CURRICULUM 2023 (Autonomous)

Version 2.0

B.TECH
Mechanical Engineering

BTech S5,S6 SYLLABUS

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Mar Ivanios Vidyanagar, Nalanchira, Thiruvananthapuram – 695 015

B.Tech MINORS

Semester	BASKET I Supply Chain and Logistics				BASKET II Unmanned Aerial Vehicle (UAV)				BASKET III Computational Design Engineering			
	Course code	Course Name	L-T-P-J	Credits	Course code	Course Name	L-T-P-J	Credits	Course code	Course Name	L-T-P-J	Credits
S3	23MEL2MA	Supply chain and Logistics Management	3-0-0-0	3	23MEL2MC	Introduction to Unmanned Aerial Vehicles (UAV)	2-1-0-0	3	23MEL2ME	Computer Aided Design	2-1-0-0	3
S4	23MEL2MB	Emerging Technologies in SCM	2-1-0-0	3	23MEL2MD	Basics elements of UAV system	2-1-0-0	3	23MEL2MF	Finite Element Method	2-1-0-0	3
S5	23MEL3MA	Green Logistics and operations management	2-1-0-0	3	23MEL3MC	Design and Simulation of UAV	2-1-0-0	3	23MEL3ME	Computational Mechanics	2-1-0-0	3
S6	23MEL3MB	Digital Manufacturing Transformation	2-1-0-0	3	23MEL3MD	Fabrication and Testing of UAV	2-1-0-0	3	23MEL3MF	Optimization Techniques	2-1-0-0	3
S7/S8	23MEJ4MA	Mini Project	0-0-6-0	3	23MEJ4MC	Mini Project	0-0-6-0	3	23MEJ4ME	Mini Project	0-0-6-0	3

B.Tech HONORS

Semester	Basket 1: Power Plant and Energy Engineering				Basket 2: Manufacturing Engineering			
	Course Code	**Course Name**	**L-T-P-J**	**Credit**	**Course Code**	**Course Name**	**L-T-P-J**	**Credit**
4	**23MEL2HB**	Thermal and Nuclear Power Plants	**2-1-0-0**	**3**	**23MEL2HD**	Additive Manufacturing	**2-1-0-0**	**3**
5	**23MEL3HA**	Emerging Technologies in Renewable Energy Sources	**2-1-0-0**	**3**	**23MEL3HC**	Theory of Metal Forming	**2-1-0-0**	**3**
6	**23MEL3HB**	Equipment Design for Thermal Systems	**2-1-0-0**	**3**	**23MEL3HD**	Reliability Engineering	**2-1-0-0**	**3**
7	**23MEL4HA**	Environmental and Safety Engineering	**2-1-0-0**	**3**	**23MEL4HC**	Manufacturing Automation	**2-1-0-0**	**3**
8	**23MEJ4HB**	Mini Project	**0-0-6-0**	**3**	**23MEJ4HD**	Mini Project	**0-0-6-0**	**3**

Semester	Basket 3: Machine Design				Basket 4: Sports Engineering and Management			
	Course Code	**Course Name**	**L-T-P-J**	**Credit**	**Course Code**	**Course Name**	**L-T-P-J**	**Credit**
4	**23MEL2HF**	Continuum Mechanics	**2-1-0-0**	**3**	**23MEL2HH**	Sports Psychology	**2-1-0-0**	**3**
5	**23MEL3HE**	Advanced Design Synthesis	**2-1-0-0**	**3**	**23MEL3HG**	Sports Analytics	**2-1-0-0**	**3**
6	**23MEL3HF**	Design of Pressure Vessels	**2-1-0-0**	**3**	**23MEL3HH**	Sports Engineering	**2-1-0-0**	**3**
7	**23MEL4HE**	Advanced Theory of Vibrations	**2-1-0-0**	**3**	**23MEL4HG**	Sports Product Design	**2-1-0-0**	**3**
8	**23MEJ4HF**	Mini Project	**0-0-6-0**	**3**	**23MEJ4HH**	Mini Project	**0-0-6-0**	**3**

S5 Program Elective I

Management Course			
Course Code	**Course Name**	**L-T-P-J**	**Credit**
23MEL31A	Management Information System	**3-0-0-0**	**3**
23MEL31B	Total Quality Management	**3-0-0-0**	**3**
23MEL31C	Human Resource Management	**3-0-0-0**	**3**
23MEL31D	Entrepreneurship Development	**2-1-0-0**	**3**

SEMESTER V

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MEL30A	Dynamics and Design of Machinery	PCC	3	1	0	0	4	2023

i) COURSE OVERVIEW

This course covers the dynamics of flywheels in machines using turning moment diagrams, the gyroscopic effect in automobiles, and the balancing of machines. It also provides a detailed analysis of free and forced vibrations in single-degree-of-freedom systems. Additionally, the course explores the design of machine elements under static and fatigue loading, as well as welded and riveted joints.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Analyse the dynamics of flywheel and gyroscopic effect.	Apply
CO2	Analyse rotating and reciprocating masses for its unbalance	Apply
CO3	Analyse the vibration of single degree of freedom systems	Apply
CO4	Design machine elements subjected to static and fatigue loading.	Apply
CO5	Design welded and riveted joints in machine elements.	Apply

iii) SYLLABUS

Design of flywheels. Gyroscopic couple in two wheelers, four wheelers, sea vessels and air crafts.

Static and dynamic balancing. Balancing of reciprocating masses -Single cylinder engine- multi cylinder engine- V engines.

Mechanical Vibrations- free vibration of single degree undamped systems. Forced vibration- magnification factor- base excitation- rotating unbalance- transmissibility- whirling of shafts.

Introduction to design- Design under static loads, impact loads, simple and combined fatigue loading. Design of riveted joints- efficiency of joint. Design of welded joints- fillet weld in tension, under torsion and bending. eccentrically loaded welds.

iv) a) TEXTBOOKS

1. D.H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, 4th edition, Pearson Education,2011.
2. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,2010
3. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill,2017
4. S. S. Rattan, Theory of Machines, 5th Edition, Tata Mc Graw Hill,2019

5. Bhandari V B, Design of Machine Elements, Tata McGraw-Hill Education, 2010

b) REFERENCES

1. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education,2005.
2. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and synthesis Vol I & II, Prentice Hall of India,1984.
3. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press,2008

v) COURSE PLAN

Module	Contents	No. of hours
I	Flywheels-turning moment diagram- Design of flywheels. Gyroscopes- precession -gyroscopic couple -effects on the stability of two wheelers, four wheelers, sea vessels and air crafts.	12
II	Static balancing-dynamic balancing-graphical or analytical method. Balancing of reciprocating masses -Single cylinder engine-multi cylinder engine- V engines.	12
III	Mechanical Vibrations- free vibration of single degree undamped systems- natural frequency-energy method- Newton's second law (free body diagram)-damped systems- logarithmic decrement. Forced vibration- Harmonic excitation- Magnification Factor- Base excitation- rotating unbalance- transmissibility- whirling of shafts.	12
IV	Introduction to design-definition, steps in the design process, factor of safety, combined stresses, stress concentration factor- Design under static loads, impact loads. Design of machine elements under simple and combined fatigue loading- Gerber, Goodman and Soderberg criteria.	12
V	Design of riveted joints- material for rivets, modes of failure, efficiency of joint, design of boiler and tank joints. Design of welded joints-welding symbols, stresses in fillet and butt welds, fillet weld in tension, fillet joint under torsion, fillet weld under bending, eccentrically loaded welds.	12
	Total	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL30B	Thermal Engineering	PCC	3	1	0	0	4	2023

i) COURSE OVERVIEW:

This course involve the application of principles studied in thermodynamics to different energy conversion systems like steam turbine, steam nozzle, steam powerplant, IC engines and refrigeration systems. This course also covers the methods for improving and evaluating the performance of different energy conversion systems.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the concept and working of steam power cycles, steam turbines, nozzle, refrigeration and air conditioning systems.	Understand
CO 2	Apply thermodynamic principles to study the performance of steam turbines, steam Nozzles.	Apply
CO 3	Apply the thermodynamic concepts to study the performance of IC engines.	Apply
CO 4	Explain the combustion phenomenon and pollution in IC engines.	Understand
CO 5	Apply the thermodynamic principles to study the performance of refrigeration and air-conditioning system.	Apply

iii) SYLLABUS

Steam engineering- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle. Steam Boilers: Types of boilers, Boiler Mountings and Accessories. Steam nozzles:-Types of nozzle- Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow.

Steam Turbines - Classification, compounding of turbines-pressure velocity variation, velocity diagrams. Work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency. Reheat factor, degree of reaction, governing of turbines.

Actual cycle analysis of IC engines– Deviation of actual engine cycle from ideal cycle, variable specific heat. Performance Testing of I C Engines- Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency, mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption

Combustion in IC engines- Analysis of fuel combustion-A/F ratio, equivalence ratio, excess air. Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels; pre- ignition; S.I. engine combustion chambers. Combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.

Refrigeration - Reversed Carnot cycle, Air refrigeration system - Reversed Joule cycle. Vapour compression systems-simple cycle - representation on T- s and P- h Diagrams. Effect of operating parameters on COP, Methods of improving COP of simple cycle, Super heating and under cooling. Psychometric properties – specific humidity, relative humidity and degree of saturation- thermodynamic equations- enthalpy of moisture- DBT, WBT and DPT–psychrometers, psychometric chart. Psychometric process. Comfort and Industrial air conditioning.

iv) (a) TEXT BOOKS

1) R.K Rajput, Thermal Engineering, Laxmi publications, Tenth Edition, 2018.

2) R. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2017.

3) Mahesh M Rathore, Thermal Engineering, McGraw Hill Education India, First Edition, 2010.

4) Arora S. C. and Domkundwar, Refrigeration and Air-Conditioning, Dhanpat Rai, 2018.

5) Arora C. P, Refrigeration and Air-Conditioning, McGraw-Hill, 2017.

(b) CODES OF PRACTICE

1) R.S.Khurmi, Steam table with Mollier chart,S.Chand,2008.

2) C P Kothandaraman, Refrigeration Tables & chart, New age International Private Limited,2015.

(c) REFERENCES

1) V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002.

2) J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011.

3) T. D. Eastop and A McConkey, Applied thermodynamics for engineering technology, Pearson education,1996.

4) Stoecker W.F, Refrigeration and Air-Conditioning, McGraw-Hill Publishing Company, 1989.

