	**12**
Module – 2 **Micro machines:** Micro machines in robotics, machine vision, ranging, laser, acoustic , magnetic, fiber optic. **Control Systems;** Open loop and Closed loop control system, Controllers, Types of controllers, Control systemanalysis, Encoders, Resolvers.	**10**
Module - 3 **Manipulators, Grippers:** Construction of manipulators**,** End effectors, Types of end effectors, Mechanical, Vacuum, Adhesive grippers. General considerations in gripper selection. **Robot Actuators**: Pneumatic and Hydraulic actuators; Electric motors including DC Motor, AC Motor, Servo and Stepper motors; Solenoids and relays, Power Transmission systems	**12**

Module – 4 **Introduction to Automation** Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries. **Industrial Automation:** List basic Devices in Automated Systems • Distinguish Different Controllers Employed In Automated Systems. Identify Safety in Industrial Automation	**12**
Module - 5 **Material handling:** Material Handling Systems, Principles and Design Consideration, Advantages, Applications MaterialTransport Systems, Storage Systems, **Identification Technologies**: Automatic Identification Methods, Categories of AIDC, Bar code technology, Radio frequency identification,	**10**

SI. NO	Topic	Activity link
1.	Robot	https://www.youtube.com/watch?v=McbyQNLZ6nQ
2.	AID Technology	https://www.youtube.com/watch?v=n5qkGxHQRUQ
3	Automation	https://www.youtube.com/watch?v=nmuGlM3fC84

Course outcomes: After a successful completion of the course, the student will be able to:CO1:Describe anatomy of robot.

C02**:** Explain Machine vision system and control system CO3:Discuss about Automation and AID Technologies CO4:Describe Material Handling Systems & Storage system.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

TEXT BOOKS:

1. Mikell P Groover. Weiss G.M., Nagel R.N., Odraj N.G., Industrial Robotics, McGraw-Hill , Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied 4. Publishers, Chennai, 1998.

REFERENCE BOOKS

1. Deb.S.R., Robotics technology and flexible Automation, John Wiley, USA 1992.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992.
3. Klafter R.D., Chimielewski T.A., Negin M., Robotic Engineering – An integrated approach, Prentice Hall of India, New Delhi, 1994.
4. Mc Kerrow P.J. Introduction to Robotics, Addison Wesley, USA, 1991. 5. Issac Asimov I Robot, Ballantine Books, New York, 1986.

CourseCode	22MEIPC45	Course Title	Computer Aided Machine Drawing	Semester	IV
Credits	3	L – T – P –TL*	2 – 0 – 3– 5	Teaching Hrs	48
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to; • To Sketch orthographic drawing of simple machine parts and threads. • To Sketch orthographic drawing of different fasteners and rivets. • To Develop solid modeling skills to produce assembly drawings of mechanical components.	Teaching Hr
Module-1 Part – A **Sections Of Solids:** Sections of Pyramids, Prisms, Cube, Tetrahedron, Cone and Cylinder resting only on their bases (Noproblems on axis inclinations, spheres and hollow solids). True shape of sections. **Orthographic Views:** Conversion of pictorial views into orthographic projections of simple machine parts with and without section.(Bureau of Indian standards conventions are to be followed for the drawings), Line conventions.	**8**
Module-2 **Thread Forms:** Thread terminology, sectional view of threads. ISO Metric (Internal & External), BSW (Internal & External),squareand Acme threads, Buttress thread, Sellers thread, American Standard thread.	**5**
Module-3 Part – B **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simpleassembly using stud bolts with nut and lock nut.	**5**
Module-4 **Riveted Joints**: Single and Double riveted lap joints, butt joints with single/double cover straps (chain and Zigzag, using snap headrivets).	**5**

Module-5 Part – C **Assembly** **Drawings:** Solids of Protrusion, Assembly drawing of following machine parts (3D parts to be created and assemble and then getting 2D drawingwith required views, including part drawing). 1. Screw Jack 2. Plummer Block (Pedestal Bearing) 3. Petrol Engine piston 4. I.C. Engine connecting rod 5. Machine Vice Stuffing Box	**25**
Course outcomes: By the end of the course student shall be able to CO1: Sketch detailed orthographic drawings of simple machine parts and threadsCO2: Construct hexagonal, square headed bolts and nuts. CO3:Construct single and double riveted lap joint, butt jointswith single/double cover straps CO4: Create solid assembly models of screw jack Plummer Block (Pedestal Bearing), Petrol Engine piston, machine-vice, I.C. engine connecting rod, StuffingBox.	
Question paper pattern: The students will have to answer questions, selecting one full question from each Part. Scheme of Examination: ONE question from part -A: 15 Marks ONE question from part -B: 15 Marks ONE question from part -C: 70 Marks Total: 100 Marks (To be reduced to 50 marks)	