V) COURSE PLAN

Module	Contents	No. of hours
I	Steam engineering- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapour cycle. Steam Boilers: Types of boilers, Boiler Mountings and Accessories. Steam nozzles: -Types of nozzle, Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow.	**12**
II	Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, multistage turbines- condition line, stage efficiency. Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines.	**12**
III	Actual cycle analysis of IC engines- Deviation of actual engine cycle from ideal cycle, variable specific heats. Rotary engines, Stratified charge engine, Super charging and turbo charging. Performance Testing of I C Engines- Indicator diagram, mean effective pressure. Torque, Engines- Indicator diagram, mean	**12**

	effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency, mechanical efficiency, volumetric efficiency, thermal efficiency, relative efficiency and Specific fuel consumption. MORSE test, Heat balance and Retardation test.	
IV	Combustion in I.C. Engines- Analysis of fuel combustion-A/F ratio, equivalence ratio, excess air. Combustion phenomena in S.I. engines; stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; octane rating of fuels; pre-ignition; S.I. engine combustion chambers. Combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating;. Air pollution from I.C. Engine and its control.	**12**
V	Refrigeration– Reversed Carnot cycle, Air refrigeration system- Reversed Joule cycle. Vapour compression systems-simple cycle - representation on T- s and P-h Diagrams. Effect of operating parameters on COP, Methods of improving COP, Super heating and under cooling. Psychometric properties – specific humidity, relative humidity and degree of saturation, thermodynamic equations. Psychometric chart. Psychometric processes- adiabatic mixing, sensible heating and cooling, humidifying and dehumidifying, air washer, bypass factor, sensible heat factor, Comfort and industrial air conditioning, factors affecting cooling load estimation.	**12**
	Total	**60**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Continuous Assessment Tests (2 Nos)	:	20 marks
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
Total	**:**	**100 marks**

VII) CONTINUOUS ASSESMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

VII) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEJ30C	Machine Tools and Metrology	PCC	2	1	0	1	4	2023

i) COURSE OVERVIEW

Objective of the course is to develop a platform where the students can develop knowledge of appropriate process parameters to be used for various machining operations. They should be able to understand the fundamentals of modem quality concept. They will also understand the principles and operation of precision measurement tools and equipment used in modern manufacturing.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Explain the different forces and material removal phenomenon in various machining processes.	Understand
CO 2	Demonstrate the working of different machine tools including lathes, shaper, milling, drilling, grinding, broaching machines and CNC part programming.	Understand
CO 3	Solve for the cutting forces and their variation due to different process parameters.	Apply
CO 4	Explain various aspects of metrology and surface roughness.	Understand
CO 5	Illustrate the working of various measuring instruments and machines used in engineering metrology.	Understand
CO6	Make use of conventional and CNC machine tools to fabricate a model or prototype as per desired requirements.	Apply

iii) SYLLABUS

General purpose machine tools – types and classification of machine tools –types and classification of lathe – methods of holding work and tool –lathe accessories and attachments –lathe operations -tool room lathe – duplicate lathe –capstan and turret lathe – horizontal and vertical-single spindle and multi spindle screw machines - Shaping, Plaining and Slotting machines – Work holding devices-types of operations - surface roughness obtainable indexing - Drilling and boring Machines – -Drill bit nomenclature-cutting forces in drilling – tool and work holding devices-boring tools and reamer.

Milling Machines- Cutting forces in milling – Calculation of machining time. Indexing head - Different indexing methods -Grinding, honing and lapping – types of grinding machines-operations: cutting forces in grinding -Grinding mechanisms – Grinding wheels - surface roughness obtainable in grinding, honing and lapping.

Broaching machines – cutter for broaching – broaching processes.

Metrology –principles of achieving accuracy -Theory of tolerances and allowances –

system of limits and fits – types of fits – interchangeability and selective assembly – standards of measurements- Gauges – classification of gauges –principle of gauge tolerance –wear allowance. Instruments for checking straightness, flatness and squareness–pneumatic gauging – precision gauging – automatic gauging for inspection- Optical measuring instruments – Comparators Measurements of surface roughness –- gauging and measurements of screw and gears- Advanced measuring devices – Laser interferometers- Coordinate Measuring Machine (CMM)

iv) a) TEXTBOOKS

1. Amitabha Ghosh and Mallick A. K., Manufacturing Science. Affiliated East-West Press Pvt. Ltd. 2010
2. Serope Kalpakjian; Steven R. Schmid, Manufacturing Engineering and Technology, 7th Edition, Publisher: Prentice Hall, ISBN-10 0-13-608168-1, 2018.

b) REFERENCES

1. HMT, Production Technology, Tata McGraw-Hill,2017.
2. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E , Pearson Prentice Hall, 2007.

v) COURSE PLAN

Module	Contents	Hours
I	General purpose machine tools – types and classification of machine tools – Lathe – types and classification of lathe – specification for a lathe –Feed, depth of cut, speed-methods of holding work and tool – lathe accessories and attachments –lathe operations and tools used for each operations, Types of lathe. Shaping, Plaining and Slotting machines – Types and specifications – quick return motion –hydraulic feed and its advantages - automatic feed – speed, feed and depth of cut– Work holding devices-types of operations Drilling and boring Machines – Types and specifications – Brief descriptions about the machines and nature. Drill bit nomenclature - cutting forces in drilling – tool and work holding devices -boring tools and reamers	13
II	Milling machines – types and specifications- Milling operations and types of milling cutters used for each - Milling tool nomenclature - Cutting forces in milling – Calculation of machining time - Indexing head and its use - Different indexing methods - Differential indexing (Fundamentals only) Grinding, honing and lapping – types of grinding machines - operations: cylindrical, surface and center less grinding – internal grinding, tool and cutter grinding - cutting forces in grinding - Grinding mechanisms – Grinding wheels: Specification – types of abrasives, grain size -Types of bond, grade, and structure – Marking system of grinding wheels.	12
III	Broaching machines –different machines – cutter for broaching – different broaching processes – internal external broaching. NC part programming: part programming fundamentals – manual	10

	programming –NC coordinate systems and axes – tape format – sequence number, preparatory functions, dimension words, speed word, feed world, tool world, miscellaneous functions – Computer aided part programming: – CNC languages – APT language structure. Simple CNC programming exercises on turning and drilling.	
IV	Metrology –principles of achieving accuracy –economic machining accuracy – precision vs accuracy - errors- standards of measurements. Theory of tolerances and allowances –system of limits and fits – types of fits – interchangeability and selective assembly – Taylor's Principle Gauges – classification of gauges - plug, ring, taper angle, slip and snap gauges –feeler gauges -dial indicator –principle of gauge tolerance –wear allowance -gauge materials	**12**
V	Instruments for checking straightness, angle, flatness and squareness of guiding surface. Optical measuring instruments, basic principle – interferometer - optical flat –optical tool makers 'microscope - autocollimator. Comparators – mechanical, optical, pneumatic, electric and electronic comparators. (Fundamentals only). Measurements of surface roughness – elements of roughness – symbols specifying –instruments and for measuring surface roughness - Measurements of screw: terminology, measurement of screw thread elements -measurement of gears: terminology, errors in spur gears, measurement of gear elements. Advanced measuring devices – Laser interferometers - Coordinate Measuring Machine (CMM)	**13**
	Total	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Course project	:	20 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

NB: **It is mandatory that a course project shall be undertaken by each student for this course. Evaluations will be performed on the project and upon successful completion a brief report must be submitted by the student.**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MEL30D	PRODUCTION AND OPERATIONS MANAGEMENT	PCC	3	0	0	0	3	2023

i) COURSE OVERVIEW

The objective of this course is to impart students to the fundamentals of operations management and various techniques for application to industrial needs. Student will be able to understand the methods of production scheduling, demand forecasting and logistics management through this course.

ii COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the types of production system, facility location techniques, production scheduling and demand forecasting.	Understand
CO2	Explain the Layout planning techniques and Material handling selection.	Understand
CO3	Explain the Work study and Quality management techniques.	Understand
CO4	Apply the techniques of production planning scheduling and demand forecasting	Apply
CO5	Explain the role of Logistics management in Supply chain	Understand

iii) SYLLABUS

Production and Operations Management: Types of Production Systems, Strategic Operations Management, Operations Strategies, Facilities location: Facility location factors, location analysis techniques

Plant location & Layout: Principles of layout, Layout Tools and Techniques, Materials Handling, Material Handling Principles, Types, Selection and Design of Handling System.

Materials Management: Inventory Models, EOQ, Work Study, Work Measurement. Quality Management, Statistical Quality Control (SQC), Total Quality Management (TQM), Kaizen, Six sigma, ISO Systems, Supply chain management

Production /Operations Planning & Control: Aggregate Planning, Master Production Schedule, Scheduling, Line Balancing and sequencing, Capacity Planning, Demand forecasting components of forecasting demand.Algorithms for production scheduling

Logistics Management: Third party logistics -Fourth party logistics, Stages-Role of logistics providers, Strategic role of Logistics Management.

iv) a) TEXTBOOKS

1. Pannerselvam, R. Production and Operations Management, New Delhi, Prentice Hall of India.2012

2. Buffa, E.S. and Sarin, R.K. Modern Production/Operations Management, New Delhi, Wiley India.2007
3. Pannerselvam, R. Production and Operations Management, New Delhi, Prentice Hall of India.2012

b) REFERENCES

1. Starr. M. K. Production Management - Systems and Synthesis, New York, Prentice Hall.1972
2. Gaither, N. Production and Operations Management. Cincinnati, South Western College Publications.2002

v) COURSE PLAN

Module	Contents	No. of hours
I	**Production and Operations Management:** Types of Production Systems- Job , Batch ,Mass, Continuous, Strategic Operations Management, Role of Operations Strategy, Operations Strategies, Capacity Planning ,Facilities location: Facility location factors, Location analysis techniques- Qualitative Techniques ,Quantitative Techniques	9
II	**Plant location & Layout:** Principles of layout-Product layout, Process layout,Fixed position layout .Layout Tools and Techniques-Flow process chart,Travel chart,REL Chart. Materials Handling, Material Handling Principles, Types, Selection and Design of Handling System.	9
III	**Materials Management:** Inventory Models- Deterministic Models, EOQ, Work Study- Method study , Work measurement. Quality Management, Statistical Quality Control (SQC)- Control chart, Total Quality Management (TQM)-PDCA cycle, Bench marking Kaizen, Six sigma,DMAIC pocess, ISO Systems-ISO 9001, ISO 14001, Supply chain management	11
IV	**Production /Operations Planning & Control:** Aggregate Planning, Master Production Schedule,Material Requirement Planning, Scheduling- Forward and Backward, Line Balancing and sequencing, Capacity Planning, Demand forecasting, Components of forecasting demand - Trend,Seasonality.Algorithms for production scheduling-Johnson's rule	7
V	**Logistics Management:** Third party logistics ,Fourth party logistics-Key characterisctics and functions , Stages-Inbound,Internal,Outbound,Reverse,Role of logistics providers, Strategic roles and functions of Logistics Management.	9
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23ESL00A	DESIGN ENGINEERING	ESC	2	0	0	0	2	2023

i. COURSE OVERVIEW

Goal of this course is to expose the students to the fundamental principles of design engineering. Students are required to utilize design thinking as a crucial and pertinent approach to learning, reflecting its significance and relevance in contemporary contexts. The course also focuses on familiarizing the students with the concepts of innovative idea generation and presentation along with its market viability and business model.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Demonstrate the ability to effectively apply the principles of the design process in solving real-world engineering challenges.	Apply
CO 2	Analyse user needs and frame well-defined problem statements	Analyse
CO 3	Create innovative ideas to solve real-world problems by applying the principles of Design Thinking	Create
CO 4	Explain the concepts of Modular design, Ergonomics and Aesthetics to address design challenges	Understand
CO 5	Create a pitch deck and deliver a presentation that effectively communicates an innovative idea.	Create

iii. SYLLABUS

Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Empathize: Understanding User Needs, Define- Framing the Problem. Translating empathy findings into actionable problem statements.

Ideate: Brainstorming, Steps in Brain Storming: Divergent-Convergent Thinking and Questioning. Prototype: Inexpensive prototypes to quickly explore and iterate on ideas.

Test: Gathering feedback from real users through interactions.

Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Bio-mimicry, Aesthetics and Ergonomics in Design. Design for Production, Use, and Sustainability.

Product Viability and Business Model- Value Proposition, Market Opportunity, Cost-Revenue Relationship, Technology and Implementation, Competitive Analysis, Traction and Milestones.

iv (a) TEXT BOOKS

1. Yousef Haik, Sangarappillai Sivaloganathan, Tamer M. Shahin, Engineering Design Process, Third Edition, Cengage Learning, January 2017.
2. Michael Lewrick, Patrick Link, Larry Leifer, Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, Wiley Publications, June 2018
3. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Wiley Publications, April 2020
4. A Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want, Wiley Publications, October 2014

(b) REFERENCES

1. Dr. Amitkumar Goudar, The Secrets of Design Thinking Mindset: More Tools And Techniques To Enhance Your Design Thinking Skill, Clever Fox Publishing, October 2023
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving, Penguin Random House India Private Limited, 2020
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business; Revised, Updated edition, March 2019
4. Don Norman , The Design of Everyday Things, Basic Books; 2 edition November 2013
5. Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

v. COURSE PLAN

Module	Contents	Hours
I	Design Process: - Defining a Design Process-: Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design. Practical Exercise: Need Identification Case studies. How to define a Problem Statement. Present an idea using the stages of the Design Process.	6
II	Design Thinking Approach: -Introduction to Design Thinking. Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Empathize: Understanding User Needs, Gathering meaningful insights from users. Define: Framing the Problem. Translating empathy findings into actionable problem statements. Utilizing tools such as problem statements, point-of-view statements, and user personas. Practical Exercise: Analyse user needs and frame well-defined problem statements	6
III	Ideate: Brainstorming, Steps in Brain Storming: Divergent-Convergent Thinking and Questioning. Prototype: Low-Fidelity Prototyping: Building rough, inexpensive prototypes using materials like paper, cardboard, or digital wireframes to quickly explore and iterate on ideas. Test: Gathering feedback from real users through interviews, surveys, or usability tests to evaluate prototypes and refine designs. Practical Exercise: Design Thinking in a Team Environment. Create innovative ideas to solve real-world problems by applying the principles of Design Thinking	6
IV	Design Engineering Concepts: Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry, Aesthetics and Ergonomics in Design. Design for Production, Use, and Sustainability. Design Communication: Communicating Designs Graphically, Communicating Designs Orally and in Writing. Practical Exercise: Apply the concepts of Modular design, Ergonomics and Aesthetics to address design challenges	6
V	Product Viability and Business Model: Customer Segments, Value Proposition, Market Opportunity, Cost- Revenue Relationship,	6

	Technology and Implementation, Competitive Analysis, Traction and Milestones. Practical Exercise: Create a Pitch deck and make a presentation of the idea generated along with its business model.	
	Total Hours	**30**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Evaluation – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignment	:	15 marks
Assessment through Test	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Evaluation (Design Presentation)	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 01
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EVALUATION (60 Marks)

The end semester evaluation for Design and Engineering will consist of a group presentation, with a maximum group size of 5 students. Students will be required to apply the fundamentals of design thinking learned during the course to identify and address a problem statement. The problem statement shall be selected from the pool of problems provided by various Government departments and industries listed in initiatives such as Smart India Hackathon or Young Innovators Programme or their own solution to a potential regional real-world problem.

Mark Distribution for Design Presentation (60 Marks):

Understanding of User Needs and Problem Statement: 10 marks

Demonstrating a clear understanding of user needs and articulating a well-defined problem statement.

Creativity and Innovation in Solution Design: 10 marks

Presenting innovative and creative solutions that address the identified problem statement effectively.

Product Market Fit: 10 Marks

Evaluating the market potential and ensuring alignment between the proposed solution and market demands.

Clarity and Effectiveness of Presentation: 10 marks

Delivering a clear and engaging presentation that effectively communicates the proposed solution and its benefits.

Competitive Analysis: 10 Marks

Conducting a thorough analysis of competitors and market dynamics to inform strategic decision-making.

Individual and Teamwork: 10 Marks

Assessing individual contributions to the presentation as well as the effectiveness of teamwork and collaboration within the group.

This evaluation format provides students with an opportunity to apply their knowledge and skills in design thinking to real-world problems, while also evaluating their ability to work effectively in teams and deliver compelling presentations.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEP30A	METROLOGY AND INSTRUMENTATION LAB	PCC	0	0	2	0	1	2023

i) COURSE OVERVIEW:

Objective of the course is to develop a platform where the students can enhance their engineering knowledge in measurement principles by applying the theoretical knowledge acquired. Students can also gain hands-on experience in using instruments like micrometers, Vernier calipers, dial gauges, height gauges and CNC machines.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Apply the procedures to measure length, angles, width, depth, bore diameters, internal and external tapers and tool angles by different instruments and utilize grinding machines to conduct simple finishing operations.	Apply
CO 2	Utilize effective methods of measuring straightness, Squareness, flatness, roundness, profile, screw threads and gear teeth	Apply
CO 3	Utilize various sensors and transducers for strain and displacement measurements.	Apply
CO 4	Make use of CNC machines to conduct facing, turning and milling operations on a given work piece as per desired requirements.	Apply

iii) LIST OF EXPERIMENTS

1. Displacement measurement using LVDT
2. Calibration of vernier caliper, micrometer and dial gauge
3. Screw thread measurement using Tool maker's microscope
4. Screw thread measurement using Profile projector
5. Gear dimensions' measurement using Profile projector
6. Rotation measurement using tachometer and stroboscope
7. Flatness measurement for different surfaces using optical flats
8. Measurement of angle using Sine bar
9. Roundness measurement experiment
10. Measurement of V angle using rollers
11. CNC simulation and experiment in lathe
12. CNC simulation and experiment in milling machine.
13. Acceptance sampling tests using vernier caliper and micrometer
14. Exercise on surface grinding and cylindrical grinding

15. Experiment using Tool maker's microscope.

(Note: Minimum 12 experiments to be conducted as part of the course.)

iv) REFERENCES

1) Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill.

2) Shotbolt C.R. and Gayler J.F.W, Metrology for Engineers, 5th edition, ELBS, London.

3) Sharp K.W.B. and Hume, Practical Engineering Metrology, Sir Isaac Pitman and sons Ltd

v) CONTINUOUS ASSESMENT EVALUATION PATTERN

Continuous Assessment: 100 marks

Attendance	:	**5 marks**
Lab work/ Viva	:	**55 marks**
Final Exam	:	**40 marks**
Total	:	**100 marks**

vi) END SEMESTER EXAMINATION PATTERN

Maximum marks: **40 marks**

Duration – **3 hours**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEP30B	THERMAL ENGINEERING LAB	PCC	0	0	3	0	2	2023

i) COURSE OVERVIEW:

Objective of the course is to develop a platform where the students can enhance their engineering knowledge in thermal engineering domain by applying the theoretical knowledge acquired.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Conduct performance test on engine with different loading systems	Apply
CO 2	Analyse the performance characteristics of different engines	Apply
CO 3	Measure the properties of different fuels and oils used in engine	Apply
CO 4	Conduct performance test on blower and compressors	Apply

iii) LIST OF EXPERIMENTS

1. Determination of flash and fire points of petroleum fuels and oils.
2. Determination of viscosity of lubricating oils and fuels and its variation with temperature.
3. Determination of calorific value of solid and liquid fuels- Bomb Calorimeter
4. Familiarization of various systems and subsystems of petrol engine, MPFI engine and diesel engine.
5. Performance test on petrol engines / MPFI engine
6. Performance test on Diesel engines
7. Determination volumetric efficiency and Air-fuel ratio of IC engines
8. Cooling curve and economic speed test on IC engines
9. Valve timing diagram of IC engines
10. Retardation test on IC engines
11. Morse test on petrol engine
12. Performance test on reciprocating/rotary compressor and blower.

Minimum of 10 experiments to be conducted.

iv) REFERENCES

1) J.B.Heywood, I.C engine fundamentals, McGraw-Hill, July 2017

2) V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill, 2017

3) Stephen R Turns, An Introduction to Combustion: Concepts and Applications, McGraw-Hill, 2017

v) CONTINUOUS ASSESMENT EVALUATION PATTERN

Continuous Assessment : 100 marks

Attendance	:	**5 marks**
Lab work/ Viva	:	**55 marks**
Final Exam	:	**40 marks**
Total	:	**100 marks**

vi) END SEMESTER EXAMINATION PATTERN

Maximum marks : 40

Duration – **3 hours**

SEMESTER VI

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEJ30E	HEAT AND MASS TRANSFER	PCC	2	1	0	1	4	2023

i) COURSE OVERVIEW:

The aim of the course is to develop a platform where the students can enhance their engineering knowledge in the various modes of heat transfer and mass transfer.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the concept of various modes of heat and mass transfer, their analogy, and applications.	Understand
CO 2	Apply the principles of steady and transient conductive heat transfer to solve engineering problems.	Apply
CO 3	Apply the principles of convective heat transfer to solve engineering problems.	Apply
CO 4	Apply principles of radiation heat transfer to solve engineering problems.	Apply
CO 5	Make use of the principles of diffusion and convective mass transfer to solve engineering problems.	Apply

iii) SYLLABUS

Modes of Heat Transfer: Conduction: Most general heat conduction equation, One dimensional steady state conduction with and without heat generation, Critical radius of insulation.

Convection: Elementary ideas of hydrodynamics and thermal boundary layers, Convection heat transfer: Newton's law of cooling, Dimensionless numbers, Dimensional analysis, Problems.

Fins: Types of fins, Fin efficiency and effectiveness. Boiling and condensation heat transfer, Introduction to heat pipe. Transient heat conduction.

Heat exchangers: LMTD and NTU methods.

Radiation: Laws of radiation, Electrical analogy, Radiation shields.

Mass Transfer: Mass transfer by molecular diffusion, Convective mass transfer.

iv) (a) TEXT BOOKS

1) Sachdeva R.C., Fundamentals of Engineering Heat and Mass Transfer, New Age Science Limited, 2017, ISBN:9789386070968H.K. Malik, A.K. Singh, *Engineering Physics,* McGraw Hill Education, 2nd Edition, 2017.

2) R.K. Rajput. Heat and mass transfer, S.Chand&Co., 2018. ISBN-109352533844.

3) Nag P.K., Heat and Mass Transfer, McGrawHill, 2011. ISBN-10 :9780070702530.

4) Kothandaraman C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi,2012.

(b) REFERENCES

1) Holman J.P, —Heat transfer‖, Mc Graw-Hill, 10th. Ed.,2009. ISBN: 9780071069670
2) Frank P. Incropera and David P. Dewitt, Heat and Mass Transfer, John Wiley and sons,2018 ISBN-10: 8126578246.
3) Yunus A. Cengel, —Heat and Mass Transfer: Fundamentals and Applications‖ McGraw-Hill Higher Education; 6th edition,2019.

V) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to heat transfer- thermodynamics and heat transfer- typical heat transfer situations- modes of heat transfer- mechanism of heat transfer- basic laws of heat transfer- thermal conductivity- effect of temperature on thermal conductivity- combined heat transfer mechanism-real life situations of combined heat transfer. Differential equations of heat conduction-boundary conditions and initial conditions, one dimensional steady state situations – plane wall, cylinder, sphere. Concept of thermal resistance, critical radius, conduction with heat generation. Transient conduction, Lumped capacitance model, concept of Heisler chart. Extended surfaces: Types of fins, thermal analysis of fins.	**12**
II	Convective heat transfer: Concepts of fluid mechanics- hydrodynamic and thermal boundary Layers, thermal entrance region. Relation between fluid friction and heat transfer. External flow Heat transfer- Laminar and turbulent flows over a flat plate, across cylinder and sphere. Internal flow heat transfer through pipes and ducts. Reynolds analogy. Natural convection basics: free convection heat transfer on a vertical flat plate-empirical relations for free convection heat transfer.	**12**
III	Condensation heat transfer phenomena- the condensation Number- Boiling heat transfer Phenomena- Simplified relations for boiling heat transfer. Introduction to heat exchangers-types of heat exchangers-the overall heat transfer coefficient, Fouling factor, heat exchanger design considerations. LMTD analysis of heat exchanger effectiveness- NTU method. Heat transfer through heat pipe.	**12**
IV	Physical mechanism of radiation heat transfer-Radiation properties-; Black body radiation Planck'slaw, Wein's displacement law, Stefan Boltzmann law, Kirchoff's law; Gray body Radiation shape factors- heat exchange between non black bodies-Infinite parallel planes. Radiation heat shield. Radiation combined with conduction and convection.	**12**
V	Introduction to mass transfer- Fick's law of diffusion-Types of solid diffusion, Molecular diffusion in fluids: Steady state molecular diffusion in fluids under stagnant and laminar flow condition. Equimolar counter diffusion.	**12**

	Introduction to mass transfer coefficient. Correlation for convective mass transfer coefficient. Mass transfer coefficients in laminar and turbulent flows.	
	Total	**60**

It is mandatory that a course project shall be undertaken by a student for this subject. Evaluations will be performed on the project and upon successful completion a brief report must be submitted by the student.