Textbooks:

1. Machine Drawing by K. R. Gopalkrishna,; 2014, Publisher. Subhas Stores, ISBN: 4567142527
2. N.D. Bhat and V.M.Panchal, "Machine Drawing", Charotar Publishing House, 46th Edition, 2011, ISBN: 9789380358390
3. Tryambaka Murthy, "Machine Drawing", CBS Publications, 2nd Edition, 2008, ISBN: 9788123916590

Reference Books:

1. Machine Drawing by P.S.Gill, S.K.Kataria and Sons, Seventeenth Revised Edition, 2008.
2. Machine Drawing by N.D. Bhatt and V.M. Panchal, 48th edition (2013); Charotar Publishing House Pvt. Ltd., ISBN : 978-93-80358-69-7

Machine Drawing – N. Sidheshwar, P. Kannaiah, V.V.S. Sastry , McGraw Hill Edition 48th ISBN 10: 007460337X/ ISBN 13: 9780074603376

Course Code	22MEL46	Course Title	M&M Lab	Semester	IV
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	TeachingHrs	42
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**
CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;

- To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
- To illustrate the use of various measuring tools and measuring techniques.
- To understand calibration techniques of various measuring devices.

Teaching Hrs

List of Experiment

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Study of modulus of elasticity of a mild steel specimen using strain gauges.(Activity)

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.
5. .Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
6. Measurement of gear tooth profile using gear tooth Venire /Gear tooth micrometer

7. Calibration of Micrometer using slip gauges 8. Study of various gear tooth profile using Optical Flats.(Activity) Study of Screw thread Parameters using two wire or Three-wire methods.(Activity)	
List of Experiment **PART-A: MECHANICAL MEASUREMENTS** 6. Calibration of Pressure Gauge 7. Calibration of Thermocouple 8. Calibration of LVDT 9. Calibration of Load cell 10. Study of modulus of elasticity of a mild steel specimen using strain gauges.(Activity) **PART-B: METROLOGY** 9. Measurements using Optical Projector / Toolmaker Microscope. 10. Measurement of angle using Sine Center / Sine bar / bevel protractor 11. Measurement of alignment using Autocollimator / Roller set 12. Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer. 13. .Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator 14. Measurement of gear tooth profile using gear tooth Venire /Gear tooth micrometer 15. Calibration of Micrometer using slip gauges 16. Study of various gear tooth profile using Optical Flats.(Activity) 17. Study of Screw thread Parameters using two wire or Three-wire methods.(Activity)	

Course outcomes: By the end of the course student shall be able to **CO1**: To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer. **CO2:** To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set. **CO3**: To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats. **C04** :To measure cutting tool forcesusing Lathe/Drill tool dynamometer. **CO5**: To Study Screw thread parameters using 2-Wire or 3-Wire method and measure gear tooth profile using gear toothvernier /Gear tooth micrometer.	
Question paper pattern: ● The question paper will have ten full questions carrying equal marks. ● Each full question will be for 20 marks. ● There will be two full questions (with a maximum of four sub- questions) from each module. ● Each full question will have sub- question covering all the topics under a module. The students will have to answer five full questions, selecting one full question from each module.Scheme of Examination: ONE question from part -A: 30 Marks ONE question from part -B: 50 Marks Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 50 Marks)	

Course Code	22MEL47	Course Title	MACHINE SHOP	Semester	IV
Credits	2	L – T – P –TL*	1 – 0 – 2 - 3	Teaching Hrs	42
Total Marks	100	CIE*	50	SEE*	50

***NOTE: L – Lecture; T – Tutorial; P – Practical; TL – Total;**

CIE – Continuous Internal Evaluation; SEE – Semester End Examination

Course Learning Objectives: This course will enable students to;	**Teaching Hr**
• To understand various operations carry out through various machines. • To provide knowledge about various machine tools. • To learn turning, milling and shaping operations. • Introduce measuring instruments and familiarize the students about measurement of surface roughness.	
List of Experiments **PART-A:** Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning. **PART-B** Cutting of V Groove/ dovetail / Rectangular groove using a shaper Cutting of Gear Teeth using Milling Machine. **PART C** For demonstration Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling	

Course outcomes: By the end of the course the student shall be able to

CO1: Identify the various operations required to prepare the model.CO2: Select the suitable machine for a particular operation.

CO3: Prepare the specimen as per the given dimension for the given raw material.

CO4: Demonstrate the measurement of cutting forces, thread parameters, gear parameters and angles of the component.CO5: Prepare the document based on the experiment/test conducted.

Question paper pattern:

The students will have to answer ONE full questions, selecting one full question from each module.

Scheme of Examination:

ONE question from part -A: 30 MarksONE
question from part -B: 50 Marks

Viva -Voice: 20 Marks Total: 100 Marks (To be reduced to 50 Marks)