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Assignments and Course Project	:	15 marks
Continuous Assessment Tests (2 Nos)	:	20 marks
Project Work	:	20 marks
Total Continuous Assessment	**:**	**60 marks**
End Semester Examination	**:**	**40 marks**
Total		**: 100 marks**

VII) CONTINUOUS ASSESMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

VII) END SEMESTER EXAMINATION

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MEB30F	Computer Aided Design and FEM	PCC	3	0	2	0	4	2023

i) COURSE OVERVIEW

This course covers the basic knowledge of computer aided design methods and finite element methods in solving engineering problems. It also focuses on giving students a hands-on experience in creating assembly and analysis using any modelling and FEA softwares.

ii COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the basics of Computer Aided Design methods	Understand
CO2	Solve simple geometry modifications using transformation operations	Apply
CO3	Explain the basic knowledge of finite element analysis procedures	Understand
CO4	Solve simple structural engineering problems using FEA	Apply
CO5	Develop assembly model of machine elements using any modelling software	Apply
CO6	Solve simple structural and thermal problems using any FEA software	Analyze

iii) SYLLABUS

Introduction to CAD: Historical developments, Industrial look at CAD, . Basics of geometric and solid modeling packages, Transformation of points and line

Algebraic and geometric forms: tangents and normal, blending functions, curves and surfaces.

Solid models and representation scheme: boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modeling.

Introduction to finite element analysis: steps involved in FEM, types of elementsFormulation of stiffness matrix (direct method, 1-D element).simple problems with axial bar element (structural problems only).

Interpolation: selection of interpolation functions, CST element, isoparametric formulation (using minimum PE theorem) , Gauss- quadrature.

iv) a) TEXTBOOKS

1. M.P. Groover, E.M. Zimmers, Jr.CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
2. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2001

b) REFERENCES

1. Chris Mcmahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, Addision Wesley England,1998
2. D. F. Rogers and J. A. Adams, Mathematical Elements in Computer Graphics McGraw- Hill,19
3. Daryl Logan, A First course in Finite Element Method, Thomson Learning,2007
4. David V Hutton, Fundamentals of Finite Element Analysis, THM,2003
5. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill,2007
6. P. Radhakrishnan and S. Subramanyan, CAD / CAM / CIM, New Age Int. Ltd.,2008

v) COURSE PLAN

Module	Contents	No. of hours
I	Introduction to CAD, Historical developments, Industrial look at CAD, Comparison of CAD with traditional designing, Application of computers in Design. Basics of geometric and solid modeling, Packages for CAD/CAM/CAE/CAPP. Transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling. Shearing, rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.	9
II	Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves. Plane surface, ruled surface, surface of revolution, tabulated cylinder, bi- cubic surface, bezier surface, B-spline surfaces and their modeling techniques	9
III	Solid models and representation scheme, boundary representation, constructive solid geometry. Sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modeling.	9
IV	Introduction to finite element analysis - steps involved in FEM- Preprocessing phase – discretisation - types of elements. Formulation of stiffness matrix (direct method, 1-D element) - formulation of load vector - assembly of global equations -implementation of boundary conditions - solution procedure - post processing phase. Simple problems with axial bar element (structural problems only).	9

V	Interpolation – selection of interpolation functions - CST element, stiffness formulation, Linear-Strain Triangle equations, Isoparametric formulation (using minimum PE theorem) , Numerical integration,Full and reduced integration	9
	Total	**45**

vi) LIST OF EXPERIMENTS

Sl. No.	Experiments	No. of hours
1	Creating assembly models of stuffing block	8
2	Creating assembly models of Plummer block	
3	Creating assembly models of Single plate clutch and Cone friction clutch	
4	Creating assembly models of Screw jack	
5	Creating assembly models of Pipe joints	
6	Creating assembly models of Tail stock (minimum 4 models to be done)	
7	Structural analysis. (minimum 3 problems)	14
8	Thermal analysis. (minimum 2 problems)	8
	Total	**30**

vii) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Assessment through Lab work	:	10 marks
Assessment through Lab exam	:	10 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

viii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours

- Topics: 2 ½ modules

ix) END SEMESTER EXAMINATION

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL30G	Mechatronics and Control Systems	PCC	3	1	0	0	4	2023

i) COURSE OVERVIEW

This course aims to provide students with a comprehensive understanding of mechatronics and control systems, integrating mechanical, electrical, and electronic engineering principles. Students will learn the fundamentals of sensors, actuators, logic controllers, control systems and system modelling.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Explain the different types of sensors, actuators and control valves used in mechatronics.	Understand
CO 2	Demonstrate the constructional features and operations in Programmable Logic Controllers (PLC) , CNC machines, Micro Electro Mechanical Systems (MEMS) and control systems.	Understand
CO 3	Illustrate the aspects of mathematical modelling and robotics in mechatronics systems.	Understand
CO 4	Develop simple PLC ladder programs for automation tasks.	Apply
CO 5	Apply stability analysis techniques, including Routh's Hurwitz Criterion and Bode plots to determine system stability, evaluate gain and phase margins, and assess relative stability in control systems.	Apply

iii) SYLLABUS

Structure of Mechatronics system. Sensors – Characteristics – Structure of Mechatronics system. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors.

Actuators: Mechanical actuators, Electrical actuators, Hydraulic and Pneumatic actuators.

Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography,

Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Mechatronics elements.

System modelling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems.

Programmable Logic Controllers (PLC) –Basic structure, input/ output processing.

Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.

Mechatronics in Robotics-Electrical drives, Force and tactile sensors. Range finders: ultrasonic and light-based range finders Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.

Control systems – Open loop and closed loop control systems, Time response specifications, Stability of linear control systems: methods of determining stability, Routh's Hurwitz Criterion. Frequency domain analysis: Frequency domain specifications, Relative stability: gain margin and phase margin. Stability analysis with Bode plot.

iv) a) TEXTBOOKS

1. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.

2. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007

b) REFERENCES

1. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

2. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi, 2006.

v) COURSE PLAN

Module	Contents	Hours
I	Introduction to Mechatronics: Structure of Mechatronics system. Sensors - Characteristics. Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchro. Piezoelectric sensors. Acoustic Emission sensors. Principle and types of vibration sensors. Actuators: Mechanical actuators, Electrical actuators, Hydraulic and Pneumatic actuators	12
II	Directional control valves, pressure control valves, process control valves. Rotary actuators. Hydraulic and pneumatic circuits using standard Symbols.	12

	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.	
III	Mechatronics in Computer Numerical Control (CNC) machines: Mechatronics elements - Machine structure: guide ways, slide ways. Re-circulating ball screws, pre-loading methods. Re-circulating roller screws. System modelling - Mathematical models and basic building blocks of general mechanical, electrical, thermal and fluid system	**10**
IV	Programmable Logic Controllers (PLC) – Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes. Mechatronics in Robotics-Electrical drives, tactile sensors. Range finders: ultrasonic and light-based range finders, Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.	**13**
V	Control systems – Open loop and closed loop control systems. Time response specifications. Time response of first and second order systems to unit step input. Stability of linear control systems: methods of determining stability, Routh 's Hurwitz Criterion. Frequency domain analysis - Relative stability: gain margin and phase margin. Stability analysis with Bode plot. Root Locus Technique: Introduction, properties and its construction.	**13**
	Total	**60**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

.

Course Code	Course Name	Category	L	T	P	J	Credit
23HSL30A	Business Economics and Accountancy	HSC	3	0	0	0	3

i) COURSE OVERVIEW: To familiarize the prospective engineers with elementary Principles of Business Economics and Accountancy to analyse various business structures by using Economics principles and Accounting tools at an elementary level.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the problem of scarcity of resources and consumer behaviour	Understand
CO 2	Examine the production efficiency and profitability with the help of quantitative and qualitative methods	Analyse
CO3	Interpret the macro-economic policies, trends and issues of the economy	Understand
CO4	Analyse business viability with the help of business models and financial planning.	Analyse
CO5	Develop an accurate and compliant balance sheet by classifying and recording financial transactions systematically	Apply

iii) SYLLABUS

Introductory Micro-Economics

Scarcity and choice - Basic economic problems- PPC – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Microeconomic Foundations: Production, Cost, Market Structures & Pricing Strategies

Production function – law of variable proportion – economies of scale – internal and external economies – Cobb-Douglas production function - Cost concepts - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point. Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopolyNon-price competition – Product pricing strategies

Introductory Macro-Economics

Circular flow of income-two sector and multi-sector models- National Income Concepts-Measurement Methods-Problems-Inflation, deflation - Fiscal Policy

(Government spending & taxation) - Monetary Policy (Interest rates & money supply) - Wage Rigidity & Unemployment - Demand-Pull vs. Cost-Push Inflation

Business Models and Financial Planning

Innovation and creativity in entrepreneurship - Business idea generation and feasibility analysis - Business planning (Lean Canvas, SWOT, PESTEL analysis) - Types of business structures (sole proprietorship, partnership, corporation) - Legal aspects and regulatory requirements - Sources of funding: Bootstrapping and personal savings, Venture capital and angel investors, Bank loans and government grants (Startup India, MSME financing), Crowdfunding and alternative finance - Financial planning and forecasting - Challenges in entrepreneurial finance (liquidity, risk management) - Exit strategies (IPO, mergers, acquisitions)

Introduction to Accounting

Book-Keeping and Accountancy- Elements of Double Entry- Book –Keeping-rules for journalizing-Ledger Accounts-Cash book- Banking transactions- Trial Balance- Method of Balancing accounts-the journal proper.

Final accounts: Preparation of trading and profit and loss Account- Balance sheet preparation and interpretation - Introduction to accounting packages. Modern methods in book keeping accounting.

iv) Text Books

1. Gregory N Mankiw, Principles of Micro Economics, Cengage Publications 2023
2. Gregory N Mankiw, Principles of Macro Economics, Cengage Publications 2023
3. Steven Rogers, Entrepreneurial Finance, McGraw-Hill, Fourth Edition, 2020
4. Agrawal R and Sriniwasan R, Accounting Made Easy, Tata McGraw-Hill 2010

REFERENCES

1. Dominick Salvatore, Theory and Problems of Micro Economic Theory. Tata Mac Graw- Hill, New Delhi.2017
2. Dwivedi D.N., Macroeconomics: Theory And Policy, Tata McGraw Hill, New Delhi 2018
3. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 12th edition, 2018.
4. Janet Kiholm Smith and Richard L Smith, Entrepreneurial Finance: Venture Capital, Deal Structure & Valuation, Stanford Business Books US, 2019
5. M.Kasi Reddy and S.Saraswathi, Managerial Economics and Financial Accounting. Prentice Hall of India. New Delhi. 2008

v) COURSE PLAN

Module	Contents	No. of hours
I	Scarcity and choice - Basic economic problems - PPC – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes	9

	in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	
II	Production function – law of variable proportion – economies of scale – internal and external economies – Cobb-Douglas production function - Cost concepts - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point. Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly - Non-price competition – Product pricing strategies	**8**
III	Circular flow of income - two sector and multi-sector models - National Income Concepts - Measurement Methods – Problems - Inflation, deflation - Fiscal Policy (Government spending & taxation) - Monetary Policy (Interest rates & money supply) - Wage Rigidity & Unemployment - Demand-Pull vs. Cost-Push Inflation	**9**
IV	Innovation and creativity in entrepreneurship - Business idea generation and feasibility analysis - Business planning (Lean Canvas, SWOT, PESTEL analysis) - Types of business structures (sole proprietorship, partnership, corporation) - Legal aspects and regulatory requirements - Sources of funding: Bootstrapping and personal savings, Venture capital and angel investors, Bank loans and government grants (Startup India, MSME financing), Crowdfunding and alternative finance - Financial planning and forecasting - Challenges in entrepreneurial finance (liquidity, risk management) - Exit strategies (IPO, mergers, acquisitions)	**9**
V	Book-Keeping and Accountancy - Elements of Double Entry - Book – Keeping - rules for journalizing - Ledger accounts - Cash book- Banking transactions - Trial Balance - Method of Balancing accounts - the journal proper. Final accounts: Preparation of trading and profit and loss Account - Balance sheet preparation and interpretation - Introduction to accounting packages. Modern methods in book keeping accounting	**10**
	Total	**45**

vi) Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	**:**	**40 Marks**

vii) End Semester Examination

There will be an end semester examination for 60 marks with a duration of 3 hours.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEP30C	Heat Transfer Lab	PCC	0	0	3	0	2	2023

i) COURSE OVERVIEW:

The course is intended to enable the students to get exposed to equipment related to heat and mass transfer. This includes understanding the working of equipments related to various heat transfer processes. Apart from this, calibration of various instruments which are essential to these equipments will be done.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Measure experimentally the thermal properties of materials in conduction, convection and radiation under steady state conditions.	Apply
CO 2	Analyse experimentally parallel-flow and counter-flow heat exchangers under steady state conditions.	Apply
CO 3	Analyse experimentally the performance of refrigeration and air-conditioning equipment under steady state conditions.	Apply
CO 4	Analyse experimentally the unsteady state heat transfer process.	Apply

iii) LIST OF EXPERIMENTS

1. Determination of LMTD and effectiveness of parallel flow and counter-flow heat exchangers
2. Determination of heat transfer coefficients in free convection
3. Determination of heat transfer coefficients in forced convection
4. Determination of thermal conductivity of solids (composite wall/metal rod)
5. Heat conduction through fins
6. Determination of thermal conductivity of liquids
7. Measurement of unsteady state conduction heat transfer
8. Determination of emissivity of a specimen
9. Determination of Stefan-Boltzmann constant
10. Study and performance test on refrigeration (Refrigeration Test rig)
11. Study and performance test on air conditioning equipment
12. Performance study on heat pipe

13. Boiling and condensation heat transfer

Minimum 10 experiments to be conducted.

iv) REFERENCES

1. Yunus A. Cengel, —Heat Transfer a Practical Approach, Tata McGraw-Hill Education, 4th Edition, 2012.
2. Yunus A. Cengel, Afshin J. Ghajar, —Heat and Mass Transfer - Fundamentals and Applications, 6th Edition, 2018.
3. Holman J.P, —Heat transfer, Mc Graw-Hill, 10th Ed., 2009
4. Incropera Frank P, — Principles of Heat and Mass Transfer, Wiley Indian Edition, 2018.
5. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2006.
6. Kothandaraman, C P and Subramanyan, S —Heat and Mass Transfer Data Book, 9thEdition, 2018.

v) CONTINUOUS ASSESMENT EVALUATION PATTERN

Continuous Assessment: 100 marks

Attendance	:	**5 marks**
Lab work / Viva	:	**55 marks**
Final Exam	:	**40 marks**
Total	:	**100 marks**

vi) END SEMESTER EXAMINATION PATTERN

Maximum marks: 40

Duration – 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MES38A	SEMINAR	PWS	0	0	4	0	2	2023

i) COURSE OVERVIEW

The course involves exploring academic literature to select a relevant document in the student's area of interest and, under a seminar guide's supervision, develop skills in presenting and preparing technical reports. The course aims to enhance students ability to engage critically with scholarly work and communicate technical information effectively.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Outline topic based on recent advancements and emerging trends	Understand
CO 2	Identify academic documents from the literature which are related to one's areas of interest.	Apply
CO 3	Select and critically analyse key theoretical perspectives associated with the chosen topic	Apply
CO 4	Organize and communicate ideas effectively through presentations on selected topic	Apply
CO 5	Develop a technical report on the topic identified.	Apply

iii) GENERAL GUIDELINES

- An Internal Evaluation Committee (IEC) shall be constituted by the department, comprising the program's HoD/Senior Faculty as Chairperson, along with the seminar coordinator and the student's seminar guide as members. All IEC members must be present during each student's seminar presentation.
- Formation of IEC and guide allotment shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- The seminar topic should be current and broad-based/narrowly focused on specific research. Ideally, it should be closely related to the student's final year project area. Team

members may select or be assigned seminar topics that cover different aspects of their common project theme.

- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

iv. EVALUATION PATTERN

Total Marks	CIE Marks
100	100

CONTINUOUS ASSESSMENT EVALUATION PATTERN

Seminar Guide (20 Marks):

Background Knowledge – 10 marks (based on the student's understanding of the selected topic).

Relevance of Topic – 10 marks (based on the suitability and significance of the s elected paper/topic).

Seminar Coordinator (15 Marks):

Seminar Diary – 10 marks (weekly progress tracked and approved by the guide).

Attendance – 5 marks.

Evaluation of Presentation by IEC (45 Marks):

Clarity of Presentation – 10 marks.

Interaction – 10 marks (ability to answer questions).

Overall Participation – 10 marks (engagement during others' presentations).

Quality of the content – 15 marks.

Marks awarded by IEC for report (20 Marks)

2023 SCHEME

S5 PROGRAM ELECTIVE - MANAGEMENT COURSES

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL31A	Management Information System	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course explains about the types of information system and its classifications. The topics provide a general knowledge application of information management using technology that are used in different functional areas and at different hierarchical levels in an organisation.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Explain the types of MIS in organizations	Understand
CO 2	Explain about the information system used in management	Understand
CO 3	Explain the application systems used in management	Understand
CO 4	Explain about the decision making models in management	Understand
CO5	Illustrate the appropriate MIS to meet management requirements	Understand

iii) SYLLABUS

Concepts on Information management in Organisations - Organisation & Types, Management activities, roles and levels, Decision Making. Management Planning and Control. Data & information, Characteristics & Classification of information, Cost & value of information, various channels of information & MIS.

Foundation of Information System: Fundamentals of Information System in Business, Solving Business Problems with Information System, Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS-dataflow diagram, document flow diagram, flow chart etc.

Business application of information technology: electronic commerce Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations, Information system for managerial Decision Support, Information System for Strategic Advantage. Social , ethical and security Issues in MIS.

Information System-Data and Information-functions-technical and behavioural approach to IS. The nature of information and decision-making at different management

levels. Measurement of MIS performance and capabilities. Database management systems, Data Warehousing, Foundations of business intelligence, Data and Text Mining.

Applications of MIS in functional areas -Enterprise Systems-SCM, CRM, KMS-e-business-e-commerce-e-government. Systems analysis and design – System requirement Analysis, SRS, System development life cycles.

iv) a) TEXTBOOKS

1. Gordon Davis, Management Information System: Conceptual Foundations, Structure and Development, 2017,Tata McGraw Hill
2. Haag, Cummings and Mc Cubbrey, Management Information Systems for the Information Age,2012, McGraw Hill.

b) REFERENCES

1. C. Laudon and Jane Price Laudon, Management Information Systems – Managing the digital firm,16th Edition ,2020,PHI Learning / Pearson Education, PHI.
2. Turban E. F., Potter R. E., Introduction to Information Technology,2005,Wiley

v) COURSE PLAN

Module	Contents	Hours
I	Organisation & Types, Management activities, roles and levels, Decision Making. Management Planning and Control. Data & information, Characteristics & Classification of information, Cost & value of information, various channels of information & MIS.	**9**
II	Foundation of Information System: Fundamentals of Information System in Business, Solving Business Problems with Information System, Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS-dataflow diagram, document flow diagram, flow chart etc.	**9**
III	Business application of information technology: electronic commerce Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations, Information system for managerial Decision Support, Information System for Strategic Advantage. Social , ethical and security Issues in MIS	**9**
IV	Information System-Data and Information-functions-technical and behavioural approach to IS. The nature of information and decision-making at different management levels. Measurement of MIS performance and capabilities. Database management systems, Data Warehousing, Foundations of business intelligence, Data and Text Mining.	**9**
V	Applications of MIS in functional areas -Enterprise Systems-SCM, CRM, KMS-e-business-e-commerce-e-government. Systems analysis and design –	

	System requirement Analysis, SRS, System development life cycles.	**9**
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL31B	Total Quality Management	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course explains the basic concepts of TQM and the tools and techniques used for quality improvement. The course also explains the need for ISO documentation and auditing standards related to TQM implementation.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Explain the concepts and framework of TQM	Understand
CO 2	Outline the principles of TQM for process improvement	Understand
CO 3	Explain the quality management tools and techniques used for performance measurement	Understand
CO 4	Outline the use of cost of quality in TQM	Understand
CO5	Explain the documentation and auditing of quality systems	Understand

iii) SYLLABUS

Basic concepts of TQM - TQM Framework, Performance appraisal- Continuous process improvement, management tools of quality, Control Charts - statistical process control, Quality Function Development (QFD), Cost of Quality, Measuring Quality Costs. Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing.

TQM Principles-Leadership - Strategic quality planning, Quality Councils - Employee involvement

TQM Tools And Techniques- The seven traditional tools of quality - New management tools

The Cost Of Quality- Definition of the Cost of Quality, Measuring Quality Costs

Quality Systems- Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing

iv) a) TEXTBOOKS

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint 2006
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012

b) REFERENCES

1. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

v) COURSE PLAN

Module	Contents	Hours
I	**Introduction** - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation,.	9
II	**TQM Principles**-Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal- Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.	9
III	**TQM Tools And Techniques-** The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Bench marking process - FMEA - Stages, Types. Control Charts - statistical process control - control charts for variables – process capability indices - control charts for attributes - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function .	9
IV	**The Cost Of Quality**- Definition of the Cost of Quality, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management - TPM - Concepts, improvement needs - Performance measures.	9
V	**Quality Systems**- Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.	9
	Total	45

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL31C	Human Resource Management	PEC	3	0	0	0	3	2023

i) COURSE OVERVIEW

This course intends to convey an idea about human resource planning, training and development and the importance of workers' participation in management. The course also gives an overview about the significance of performance appraisal and principles of HRM in an organisation.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Outline the evolution and principles of HRM.	Understand
CO 2	Explain techniques of Human Resource Planning	Understand
CO 3	Explain the implementation of training and development in organisations	Understand
CO 4	Explain the process of performance appraisal and compensation	Understand
CO5	Explain need for workers participation in management.	Understand

iii) SYLLABUS

Introduction to HRM- Evolution of HRM- Systems Approach- Human Resource Planning- Job Design- Recruitment and Selection- Training and Development- Performance Appraisal and Compensation-Workers participation in management- Quality of Work Life.

Human Resource Planning (HRP) - Need and importance- process of HRP- Job analysis- Job description- Job design- Recruitment

Performance Appraisal and Compensation- Performance appraisal: meaning nature- objectives-process and methods.

Development Initiative- Workers participation in management- Team building- Collective bargaining

iv) a) TEXTBOOKS

1. Gary Dessler ,Human Resource Management ,Pearson,15th Edition 2017.
2. Aswathappa, K. Human Resource Management-– McGraw Hill Education,8th

Edition,2017.

b) REFERENCES

1. Llyod Byars, Leslie Rue, Human Resource Management, McGraw Hill Education,11th Edition,2015

v) COURSE PLAN

Module	Contents	Hours
I	Evolution of human resource management – The importance of the human factor – Challenges – Inclusive growth and affirmative action - Personnel management Vs Human Resource Management- functions of HRM- role of human resource manager . Systems approach to HRM	9
II	Human Resource Planning (HRP) - Need and importance- process of HRP- Job analysis- Job description- Job design- Recruitment – meaning- sources- Selection- meaning and importance-steps in selection procedure- interview- types of interview- Induction- Placement-Socialization benefits.	9
III	Training and Development- meaning- importance- methods of training- Development objectives- types of management development	9
IV	Performance Appraisal and Compensation- Performance appraisal: meaning nature- objectives-process and methods of performance appraisal- Compensation to employees- Wage System Incentive wage plan- Profit sharing- Morale- Fringe benefits.	9
V	Development Initiative- Workers participation in management- Team building- Collective bargaining- Absenteeism and turnover- QWL- Definition- Concepts- Constitution of QWL Quality circle- Outsourcing	9
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL31D	Entrepreneurship Development	PEC	2	1	0	0	3	2023

i) COURSE OVERVIEW

The objective of the course is to impart knowledge of entrepreneurship in the modern world. Thus avenues and objectives for novel development can be identified and new horizons can be explored.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Interpret an idea on entrepreneurial perspectives	Understand
CO 2	Explain about identifying and evaluating business opportunities.	Understand
CO 3	Illustrate about the strategies for new ventures.	Understand
CO 4	Explain the financial aspects related to enterprises.	Understand
CO5	Apply methods for evaluating feasibility of ideas.	Apply

iii) SYLLABUS

Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development- characteristics of entrepreneur competencies- managerial functions for enterprise.

Process of business opportunity identification and evaluation- industrial policy- environment market survey and market assessment- project report preparation-study of feasibility and viability of a project-assessment of risk in the industry.

Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment. Entrepreneurship- achievement motivation- time management - creativity and innovation structure of the enterprise- planning, implementation and growth.

Technology acquisition for small units- formalities to be completed for setting up a small scale unit- forms of organizations for small scale units. Role of IPR and types of IPR.

Financing of project and working capital - venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business incubation.

iv) a) TEXTBOOKS

1. Donald Kurado & Hodgelts R.M., Entrepreneurship A contemporary Approach, The Dryden Press, 2016.
2. Dr. Patel V.G., Seven Business Crisis, Tata McGraw hill, Reprint, 2015.

b) REFERENCES

1. Hirich R.D. & Peters Irwin M.P., Entrepreneurship, McGraw Hill, 3e, 2018.
2. Pandey G.W., A complete Guide to successful Entrepreneurship, Vikas Publishing, 2017

v) COURSE PLAN

Module	Contents	Hours
I	Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development- characteristics of entrepreneur competencies- managerial functions for enterprise	**9**
II	Process of business opportunity identification and evaluation- industrial policy- environment market survey and market assessment- project report preparation-study of feasibility and viability of a project-assessment of risk in the industry	**9**
III	Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment. Entrepreneurship- achievement motivation- time management - creativity and innovation structure of the enterprise- planning, implementation and growth	**9**
IV	Technology acquisition for small units- formalities to be completed for setting up a small scale unit- forms of organizations for small scale units. Role of IPR.	**9**
V	Financing of project and working capital - venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business incubation.	**9**
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

B.Tech HONORS

Semester	Basket 1: Power Plant and Energy Engineering				Basket 2: Manufacturing Engineering			
	Course Code	**Course Name**	**L-T-P-J**	**Credit**	**Course Code**	**Course Name**	**L-T-P-J**	**Credit**
4	**23MEL2HB**	Thermal and Nuclear Power Plants	**2-1-0-0**	**3**	**23MEL2HD**	Additive Manufacturing	**2-1-0-0**	**3**
5	**23MEL3HA**	Emerging Technologies in Renewable Energy Sources	**2-1-0-0**	**3**	**23MEL3HC**	Theory of Metal Forming	**2-1-0-0**	**3**
6	**23MEL3HB**	Equipment Design for Thermal Systems	**2-1-0-0**	**3**	**23MEL3HD**	Reliability Engineering	**2-1-0-0**	**3**
7	**23MEL4HA**	Environmental and Safety Engineering	**2-1-0-0**	**3**	**23MEL4HC**	Manufacturing Automation	**2-1-0-0**	**3**
8	**23MEJ4HB**	Mini Project	**0-0-6-0**	**3**	**23MEJ4HB**	Mini Project	**0-0-6-0**	**3**

Semester	Basket 3: Machine Design				Basket 4: Sports Engineering and Management			
	Course Code	**Course Name**	**L-T-P-J**	**Credit**	**Course Code**	**Course Name**	**L-T-P-J**	**Credit**
4	**23MEL2HF**	Continuum Mechanics	**2-1-0-0**	**3**	**23MEL2HH**	Sports Psychology	**2-1-0-0**	**3**
5	**23MEL3HE**	Advanced Design Synthesis	**2-1-0-0**	**3**	**23MEL3HG**	Sports Analytics	**2-1-0-0**	**3**
6	**23MEL3HF**	Design of Pressure Vessels	**2-1-0-0**	**3**	**23MEL3HH**	Sports Engineering	**2-1-0-0**	**3**
7	**23MEL4HE**	Advanced Theory of Vibrations	**2-1-0-0**	**3**	**23MEL4HG**	Sports Product Design	**2-1-0-0**	**3**
8	**23MEJ4HB**	Mini Project	**0-0-6-0**	**3**	**23MEJ4HB**	Mini Project	**0-0-6-0**	**3**

2023 SCHEME

S5 HONOURS

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL3HA	Emerging Technologies in Renewable Energy Sources	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW:

The course provides a comprehensive coverage of the evolving landscape of renewable energy sources and associated technologies. This course covers an imperative for renewable energy demands, and explores various energy sources such as solar, wind, biomass, ocean and fuel cell technology. The course applies basic principles of thermodynamics to study the applications of energy sources and energy conversion and integration systems and introduces aspects of energy audit.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Apply basics of solar radiation to study solar energy systems and outline the energy scenario in India with a focus on solar energy technologies.	Apply
CO 2	Apply basics of fluid mechanics to study wind mills, wind turbine performance, and assess the wind energy potential and installations in India.	Apply
CO 3	Explain biomass energy conversion technologies and applications, and biodiesel production methods.	Understand
CO 4	Explain ocean, geothermal, and tidal energy sources, and demonstrate an understanding of fuel cell technology, hydrogen production and storage, and the integration of fuel cell in hybrid systems.	Understand
CO 5	Make use of case studies to apply the principles and methodologies of energy auditing and management.	Apply

iii) SYLLABUS

Energy Sources: Indian and Global scenario, classification, New emerging technologies, Prospects and achievements of non-conventional energy sources. Environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India. Solar energy – solar radiation, photovoltaic cell, flat plate collectors and their applications, solar air heaters, solar water heater, energy storage systems, Solar energy applications.

Wind Energy: Fundamental concepts, Types of Winds, Classification of different type of Wind mills, Wind Turbine components, Wind characteristics – mean wind velocity, wind velocity duration curve, Power duration characteristics and Turbine efficiency, Weibull distribution characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

Biomass: Energy conversion technologies, Constructional details, Site selection and maintenance, Biofuels. Direct combustion of biomass, Thermo-chemical conversion, Biochemical conversion, Fermentation. Types of biogas plants - applications - alcohol production from biomass – biodiesel production – Urban waste to energy conversion - Biomass energy programme in India.

Ocean energy and fuel cell technology: Ocean thermal electric conversion, Geothermal energy, Tidal energy, Solar distillation, hybrid systems. Fuel cell technology, Hydrogen

production methods and its storage, Need for hybrid systems. Fuel Cell integration: Integration of fuel cells to various thermal system, Hybrid vehicles.

Energy Audit: General Philosophy and need of Energy Audit and Management. Energy audit instruments, Energy Audit Strategies, Quality Control by Energy Audit. Energy Audit Survey Items, Need for Energy Policy for Industries, National and State level energy policies.

iv) (a) TEXT BOOKS

1) Kothari, D. P., Ranjan, R., and Singal, K. C. (2021). Renewable Energy Sources and Emerging Technologies. 3rd Edition, PHI Learning Private Limited.
2) Rai, G. D. (2003). Non-conventional Energy Sources. Khanna Publishers.
3) Sukhatme, S. P. and Nayak, J. K. (2017). Solar Energy, 4th Edition, McGraw Hill.
4) Rao, S. S., and Parulekar. B.B. Energy Technology (Non-Conventional, Renewable and Conventional), Khanna Publishers.

(b) REFERENCES

1) Kanoglu, M., Çengel, Y. A, and Cimbala, J. M. (2023). Fundamentals and Applications of Renewable Energy. 2nd Edition. McGraw Hill.
2) Twidell, J. (2022), Renewable Energy Resources, 4th Edition. Routledge.
3) Márquez, F. P. G., Karyotakis, A., and Papaelias, M. (2018). Renewable Energies: Business Outlook 2050. Springer.
4) Reddy, A.K.N. and Bhalla, A.S. (1997). The Technological Transformation of Rural India, UN Publications.
5) Thumann, A., Niehus, T., and Younger, W. J. (2012). Handbook of Energy Audits. 9th Edition. River Publishers.

V) COURSE PLAN

Module	Contents	No. of hours
I	Energy Sources: Indian and Global scenario, classification, New emerging technologies, Prospects and achievements of non-conventional energy sources. Environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India. Solar energy – solar radiation, photovoltaic cell, flat plate collectors and their applications, solar air heaters, solar water heater, energy storage systems, Solar energy applications.	**9**
II	Wind Energy: Fundamental concepts, Types of Winds, Classification of different type of Wind mills, Wind Turbine components, Wind characteristics – mean wind velocity, wind velocity duration curve, Power duration characteristics and Turbine efficiency, Weibull distribution characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.	**9**
III	Biomass: Energy conversion technologies, Constructional details, Site selection and maintenance, Biofuels. Direct combustion of biomass, Thermo-chemical conversion, Biochemical conversion, Fermentation. Types of biogas plants - applications - alcohol production from biomass – biodiesel production – Urban waste to energy conversion - Biomass energy programme in India.	**9**
IV	Ocean energy and fuel cell technology: Ocean thermal electric conversion, Geothermal energy, Tidal energy, Solar distillation, hybrid systems. Fuel cell	**9**

	technology, Hydrogen production methods and its storage, Need for hybrid systems. Fuel Cell integration: Integration of fuel cells to various thermal system, Hybrid vehicles.	
V	Energy Audit: General Philosophy and need of Energy Audit and Management. Energy audit instruments, Energy Audit Strategies, Quality Control by Energy Audit. Energy Audit Survey Items, Need for Energy Policy for Industries, National and State level energy policies.	**9**
	Total	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Continuous Assessment Tests (2 Nos)	:	20 marks
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
Total	**:**	**100 marks**

VII) CONTINUOUS ASSESMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

VII) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL3HC	Theory of Metal Forming	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW

This course gives an insight of different types of manufacturing/forming processes that are employed in engineering for shaping the metals into useful components. It also describes the design aspects of the forming processes for better productivity.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Explain the concept of plastic deformation for metals and alloys to convert them in to useful shapes for intended engineering applications.	Understand
CO 2	Compare and explain the various metal forming technologies.	Understand
CO 3	Apply various process variables and force parameters influencing the metal forming quality.	Apply
CO 4	Choose the appropriate metal forming technique for required engineering applications.	Apply

iii) SYLLABUS

Classification of metal forming processes, hot, cold and warm working, flow curve for materials, effect of temperature, strain rate and microstructural variables; residual stresses, experimental techniques, yielding theories, processing maps Classification of forging processes, forging equipment, forging defects, plane strain forging analysis, open die forging and close die forging operations, force calculations Classification of rolling processes, rolling mills, cold rolling, hot rolling, rolling of bars, billets and shapes, defects in rolled products, gauge control systems, process variables in rolling Types of extrusion, process variables, extrusion defects, force calculation, wire, rod, and tube drawing, lubrication processes Shearing, blanking, bending, stretch forming, deep drawing, defects in formed products, explosive forming, electro-hydraulic and magnetic forming processes, formability diagrams**.**

iv) a) TEXTBOOKS

1. Narayanasamy R, ‘Metal Forming Technology’, Ahuja Book Company, 1997.
2. Harris J.N, ‘Mechanical Working of Metals-Theory and Practice’, Pergamon Press, 1983

b) REFERENCES

1. William F. Hosford and Robert M. Caddell, 'Metal Forming – Mechanics and Metallurgy', 4 th Edition, Cambridge University Press, 2014.
2. Dieter G. E, 'Mechanical Metallurgy', 3rd Edition, McGraw Hill, 1988

v) COURSE PLAN

Module	Contents	Hours
I	Classification of metal forming processes, hot, cold and warm working, Flow curve for materials, effect of temperature, strain rate and microstructural variables, Residual stresses, experimental techniques, yielding theories, processing maps.	**9**
II	Classification of forging processes, forging equipment, Forging defects, plane strain forging analysis, Open die forging and close die forging operations, force calculations.	**9**
III	Classification of rolling processes, rolling mills. Cold rolling, hot rolling, rolling of bars, billets and shapes. Defects in rolled products, gauge control systems, process variables in rolling.	**9**
IV	Types of extrusion, process variables. Extrusion defects, force calculation. Wire, rod, and tube drawing, lubrication processes.	**9**
V	Shearing, blanking, bending. Stretch forming, deep drawing, defects in formed products. Explosive forming, electro-hydraulic and magnetic forming processes, formability diagrams.	**9**
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MEL3HE	Advanced Design Synthesis	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW

This course covers advanced kinematic analysis and synthesis of planar and spatial mechanisms using both geometric and algebraic methods. Key topics include velocity and acceleration analysis, coupler curves, pole constructions, function generation, and the design of linkages for robotics and motion control applications.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Level
CO1	Analyse Velocity and Acceleration Analysis of complex mechanisms using auxiliary points.	Apply
CO2	Perform the synthesis of slider crank mechanism with three accuracy points	Apply
CO3	Perform the synthesis of slider crank mechanism with four accuracy points	Apply
CO4	Apply algebraic methods of synthesis using displacement equations	Apply
CO5	Apply algebraic methods of synthesis using complex numbers	Apply
CO6	Explain the special methods for velocity acceleration analysis, synthesis and fundamentals of Robotics.	Understand

iii) SYLLABUS

Floating Link, Special methods of velocity and acceleration analysis using auxiliary points. Overlay method for conditioned crank mechanisms, coupler curves. Roberts – Chebyshev theorem. Inflection circle, Euler- Savery equation, Hartman construction, Bobillier construction.

Synthesis using Optimum transmission angle. Geometric methods of synthesis with three accuracy points: - poles of four bar linkages, Relative poles of four bar linkages. Synthesis of slider crank mechanism with three accuracy points.

Geometric methods of synthesis with four accuracy points Function Generators, Synthesis of slider crank mechanism with four accuracy points.

Algebraic methods of synthesis using displacement equations: - Crank and follower synthesis- three accuracy points. Crank and follower synthesis- angular velocities and accelerations.

Rectilinear mechanisms, Algebraic methods of synthesis using complex numbers. Spatial motion and spatial linkages.

iv) a) TEXTBOOKS

1. Kinematic synthesis of Linkages by Richard.S.Hartenberg, Jacques Denavit, McGraw Hill book company. 1964
2. Kinematics and linkage design by Allen.S.Hall. Prentice Hall of India, Ltd.1986

b) REFERENCES

1. Theory of Mechanisms and Machines by Shigley, McGraw Hill International Edition., 4th edition, 2014.
2. Dynamics of Machinery by A.R.Holowenko. John Wiley & Sons Inc, 1955

v) COURSE PLAN

Module	Contents	No. of hours
I	Floating Link, Special methods of velocity and acceleration analysis using auxiliary points. Overlay method for conditioned crank mechanisms, coupler curves.Roberts – Chebyshev theorem. Inflection circle, Euler- Savery equation, Hartman construction, Bobillier construction	9
II	Synthesis using Optimum transmission angle.Geometric methods of synthesis with three accuracy points: - poles of four bar linkages, Relative poles of four bar linkages, Function generators, poles of slider crank mechanisms, Relative poles of slider crank Mechanisms, Rectilinear recorder mechanisms.Synthesis of slider crank mechanism with three accuracy points.	9
III	Geometric methods of synthesis with four accuracy points: - pole triangles, center point curves, Circle point curves, Construction of circle points, Cardinal points, opposite poles, Pole quadrilaterals, Function Generators, Synthesis of slider crank mechanism with four accuracy points.	9
IV	Algebraic methods of synthesis using displacement equations: - Crank and follower synthesis- three accuracy points.Crank and follower synthesis- angular velocities and accelerations.	9
V	Rectilinear mechanisms, Algebraic methods of synthesis using complex numbers. Spatial motion and spatial linkages. Types of spatial mechanisms, Single loop linkage and multiple loop linkages. Simple mechanisms in robots.	9
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL3HG	Sports Analytics	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW

This course will help understand the world of Sports Analytics in depth through various examples, current technologies, and real-life case studies..

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Illustrate the basic mathematics of Machine learning in sports Data	Understand
CO 2	Explain the basic concepts of AI for sports	Understand
CO 3	Analyse sports data using suitable tools.	Apply
CO 4	Explain the role of data science in sports in applying fundamentals of Psychological Skills Training	Understand
CO5	Explain the importance of cognitive intelligence and information processing on sports data	Understand

ii SYLLABUS

Introduction to fundamentals of AI and Sport Data : – Fundamentals of probability and statistics for sports data management– Probability theory- sample and population – statistical interference – random process – logical relations – conditional probability – density function – distributions – regressions models for sports data– parametric estimation – non parametric – statistical. Types of Sports Data.

Introduction to AI Models Introduction to artificial intelligence - Typical Applications, Keras API, Artificial Neural Networks (ANNs): Concept, Activation Functions, Feed Forward Neural Networks and Back Propagation-Working of CNN, Convolutional Layer, Pooling, Flatten, Image recognition techniques and feature Extraction fundamentals.

Introduction to Machine Learning & Sports Sciences. Machine learning: Introduction, Types of Machine Learning: Supervised, Unsupervised and Reinforcement learning, Applications, Classification vs Prediction Problems, Linear Regression Algorithm, Python Basics – string, number, list, tuple, Dictionary, functions, conditional statement, Loop statements, simple programming exercises using python. Case studies.

Data Science PST - Introduction to PST, Goal setting, Effectiveness of goal setting, strategies to develop goal setting for individuals and teams. Personality theories [Psychoanalysis, Humanistic, Trait Theories and models] Constitutional theories (Sheldon, Trait) and Social Learning (Bandura) Personality and Performance in Sports (Ice Berg Profile by Morgan).

Information processing: Meaning, Definition and structure of Cognitive Processes- Sensation, Perception, Imagination, Memory, Information processing Decision making and Thought Process. Theories of Intelligence, Models of Intelligence- Spearman's General Intelligence, Thurston's Primary Mental Abilities, Gardner's Multiple Intelligences. Cognitive processes in Physical Activity and Sports.

iv a) TEXTBOOKS

1. Tanupriya Choudhury, Pradeep Kumar Arya, Ketan Kotecha, Ashutosh Sharma, Jung-Sup Um (Editors), *"AI and Machine Learning Applications in Sports Analytics"*, IGI Global, 2025.
2. Daniel Memmert (Editor), *"Artificial Intelligence and Machine Learning in Sports Science"*, Springer, 2025.

b) REFERENCES

1. Martin Lames, Daniel Link, Jürgen Perl (Editors), *"Artificial Intelligence in Sports, Movement, and Health"*, Springer, 2024.
2. Ted Kwartler, *"Sports Analytics in Practice with R"*, Wiley, 2021.
3. Gil Fried, Timothy D. DeSchriver, Michael Mondello, *"Sport Analytics: A Data-Driven Approach to Sport Business and Management"*, Routledge, 2020

v COURSE PLAN

Module	Contents	Hours
I	**Introduction to fundamentals of AI and Sport Data :** – Fundamentals of probability and statistics for sports data management– Probability theory- sample and population – statistical interference – random process – logical relations – conditional probability – density function – distributions – regressions models for sports data– parametric estimation – non parametric – statistical. Types of Sports Data	**9**
II	**Introduction to AI Models** Introduction to artificial intelligence - Typical Applications, Keras API, Artificial Neural Networks (ANNs): Concept, Activation Functions, Feed Forward Neural Networks and Back Propagation-Working of CNN, Convolutional Layer, Pooling, Flatten, Image recognition techniques and feature Extraction fundamentals	9
III	**Introduction to Machine Learning & Sports Sciences**. Machine learning: Introduction, Types of Machine Learning: Supervised, Unsupervised and Reinforcement learning, Applications, Classification vs Prediction Problems, Linear Regression Algorithm, Python Basics – string, number, list, tuple, Dictionary, functions, conditional statement, Loop statements, simple programming exercises using python. Case examples using data bases.	9
IV	**Data Science and PST** - Introduction to PST, Goal setting, Effectiveness of goal setting, strategies to develop goal setting for individuals and teams. Personality theories [Psychoanalysis, Humanistic, Trait Theories and models] Constitutional theories (Sheldon, Trait) and Social Learning (Bandura) Personality and Performance in Sports (Ice Berg Profile by Morgan).	**9**

V	**Information processing**: Meaning, Definition and structure of Cognitive Processes- Sensation, Perception, Imagination, Memory, Information processing Decision making and Thought Process. Theories of Intelligence, Models of Intelligence- Spearman's General Intelligence, Thurston's Primary Mental Abilities, Gardner's Multiple Intelligences. Cognitive processes in Physical Activity and Sports.	**9**
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

2023 SCHEME

S6 HONOURS

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL3HB	EQUIPMENT DESIGN FOR THERMAL SYSTEMS	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW:

This course involves the application of principles studied in thermodynamics and heat and mass transfer courses to different energy conversion systems like steam turbine, steam nozzle, steam powerplant, IC engines, and refrigeration systems. This course also covers various methods for evaluating and improving the performance of different energy conversion systems. This course also provides insights into the combustion phenomenon in IC engines.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO 1	Explain the working and classification of heat exchangers and cooling towers.	Understand
CO 2	Explain the basic design methods for heat exchangers, governing principles and design calculations.	Understand
CO 3	Design double-pipe heat exchangers and calculate heat transfer coefficients.	Apply
CO 4	Design condensers, evaporators, heat pipes, and extended surfaces for achieving specified heat transfer in thermal systems.	Apply
CO 5	Apply the governing principles for design of cooling towers.	Apply

iii) SYLLABUS

Classification of Heat Exchangers: Introduction, Recuperation & regeneration, Tubular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tubular fin. Basic Design Methods for Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multi-pass, cross flow heat exchanger design calculations.

Double Pipe Heat Exchanger: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature. The calculation of double pipe exchanger, Double pipe exchangers in series and parallel arrangements. Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

Condensation of Single Vapours: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam. Heat pipes.

Vaporizers, Evaporators and Reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

iv) (a) TEXT BOOKS

1) Kern, D. Q., Process Heat Transfer, Tata McGraw-Hill, 2000.

2) Fraas, A. P., Heat Exchanger Design, Second Edition, John Wiley & Sons, 1989

3) Stoecker W. F. – 'Design of Thermal Systems' – McGraw Hill -1980.

(b) REFERENCES

1) Ramesh K. Shah, Dusan P. Sekulic, Fundamentals of Heat Exchanger Design. John Wiley & Sons, Inc.

2) Chi, S. W., Heat Pipe Theory and Practice- A Source Book, McGraw-Hill, 1976

3) Das, S.K., Prosess heat transfer, Narosa publishing house.2005

V) COURSE PLAN

Module	Contents	No. of hours
I	Classification of Heat Exchangers: Introduction, Recuperation & regeneration, Tabular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tabular fin. Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations.	9
II	Double Pipe Heat Exchanger: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements. Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.	9
III	Condensation of Single Vapours: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam.	9

IV	Vaporizers, Evaporators and Reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger. Heat pipe operation and design.	**9**
V	Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.	**9**
	Total	**45**

VI) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Continuous Assessment Tests (2 Nos)	:	20 marks
Total Continuous Assessment	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**
Total	**:**	**100 marks**

VII) CONTINUOUS ASSESMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

VII) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23MEL3HD	Reliability Engineering	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW

This course aims to induce in students an attitude towards reliability which will ensure that they lookout for steps to avoid failures to achieve success in all assignments they take up. The course also intends to generate in students an awareness of the importance of statistical concepts, and to make them realise that engineering is also largely statistics based.

ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

	Course Outcomes	Learning Level
CO 1	Explain the basic concepts of reliability, various models of reliability and failure concepts..	Understand
CO 2	Explain the relation between reliability, availability and maintainability.	Understand
CO 3	Explain economic aspects of reliability and risk assessment.	Understand
CO 4	Identify the failure rate and reliability of a model by applying the concepts of probability distributions.	Apply
CO5	Make use of various allocation methods and Boolean algebra in reliability analysis.	Apply

iii) SYLLABUS

Basic Probability Theory, Reliability: Definition of Reliability. Significance of the terms appearing in the definition. Component reliability, Hazard rate, Reliability design process, system effectiveness, economic analysis and life cycle cost, Reliability allocation, optimal allocations, Maintainability and Availability: Definitions and basic concepts, Relationship between reliability, availability and maintainability, Economics of Reliability: Economic issues, Manufacturers cost, Customers cost, reliability achievement cost models, reliability utility cost models, depreciation cost models

iv) a) TEXTBOOKS

1. Balagurusamy E., Reliability Engineering, Tata McGraw Hill.
2. Srinath L. S., Reliability Engineering, East West Press.

b) REFERENCES

1. E.E. Lewis, Introduction to Reliability Engineering, JW.
2. J.M. Juran and Frank M. Gryna, Quality Planning and Analysis, Tata McGraw Hill.

v) COURSE PLAN

Module	Contents	Hours
I	**Basic Probability Theory**: Rules for combining probability, Probability Distributions, Random variables, density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution..	9
II	**Reliability**: Definition of Reliability. Significance of the terms appearing in the definition. Component reliability, Hazard rate, derivation of the reliability function in terms of the Hazard rate, Hazard models. Failures: Causes of failures, types of failures, Modes of failure, Bath tub curve, Effect of preventive maintenance. Measures of reliability: mean time to failure and mean time between failures..	9
III	**Reliability design process**, system effectiveness, economic analysis and life cycle cost, Reliability allocation, optimal allocations, ARINC, AGREE methods. System safety and Fault Tree Analysis, Tie-set and Cut-set methods, Use of Boolean Algebra in reliability analysis.	9
IV	**Maintainability and Availability**: Definitions and basic concepts, Relationship between reliability, availability and maintainability, Inherent availability, Achieved availability, Operational availability, Repairable systems, Markovian models. Reliability Allocation: for series system.	9
V	**Economics of Reliability**: Economic issues, Manufacturers cost, Customers cost, reliability achievement cost models, reliability utility cost models, depreciation cost models, availability cost model for parallel systems. Reliability management, Reliability management by objectives. **Risk Assessment:** Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.	9
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MEL3HF	Design of Pressure Vessels	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW

Objective of the course is to develop knowledge of pressure vessel design and familiarize with the codes and practices in design.

ii COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the design considerations of pressure vessels.	Understand
CO2	Make use of relevant stress analysis techniques to solve practical problems related to thin pressure vessel design.	Apply
CO3	Apply the design methodologies to design and analyze thick-walled pressure vessels in adherence to relevant industry standards and codes.	Apply
CO4	Apply design concepts in the design of shell and supports of vertical and horizontal pressure vessels	Apply
CO5	Solve problems involving the thickness and stiffener support requirements of cylinders under buckling loads	Apply

iii) SYLLABUS

Fundamentals of Thin Pressure Vessel Design: : Membrane stresses in general axisymmetric shell under internal Pressure. Stresses and dilation in various kinds of components. Bending plates.

Thick Pressure Vessel Analysis and Construction: Stresses in thick walled cylinders – Lame's equation - Shrink fit Stresses in built up cylinders in Built up cylinders. Autofrettage in cylinders. Thermal stresses and significance.

Design of Vertical Pressure Vessels: Design of tall vertical shell structures and its supports. Application of relevant standards and codes.

Design of Horizontal Pressure Vessels: Design of horizontal vessels. Analysis and design of supports. Application of relevant standards and codes.

Buckling Analysis and Stability: Derivation of critical buckling pressure under external pressure, Pipe sizing and stiffener support design, Combined circumferential and axial buckling design.

iv) a) TEXTBOOKS

1. John F. Harvey, "Theory and Design of Pressure Vessels" CBS Publisher and Distributors, 2018
2. Brownell, L. E., and Young, E. H., "Process Equipment Design", John Wiley and Sons

3. Somnath Chathopadhyay, “Pressure Vessels Design and practice”, C. R. C Press, 2004

b) REFERENCES

1. Henry H. Bender, “Pressure Vessels Design hand book”, Van Nostrand Reinhold Company, 1986
2. ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1, 2, and 3” 2006
3. Dennis Moss,”Pressure Vessel Design Manual” Gulf publishing, 2003

v) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Thin Pressure Vessel Design:** Membrane stresses in axisymmetric shells under internal pressure. Stress and dilation analysis of common thin-walled components (spherical, cylindrical, conical). Introduction to bending plates and their application in vessel design.	9
II	**Thick Pressure Vessel Analysis and Construction**: Derivation and application of Lame's equations for thick-walled cylinders. Shrink fit and stress analysis in built-up cylinders. Autofrettage techniques and their impact on stress distribution. Introduction to the significance of thermal stresses in pressure vessels.	9
III	**Design of Vertical Pressure Vessels**: Design considerations for tall vertical shell structures. Analysis and design of supports for vertical vessels. Application of relevant standards and codes for vertical vessel design.	11
IV	**Design of Horizontal Pressure Vessels**: Design of shell structures for horizontal vessels. Analysis and design of supports for horizontal vessels. Familiarization with industry standards and codes for horizontal vessel design.	7
V	**Buckling Analysis and Stability**: Derivation of critical buckling pressure for vessels under external pressure. Pipe sizing and stiffener support design for buckling prevention. Analysis of combined circumferential and axial buckling in pressure vessels.	9
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MEL3HH	Sports Engineering	VAC	2	1	0	0	3	2023

i) COURSE OVERVIEW

The objective of this course is to equip students with a comprehensive understanding of engineering advancements in the sports industry, emphasizing the role of emerging technologies in transforming performance, equipment design and predicting injuries.

ii COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the fundamental concepts of sports engineering	Understand
CO2	Explain the materials for equipment design in sports	Understand
CO3	Explain the motion analysis and types of tools used in sports data measurement	Understand
CO4	Analyse the relationship between Biomechanics & Human Performance and injury prediction	Apply
CO5	Explain on the future trends and emerging technologies in sports industry	Understand

iii) SYLLABUS

Fundamentals of Sports Engineering : Introduction to Sports Engineering: Scope and History, Role of Engineering in Sport Performance and Safety, Mechanical Principles in Sport (Forces, Motion, Energy, and Power), Overview of Biomechanics in Sport. Case Studies: Engineering behind the javelin, swimsuits, tennis rackets.

Sports Equipment Design & Materials Materials Used in Sports Equipment: Polymers, Composites, Metals - Design and Manufacturing of Sport Gear (bats, balls, helmets, shoes)- Ergonomics and Customization in Sports Equipment- Wear and Durability Testing Standards (e.g., ASTM, ISO)- 3D Printing and Additive Manufacturing in Sports Equipment.

Measurement, Instrumentation & Motion Analysis -Sensors and Instrumentation in Sports (IMUs, accelerometers, GPS)-Motion Capture Systems: Optical and Marker less Technologies -Force Plates, Pressure Mapping & EMG in Sports Labs-Data Acquisition and Signal Processing-Software Tools: (Dartfish, Kinovea, Vicon, MATLAB) - Common sports injuries: ACL, hamstring strain, overuse injuries- AI in injury prediction.

Biomechanics & Human Performance -Kinematics and Kinetics of Human Movement -Muscle Mechanics and Joint Analysis -Energy Expenditure and Performance Optimization-Injury Biomechanics and Prevention-Prosthetics and Assistive Technologies in Paralympic Sports. Screening tools: FMS, Y-Balance, Landing Error Scoring System - Integrating motion data into training and rehabilitation plans.

Sports Infrastructure & Emerging Technologies -Design of Playing Surfaces: Artificial Turf, Court Materials, Track Systems-Stadium and Arena Engineering: Lighting, HVAC, Acoustics -Smart Wearables and Athlete Monitoring Systems-Virtual Reality (VR) and Augmented Reality (AR) in Training-Ethics and Data Privacy in Sports Tech

iv) a) TEXTBOOKS

1. Dr. Praveen Kumar, *"Sports Biomechanics and Kinesiology"*, Friends Publications (India), 2019.
2. Dr. Hoshiyar Singh, *"Sports Engineering (New Syllabus)"*, Khel Sahitya Kendra, 2022.
3. Yubo Fan, *"Biomechanics of Injury and Prevention"*, Springer, 2022.

b) REFERENCES

1. Franz Konstantin Fuss, Aleksandar Subic, Martin Strangwood, *"Routledge Handbook of Sports Technology and Engineering"*, Routledge, 2013.
2. A. Subic, F. K. Fuss (Editors), *"The Impact of Technology on Sport II"*, Taylor & Francis, 2007.
3. Youlian Hong (Editor), *"Routledge Handbook of Ergonomics in Sport and Exercise"*, Routledge, 2008.

v) COURSE PLAN

Module	Contents	No. of hours
I	**Fundamentals of Sports Engineering** : Introduction to Sports Engineering: Scope and History, Role of Engineering in Sport Performance and Safety, Mechanical Principles in Sport (Forces, Motion, Energy, and Power), Overview of Biomechanics in Sport. Case Studies: Engineering behind the javelin, swimsuits, tennis rackets.	9
II	**Sports Equipment Design & Materials** Materials Used in Sports Equipment: Polymers, Composites, Metals - Design and Manufacturing of Sport Gear (bats, balls, helmets, shoes)- Ergonomics and Customization in Sports Equipment- Wear and Durability Testing Standards (e.g., ASTM, ISO)- 3D Printing and Additive Manufacturing in Sports Equipment.	9
III	**Measurement, Instrumentation & Motion Analysis -**Sensors and Instrumentation in Sports (IMUs, accelerometers, GPS)-Motion Capture Systems: Optical and Marker less Technologies -Force Plates, Pressure Mapping & EMG in Sports Labs-Data Acquisition and Signal Processing-Software Tools: (Dartfish, Kinovea, Vicon,	11

	MATLAB) - Common sports injuries: ACL, hamstring strain, overuse injuries- AI in injury prediction.	
IV	**Biomechanics & Human Performance -**Kinematics and Kinetics of Human Movement -Muscle Mechanics and Joint Analysis -Energy Expenditure and Performance Optimization-Injury Biomechanics and Prevention-Prosthetics and Assistive Technologies in Paralympic Sports. Screening tools: FMS, Y-Balance, Landing Error Scoring System - Integrating motion data into training and rehabilitation plans.	7
V	**Sports Infrastructure & Emerging Technologies -**Design of Playing Surfaces: Artificial Turf, Court Materials, Track Systems-Stadium and Arena Engineering: Lighting, HVAC, Acoustics -Smart Wearables and Athlete Monitoring Systems-Virtual Reality (VR) and Augmented Reality (AR) in Training-Ethics and Data Privacy in Sports Tech.	9
	Total	**45**

vi) ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

viii CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours