BMS Institute of Technology and Management

(Autonomous Institution, Affiliated to VTU)

Post Box No. 6443, Avalahalli, Doddaballapura Main Road,
Yelahanka, Bengaluru-560 064.

Bachelor of Engineering (BE)
Department of Mechanical Engineering

V and VI Semester Scheme and Syllabus

(Approved in the BoS meeting held on 22.05.2023)

2021 Scheme - Autonomous

Vision and Mission of the Department

Vision

- To develop technically competent Mechanical Engineering professionals for the benefit of the society

Mission

- Impart quality education in Mechanical Engineering and allied areas by state-of- the- art- infrastructure and dedicated faculty.
- Provide conducive environment for both students and faculty to pursue higher education & research and to work ethically for the benefit of society.

Program Educational Objectives (PEOs)

1. Be successful professionals in the field of Mechanical Engineering and allied areas.
2. Exhibit skills to work effectively and ethically in multiple domains of engineering as part of a team.
3. Excel in higher studies, research and adapt in a world of constantly developing technology.

Program Specific Outcomes (PSOs)

1. Design, Analyse and fabricate the mechanisms.
2. Analyse the fluid and thermal aspects of different mechanical systems and components.
3. Develop materials and components through different manufacturing methods with managerial skills.

BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

(An Autonomous Institution affiliated to VTU, Belagavi)
Yelahanka, Bengaluru-560064

Date: 14.06.2023

CIE and SEE Pattern for 2021 Scheme
(Applicable from the AY 2021-22 onwards)

Important Note:

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Examinations (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for SEE minimum passing mark is 35% of the maximum marks (18 marks out of 50). The student is declared as a pass in the course if he / she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

4 CREDIT and 3 CREDIT COURSES

I. CONTINUOUS INTERNAL EVALUATION (CIE): 50 MARKS

- Internal Assessment (IA) Tests: 3 IAs to be conducted for 40 Marks (90 minutes each). Total of 3 tests will be 120 and the same can be scale down to **60 marks.**
- Alternate Assignment Tool (AAT): 2 AATs each of 10 marks, total **20 marks.**
- Assignments: 2 assignments of each 10 marks, total **20 marks**.
- CIE marks = 60 + 20 + 20 = 100 and same can be scale down to **50 marks.**
- Student has to score minimum of 20 marks (40%).

II. SEMESTER END EXAMINATIONS (SEE): 50 MARKS

SEE is conducted for 100 Marks (3 hours).

Question Paper Pattern:

Part - A: Comprises 20 objective type questions carrying 1 Mark each with a total 20 Marks.

Part - B: There will be **5 modules**. Each module will have **TWO questions carrying 16 marks** each. There will be a maximum of three sub section for each question. **Student has to answer any ONE full question from each module.**

SEE Marks = 20 + 80 = 100 marks and can be scale down to 50 marks.

2 CREDIT COURSES

I. CONTINUOUS INTERNAL EVALUATION (CIE): 50 MARKS

- Internal Assessment (IA) Tests: 3 IAs of MCQ type to be conducted for 40 Marks (60 minutes each). Total of 3 tests will be 120 and the same can be scale down to **60 marks.**
- Alternate Assignment Tool (AAT): 2 AATs each of 10 marks, total **20 marks**.
- Assignments: 2 assignments of each 10marks, total **20 marks.**
- CIE marks = 60 + 20 + 20 = 100 and same can be scale down to **50 marks.**
- Student has to score minimum of 20 marks (40%).

II. SEMESTER END EXAMINATIONS (SEE): 50 MARKS

SEE is conducted for 100 Marks (2 hours).

Question Paper Pattern:

- The pattern of the question paper is MCQ.
- SEE question paper will be set for 100 questions each of 01 marks. The same is scale down to 50 marks.

1 CREDIT COURSES

I. CONTINUOUS INTERNAL EVALUATION (CIE): 50 MARKS

- Internal Assessment (IA) Tests: 3 IAs of MCQ type to be conducted for 40 Marks (60 minutes each). Total of 3 tests will be 120 and the same can be scale down to **60 marks.**
- Alternate Assignment Tool (AAT): 2 AATs each of 10 marks, total **20 marks.**
- Assignments: 2 assignments of each 10marks, total **20 marks.**
- CIE marks = 60 + 20 + 20 = 100 and same can be scale down to **50 marks.**
- Student has to score minimum of 20 marks (40%).

II. SEMESTER END EXAMINATIONS (SEE): 50 MARKS

SEE is conducted for 50 Marks (1 hours).

Question Paper Pattern:

- The pattern of the question paper is MCQ.
- SEE question paper will be set for 50 questions each of 01marks. The same is scale down to 50 marks.

1 CREDIT LABORATORY COURSES

I. CONTINUOUS INTERNAL EVALUATION (CIE): 50 MARKS

- Cumulative Assessment (CA) of each experiment is 20 Marks (Conduction 10 marks + Records 5 marks +Viva 5marks). The average of all the experiments to be taken for **20 marks.**
- Open Ended Experiments (OE) **10 marks.**
- 2 IAs Test to be conducted for 100 marks. General rubrics suggested for SEE are: Writeup 20 marks, Conduction of the experiments, calculations, graphs, results, etc.,: 60 marks and Viva: 20 marks. The average of 2 IA marks is scale down to **20 marks**.
- CIE marks =20 (CA) +10 (OE) + 20 (IA test) = 50 marks.
- Student has to score minimum of 20 marks (40%).

II. SEMESTER END EXAMINATIONS (SEE): 50 MARKS

SEE is conducted for 100 Marks and scale down to 50 Marks.

Examinations to be conducted jointly by Two examiners. All the experiments are to be included for practical examination. General rubrics suggested for SEE are: Writeup 20 marks, Conduction of the experiments, calculations, graphs, results, etc.,: 60 marks and Viva: 20 marks.

CoE 16/06/2023 Dean AA 16/06/2023 Principal 19/6/23

Scheme of VI Semester

BMS INSTITUTEOFTECHNOLOGYANDMANAGEMENT

(Autonomous Institute affiliated to VTU)

Scheme of Teaching and Examination: EffectivefromAY2021–22Choice Based Credit System(CBCS)

UG PROGRAM: Mechanical Engineering (ME) — **Semester: VI**

Sl. No	Course Category	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Credits	Examination			
					L	T	P	PW		Duration in Hours	CIE Marks	SEE Marks	Total Marks
1	HS	21HSS61	Project and Finance Management	ME	2	0	0	0	2	2	50	50	100
2	AEC	21AEC62	Bio Informatics	ME	1	0	0	0	1	1	50	50	100
3	AEC	21ME63	Supply Chain Management	ME	0	2	0	0	1	1	50	50	100
4	PE	21ME64X	Professional Elective II	ME	3	0	0	0	3	3	50	50	100
5	OE	21ME65X	Open Elective I	ME	3	0	0	0	3	3	50	50	100
6	PW	21ME66	Mini Project	ME	0	0	0	4	2	3	50	50	100
7	PC	21ME67	Finite Element Method	ME	3	2	0	0	4	3	50	50	100
8	PC	21ME68	Computer Integrated Manufacturing	ME	3	0	0	0	3	3	50	50	100
9	PC	21MEL69A	Computer Integrated Manufacturing Lab	ME	0	0	2	0	1	3	50	50	100
10	PC	21MEL69B	Finite Elements Analysis and MAT Lab	ME	0	0	2	0	1	3	50	50	100
TOTAL					15	4	4	4	**21**				

Professional Elective-Group II	
Course Code	**Course Title**
21ME641	Advanced Design of Machine Elements
21ME642	Refrigeration and Air Conditioning
21ME643	Industry 4.0
21ME644	Statistical Quality Control
21ME645	Augmented Reality and Virtual Reality

Open Elective (OE) -Group I	
Courses Code	**Course Title**
21ME651	Intellectual Property Rights
21ME652	Energy Auditing
21ME653	Industrial Safety and Maintenance Engineering
21ME654	Micro and Nano Electromechanical Systems

VI Semester Syllabus

B.E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER - VI

PROJECT & FINANCE MANAGEMENT (2:0:0) 2

(Effective from the academic year 2020-21)

Course Code	**21HSS61**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**2:0:0**	SEE Marks	50
Total Number of Contact Hours	**25**	Exam Hours	02

Course Objectives:

This course will enable students to:

1. Define the fundamentals of Project Management.
2. Identify the strategies involved in selection, prioritization, planning & scheduling of a project.
3. Understand the time value of money & apply it for decision making.
4. Analyze project risk, progress & results.
5. Make awareness about various sources of finance.
6. Gain Knowledge on working capital & capital budgeting.

Preamble: Project Management: Need for project management, management practices to meet the challenges of new economic environment, globalization process, rapid technological advancement, and quality concerns of the stakeholders.

Module – 1

Project Management: Definition of project, characteristics of projects, types of projects, project roles.

Project Selection & Prioritization: Strategic planning process, strategic objectives, identifying potential projects, feasibility study (environment, society), methods of selecting projects, prioritizing projects, securing and negotiating projects.

(05 Hours)

Self-study component: Understanding the strategic planning of any company

Module – 2

Project planning & scheduling: Project scope & check list, work break down structure, project schedule, uncertainty in project schedules.

Project resourcing & risk planning: Abilities needed when resourcing projects, estimate resource needs, cost planning & estimating, risk management planning, risk identification, risk analysis, project quality planning and project kick-off.

(05 Hours)

Self-study component: Case studies on risk management and estimation of resources

Module – 3

Project performing, progress & results: Project supply chain management, project balanced score card approach, terminate project early, finish project, customer feedback & approval.

(05 Hours)

Self-study component: Suder standing supply chain distribution networks

Module – 4

Financial Management: Evolution of financial management, key activities of finance manager, key decision areas in financial management, financial statement with balance sheet. Efficient utilization and generation of monetary resources and funds, a comparative study of finance and economics, Costs and revenue evaluation for various engineering operations.

Capital Budgeting: Types of capital budgeting decisions, capital budgeting proposals, estimating cash flows for project appraisal, green capital budgeting.

(05 Hours)

Self-study component: Anaysing debit and credit statements of any organisation

Module – 5

Working capital management: Factors affecting working capital requirement, operating cycle analysis, negative working capital, cash planning & managing cash flows.
Cost of capital and leverage Analysis: Concept, significance, assumptions, factors affecting cost of capital, Leverage Analysis: operating leverage, financial leverage.

(05 Hours)

Self-study component: Case studies on working capital management

Course outcomes:

The students will be able to:
CO1: Understand the selection, prioritization & initiation of individual projects.
CO2: Understand WBS, scheduling, uncertainty & risks associated in project.
CO3: Identify & Evaluate the progress and results of the project.
CO4: Understand time value of money & use it for decision making.
CO5: Outline capital requirements for starting a business & management of working capital.

Question paper pattern:

- The question paper will have 50 Multiple choice questions carrying equal marks.
- Each question will be for 1 mark.
- The questions will have equal weightage covering topics from all modules.
- The students will have to answer all questions, there will be no negative marks.

Textbooks:

1. Timothy J Kloppenborg, Project Management, Cengage Learning, 2nd Edition, 2009.
2. John J Hampton, Financial Management, PHI Publication, 4th edition.

Reference books:

1. Pennington Lawrence, Project Management, McGraw-Hill, 1st edition.
2. Joseph A Moder, Philips New Yark, Project Management with CPM & PRT, McGraw-Hill, 2nd edition, 1983.
3. Harold Kerzner, Project Management A system approach to Planning, Scheduling & Controlling, CBS Publication, 2nd Edition,2006.
4. S.D. Sharma, Operations Research, Kedar Nath Ramnath, Meerut, New Edition,2015.
5. M.Y. Khan, Financial Management, Tata Mc-Graw Hill, Fifth Edition,2007.
6. O.P. Khanna, Industrial Engineering & Management, Dhanpat Rai Publications, Second Edition, 1999.

B.E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER VI

Bioinformatics (1:0:0) 1

(Effective from the academic year 2021-22)

Course Code	**21AEC62**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**1:0:0**	SEE Marks	50
Total Number of Contact Hours	**15**	Exam. Hours	01

Course Objectives:

1. Better understanding of dynamic biological processes and their understanding at molecular level enabled through and correlated using internet and Bioinformatics.
2. To relate the basic knowledge in Genetics & Molecular Biology and see how it can be applied through Bioinformatics perspective.
3. To utilize bioinformatics tools and databases for retrieving, analyzing, understanding and managing biological data.

Preamble: Bio informatics is an interdisciplinary field mainly involving molecular biology and genetics, computer science, mathematics, and statistics. Data intensive, large-scale biological problems are addressed from a computational point of view.

Module – 1

Biological Data Acquisition

The form of biological information. Retrieval methods for DNA sequence, protein sequence and protein structure information

(03 Hours)

Module – 2

DATABASES

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases – primary sequence databases, protein sequence and structure databases, Organism specific databases.

(03 Hours)

Module – 3

DATA PROCESSING

Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Localversus global. Distance metrics. Similarity and homology. Scoring matrices.

(03 Hours)

Module – 4

METHODS OF ANALYSIS

Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA, and PSI BLAST.

(03 Hours)

Module – 5

APPLICATIONS

Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis: Comparative genomics, orthologs, paralogs.

(03 Hours)

Course Outcomes: The students will be able to:

CO1: Apply the basic methodology in Bioinformatics to retrieve data.

CO2: Analyze bioinformatics tools and databases for understanding and managing biological data.

CO3: Examine the applications of bioinformatics in allied areas.

Textbooks:

1. Introduction to Bioinformatics by Arthur K. Lesk, Oxford University Press.
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.

3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by Durbin, S.Eddy, A.Krogh, G.Mitchison.
4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O"Reilley Media.

Reference books:

1. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak.

B.E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER VI

Supply Chain Management (1:0:0) 1

(Effective from the academic year 2020 -2021)

Course Code	**21ME63**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**0:2:0**	SEE Marks	50
Total Number of Lecture Hours	**15**	Exam Hours	01

Course objectives:

1. To design supply chain strategies.
2. To recognize supply chain integration to support products in the various product lifecycle.
3. To balance logistics, manufacturing, and inventory policies with demand and customersatisfaction.
4. To leverage organizational capabilities and resources across supply chain business processes.

Preamble:

Supply chain management (SCM) is the centralized management of the flow of goods and services

and includes all processes that transform raw materials into final products. By managing the supplychain, companies can cut excess costs and deliver products to the consumer faster and more efficiently

Module – 1

Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy.

(03 hours)

Self-study topics: Supply Chain Performance Measures

Module – 2

Strategic Sourcing Outsourcing Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum-Sourcing Strategy-Supplier Selection and Contract Negotiation. Creating a world class supply base.

(03 Hours)

Self-study topics: Supplier Development - World Wide Sourcing and ERP contract negotiation

Module – 3

Warehouse Management, Stores management, stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement. Supply Chain Network Distribution Networks.

(03 Hours)

Self-study topics: Distribution Center Location Models.

Module – 4

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. E-commerce and ERP implementation.

(03 hours)

Self-study topics: Pricing and Revenue Management

Module – 5

Current Trends:

Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Agile Supply Chains and Reverse Supply chain.

(03 hours)

Self-study topics: IT in Supply Chain

Course outcomes: Upon the completion of course, students will be able to:
CO 1: Illustrate the framework and scope of supply chain management.
CO 2: Develop a competitive supply chain using strategies, models.
CO 3. Describe SCM techniques and Supply Chain Network
CO 4 Analyse the SCM Models and emerging trends and impact of IT on SCM

Textbooks:

1. Supply Chain Management– Text and Cases Janat Shah Pearson Education 2021
2. Supply Chain Management Strategy Planning and Operation Sunil Chopra and Peter Meindl PHI Learning / Pearson Education 2015

References:

1. Business Logistics and Supply Chain Management Ballou Ronald H Pearson Education 5th Edition, 2012
2. Designing and Managing the Supply Chain: Concepts, Strategies, and Cases David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi Tata McGraw-Hill 2005
3. Principles of Supply Chain Management- A Balanced Approach Joel D. Wisner, G. Keong Leong, Keah Choon Tan South-Western, Cengage Learning 2008

B.E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS)
SEMESTER - VI

Advanced Design of Machine Elements (3:0:0) 3
(Effective from the academic year 2021-22)

Course Code	**21ME641**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**3:0:0**	SEE Marks	50
Total Number of Contact Hours	**40**	Exam Hours	03

Course objectives:

This course will enable students to:

1. Able to analyze curved beams, select belts, bearings and understand the characteristics of journal bearings.
2. Able to design machine components such as gears, springs, clutches and brakes.

Preamble: Introduction on importance and impact of machine design on environment, economy and customer satisfaction.

Module – 1

Curved Beams: Stresses in curved beams of standard cross sections used in crane hook, punching presses and clamps.

(08 Hours)

Self-Study Component: Assumptions in analysis of curved beams, differences between straight and curved beams.

Module – 2

Belts: Materials of construction of flat and V belts, power rating of belts, concept of slip and creep, initial tension, effect of centrifugal tension, maximum power condition.

Wire ropes & Chain drive: Construction of wire ropes, Types of power transmission chains, modes of failure of chains (Theoretical treatment only).

Leaf Springs: Stresses in leaf springs. Equalized stresses and nipping of leaf springs. Design of Belleville springs.

(08 Hours)

Self-Study Component: Design of torsion springs.

Module – 3

Gear drives: Classification of gears, materials for gears, standard systems of gear tooth, gear tooth failure modes and lubrication of gears.

Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, Design for strength, Dynamic load and wear load.

Bevel Gears: Bevel Gears: Definitions, formative number of teeth, Design based on strength, dynamic and wear loads.

(08 Hours)

Self -Study Concepts: Design of Helical gears.

Module – 4

Design of Clutches: Types of clutches and their applications**,** cone clutch, Single plate and multi plate clutches.

Design of Brakes: Types of brakes, Block and Band brakes: Self locking of brakes and heat generation in Brakes.

Internal expanding brakes and disc brakes (Theoretical treatment only).

(08 Hours)

Self-Study Component: Construction and operation of disc brakes.

Module – 5

Lubrication and Bearings: Lubricants and their properties, Bearing Materials and properties, Mechanisms of Lubrication, hydrodynamic lubrication and, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, Heat Generated, Heat dissipated.

Anti friction bearings: Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship, selection of deep groove ball bearings from manufacturer's catalogue, selection of bearings subjected to cyclic loads and speeds, probability of survival. Summary of the course.

(08 Hours)

Self-Study Component: Hydrostatic bearings and air bearings.

Course outcomes:

The students will be able to:

CO 1: Design &Analyze curved beams, Journal bearing characteristics, selection of V-belts, ropes, chains.
CO 2: Design the gears.
CO 3: Design the springs, select bearings from manufacturer's catalogue.
CO 4: Design the clutches, Brakes.

Textbooks:

1. Joseph.E.Shigley, Charles.R.Mischke, "Mechanical Engineering Design", McGraw Hill International, 6th Edition 2009.
2. C.S. Sharma, Kamalesh Purohit, "Design of Machine Elements", Prentice Hall of India Private Limited, 7th Edition, 2006.

Reference books:

1. Robert. L. Norton, "Machine Design – An Integrated Approach", Pearson Education Asia, 3rd Edition, 2001.
2. George.E.Dieter, LindaSchmidt, "Engineering Design", McGraw Hill Education, Indian edition, 2003.
3. Hall, Holowenko, "Engineering Design", Laughlin (schaum's Outline series), Special Indian edition, 2008.
4. V.B.Bhandari, "Design of Machine Elements", Tata McGraw Hill Publishing Company, 2nd Edition, 2007.

Design Data Handbook:

1. K. Mahadevan, Balaveera Reddy, "Design Data Handbook", CBS publication,4thEdition, 2001.

B. E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER - V

Refrigeration and Air Conditioning (3:0:0) 3

(Effective from the academic year 2022-23)

Course Code	**21ME642**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**3:0:0**	SEE Marks	50
Total Number of lecture hours	**40**	Exam Hours	03

Course Objectives:

This course will enable students to:

1. Understand the nomenclature for refrigerating systems.
2. Study the working principles and applications of different types of refrigeration systems.
3. Understand the working of air conditioning systems and their applications.
4. Identify the performance parameters and their relations in an air conditioning system.

Preamble: Foundation, need and scope of refrigeration and air-conditioning in international Economy. Fundamental differences between refrigerator and air-conditioning.

Module-1

Introduction to Refrigeration: Basic Definitions, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications: Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature.

Industrial Refrigeration- Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain**.**

(08 Hours)

Self-Study Component: ASHRAE Nomenclature, Linde, Claude and Stirling cycles for liquefaction of air.

Module-2

Vapor Compression Refrigeration System (VCRS): Modifications in Reversed Carnot Cycle with Vapor as a refrigerant, Vapor Compression Cycle, Actual Vapor Compression Cycle, Effect of Operating Conditions. Simple Numerical problems.

Multistage or Compound Compression, Multi-evaporator systems, Cascade Systems, Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.

(08 Hours)

Self-Study Component: Modifications to standard cycle – liquid-suction heat exchangers, Grind lay cycle and Lorenz cycle

Module-3

Vapor Absorption Refrigeration Systems: Simple Vapor – Absorption System, Maximum Coefficient of Performance of a Heat Operated Refrigerating Machine, Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Modifications to Simple Vapor-Absorption.

(08 Hours)

Self-Study Component: Thermoelectric refrigeration and pulse tube refrigeration.

Module-4

Refrigerants: Primary and Secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants, Selection of a Refrigerant, Ozone Depletion Potential and Global Warming Potential of CFC Refrigerants. Thermodynamic requirements, Comparison between different refrigerants, Substitutes for CFC refrigerants, Secondary Refrigerants.

(07 Hours)

Self-Study Component: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Module-5

Air-Conditioning: Basic Processes in Conditioning of Air, Psychrometric Processes in Air-Conditioning Equipment, Summer Air Conditioning, Winter Air Conditioning.

Applied Psychrometry: Preliminary Considerations, Effective Sensible Heat Factor, Cooling Load Estimate. Psychrometric Calculations for Cooling, Selection of Air-Conditioning Apparatus for Cooling and Dehumidification, Numerical problems.

(09 Hours)

Self-Study Component: Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains.

Course Outcomes:

The student will be able to:

CO1: Illustrate the principles, methods and applications of refrigeration systems.
CO2: Differentiate between vapor compression and vapor absorption refrigeration systems.
CO3: Identify suitable refrigerant for various refrigerating systems.
CO4: Estimate the performance of air-conditioning systems using principles of psychometry.

Textbooks:

1. S. C. Arora & S. Domkundwar, "Refrigeration and Air-Conditioning", 4th edition, DhanpatRai, 2015.
2. Arora C.P, "Refrigeration and Air-conditioning", 2nd Edition, Tata McGraw –Hill, New Delhi, 2001.

References:

1. Dossat, "Principles of Refrigeration",2nd edition, Pearson, 2006.
2. McQuistion, "Heating, Ventilation and Air Conditioning", 5th edition, Wiley Students edition, 2000.
3. Manohar Prasad, "Refrigeration and Air-Conditioning", 2nd Edition, New Age Intl, 2005.

PITA, "Air conditioning",4th edition, Pearson, 2005.

B.E MECHANICAL ENIGINEERING

Choice Based Credit System (CBCS)

SEMESTER - VI

INDUSTRY 4.0 (3:0:0) 3

(Effective from the academic year 2021-2022)

Course Code	**21ME643**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**3:0:0**	SEE Marks	50
Total Number of Lecture Hours	**40**	Exam Hours	03

Course objectives:

This course will enable students:

1. To get acquainted with the basic aspects of Industry 4.0 and IIoT.
2. To learn the drivers of Industry 4.0 and end to end digital integration.
3. To comprehend technology foundation of industry 4.0 their interactions and functions.
4. To comprehend predictive analytics and building models for forecasting future possibilities.
5. To know about smart factory importance and digital transformation.

Preamble:

Industry 4.0, also known as the fourth industrial revolution, is a new era of manufacturing characterized by the integration of advanced technologies such as artificial intelligence, machine learning, and the Internet of Things (IoT). This digital transformation is changing the way businesses operate, enabling them to optimize their production processes, reduce costs, and improve product quality.

Module – 1

Introducing Industry 4.0: Defining Industry 4.0, Why Industry 4.0, Characteristics of Industry 4.0, The Value Chain, Differential Prospective, Benefits to Business, Design Principles, Building Blocks of Industry 4.0, Reference Architecture, Smart Manufacturing.

(07 hours)

Self-Study Component: Internet of services.

Module – 2

Introduction to the Industrial Internet: What Is the Industrial Internet?, The Power of 1%, Key IIoT Technologies, Why Industrial Internet and Why Now?, Catalysts and Precursors of the IIoT, Innovation and the IIoT, Intelligent Devices, Key Opportunities and Benefits, The Why Behind the Buy, The Digital and Human Workforce.

Industrial Internet Use-Cases: Healthcare, Oil and Gas Industry, Smart Office, Logistics and the Industrial Internet, Retail, IOT Innovations in Retail.

(09 hours)

Self-study component: IIoT use case in agriculture.

Module – 3

IIoT Reference Architecture: IIC Industrial Internet Reference Architecture, Industrial Internet Architecture Framework, The Three-Tier Topology, Connectivity, Key System Characteristics, Data Management.

(08 hours)

Self-Study Component: Proximity Network.

Module – 4

IIoT WAN Technologies and Protocols: IIoT Device Low-Power WAN Optimized Technologies for M2M, SigFox, Lora WAN, nWave, Dash7, Ingénue RPMA, Low Power Wi-Fi**,** LTE Category-M, Weightless, Millimetre Radio.

(07 hours)

Self-Study Component: Security in Manufacturing.

Module – 5

Smart Factories: Introducing the Smart Factory, Smart Factories in Action, Why Smart Manufacturing Is Important, Winners and Losers? Real-World Smart Factories.

Industry 4.0: The Way Forward Getting From Here to There: Digital Transformation, Transforming Operational Processes, Transforming Business Models, Develop New Business Models, Adopt Smart Architectures and Technologies.
Summary of Industry 4.0 marking its significance and future scope.

(09 hours)

Self-Study Component: Technology roadmap for Industry 4.0.

Course outcomes: The students will be able to:
CO1: Understand the fundamentals of industry 4.0 and IIoT
CO 2: Identify IIoT architecture, its technologies and protocols to solve problems in industries.
CO 3: Analyse Industry 4.0 systems to deliver better productivity.
CO 4: Interpret the given case material related to Industry 4.0

Textbook:

1. Alasdair Gilchrist., "Industry 4.0-The Industrial Internet of Things", 1st Edition, Apress, 2016.

References:

1. Alp Ustundag. Emre Cevikcan., "Industry 4.0: Managing The Digital Transformation", 1st Edition, Springer, 2018.
2. UNIDO team members, "Industry 4.0- Opportunities Behind The Challenge", UNIDO, UNIDO General conference 17, 2017.

B.E MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER - VI

Statistical Quality Control and Quality Management (3:0:0) 3

(Effective from the academic year 2021 -2022)

Course Code	**21ME644**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**3:0:0**	SEE Marks	50
Total Number of Lecture Hours	**40**	Exam Hours	03

Course objectives:

1. To understand quality control and statistical methods &apply to improve quality.
2. To implement the control charts for process improvement, analyze the process capability.
3. To apply Total Quality Management improvement tools to enhance customer satisfaction.
4. To implement the Total Quality Management approach in an organization for continuous quality improvement.

Preamble: statistical quality control is to achieve quality in production and service organizations, through the use of adequate statistical techniques and the tools and techniques of total quality management leads all manufacturing and service-oriented organization do excellence in their process by control cost and improve quality.

Module – 1

Statistical Quality Control(SQC): Introduction, Significance and scope of SQC, SQC applications in the Industries, recent developments in quality control techniques, the meaning of Quality and Quality Improvement; brief history of Quality Methodology; Statistical Methods for Quality Control and Improvement; links between quality and productivity, quality costs, quality improvement.

(08 Hours)

Self-study component : Legal aspects of quality implementing,

Module – 2

Methods And Philosophy of Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts, basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts. Process Capability: The foundation of process capability, Natural Tolerance limits, cp – process capability index, cpk, Control Charts for Variables, Control Charts for Attributes

Numerical problems. (0**8 Hours)**

Self-study component: Seven QC tools and its applications

Module – 3

Lot-By-Lot Acceptance Sampling For Attributes: The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves

Numerical problems.

Cumulative-Sum (CUSUM) & Exponentially Weighted Moving Average (EWMA) Control Charts: CUSUM Control Chart ,basic principles of the chart for monitoring the process mean; EWMA control chart (EWMA) control chart for monitoring process mean), design of an EWMA control chart.

(08 Hours)

Self-study component: Applications sampling techniques.

Module – 4

Continuous Process Improvement: The Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma.

Tools and Techniques - I

Quality Management Systems: Introduction, benefits of ISO registration, ISO 9001 requirements environmental management system(EMS): Introduction, ISO 14001 requirements, benefits of EMS, Quality Function deployment, Taguchi's Quality Loss function

(08 Hours)

Self-study component: ISO 9000 series of standards, and ISO 14000 series of standards.

Module – 5

Tools and Techniques - II

Failure mode and effect analysis, total productive maintenance, Management tools: Why forced filed analysis, nominal group technique, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, prioritization matrices, process decision program chart, activity network diagram.

(08 Hours)

Self-study component: Total Quality Management implementation in manufacturing and service organization

Course outcomes: Upon the completion of course students will be able to:

CO:1 Explain the concepts of quality, quality improvement using statistical methods.
CO:2 Construct, implement and interpret control charts for variables and attributes
CO:3 Choose acceptance sampling methods for attributes and Interpret CUSUM and EWMA control charts
CO:4 Select statistical tools for continuous improvement of systems
CO:5 Apply the tools and technique for effective implementation of TQM

Textbooks:

1. Total Quality Management, Dale H. Besterfield, Prentice Hall (India) Pvt. Ltd. 3rd edition and 2003, ISBN: 81-203-2883-3
2. Introduction to Statistical Quality Control, Douglas C Montgomery, John Wiley & Sons, Inc. ,6th Edition and 2005, ISBN: 9780470169926

Reference books:

1. Statistical Quality Control and Quality management R C Gupta, Khanna Publishers, 9th edition and 1998 ISBN: 9788174091116.
2. Total Quality Management, N.V.S.Raju, Cengage Learning, 1st edition and 2014 ISBN-13:978-81-315-2562-3
3. Principles of Quality Control, Jerry Banks, Wiley & Sons, Inc, 1st Edition and 1989, ISBN :9780471635512

DEPARTMENT OF MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER –VI

AUGMENTED REALITY AND VIRTUAL REALITY (2:0:1) 3

(Effective from the academic year 2022-23)

Course Code	**21ME645**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**2:0:2**	SEE Marks	50
Total Number of Contact Hours	**50**	Exam Hours	03

Course Objectives:

This course will enable students to:

1. Learn the fundamental Computer Vision, Computer Graphics and Human-Computer interaction Techniques related to VR
2. Augmented reality and its application
3. Review the Geometric Modeling Techniques
4. Review the Virtual Environment
5. Discuss and Examine VR Technologies
6. Use of various types of Hardware and Software in Virtual Reality systems

Preamble: Importance of Virtual Reality and Augmented Reality in the Automotive, Aerospace, Education, Healthcare, Architecture and Construction, Oil and Gas, Manufacturing Industries

Module – 1

Introduction: Definition of Virtual Reality (VR), Definition of AR, Difference between AR and VR, Four key components of VR, Configuration space of sense organs, Classification of Hardware for VR System, Classification of Human Body Sensors.

Geometry of Virtual Worlds: Geometric Models, Changing Position and Orientation,

Augmented Reality Lab 1 –Experiencing AR and VR applications using software like Unity/Unreal Engine/ Adobe Creative Cloud etc

(08Hours)

Self- Study: Various types of Geometric Modelling

Module – 2

Light and Optics: Basic behavior of Light, Lenses, Optical aberrations, Camera and Display

Visual Perception: Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information

Augmented Reality Lab 2: Creating AR applications using software like Unity/Unreal Engine/ Adobe Creative Cloud etc **(07 Hours)**

Self- Study: Implication of VR and Physiology of Human Vision

Module – 3

Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Video based Input, 3D Menus & 3D Scanner, etc.), Output (Visual/Auditory/Haptic Devices)

Generic VR system: Introduction, Virtual environment, Computer environment, VRtechnology, Model of interaction, VR Systems.

Virtual Reality Lab 1: Creating VR application model 1 using software like Unity/Unreal Engine/ Adobe Creative Cloud etc.

(08 hours)

Self- Study: Different types of Immersive User Experiences.

Module – 4

Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system.
Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft
Virtual Reality Lab 2: Creating VR application model 2 using software like Unity/Unreal Engine/ Adobe Creative Cloud etc

(08hours)

Self- Study: Implementation of VR and Physiology of Human Vision

Module – 5

Human factors: Introduction, the eye, the ear, the somatic senses
Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems.
Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML.
Laboratory Component: AR/VR Mini Project.

(09 hours)

Self- Study: Health and Safety Issues associated with Virtual Reality.

Course Outcomes:
The students will be able to:

CO1: Describe four key components of Augmented Reality and Virtual Reality
CO2: Explain influence of human factors on a Virtual Reality system
CO3: Apprise the importance of light and optics creating Visual Perceptions under VR System
CO4: Analyse various input/output devices, hardware and software used in a VR System

CONTINUOUS INTERNAL EVALUATION (CIE)

		Internal Assessments	Max. Marks	Average Marks	Marks after scale-down	Final Marks
Theory Component	IA	IA-1 (1.5 hrs)	40	40	30	50 **Passing Standard** (40% i. e 20 Marks)
		IA-2 (1.5 hrs)	40			
		IA-3 (1.5 hrs)	40			
	Assignment	A-1 (1hr)	20	20	20	
	AAT	AAT-1 (1 hr)	20			

SEMESTER END EXAMINATION (SEE)
Examination Duration: 03 hrs Max. Marks: 100

			Max. Marks	Max. Marks	Final Marks
Theory Component	No. of Modules	05	200	100	50
	Questions/Module	02	40		
	Marks/ Question	20	20		
	No. of Questions to be answered/ module	01	20		

	No. of Questions to be answered/ course	05	100		**Passing Standard** (40% i. e 20 Marks)
A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if **CIE Score ≥ 40 %**, **SEE Score ≥ 35 %,** and a sum total of **CIE + SEE Score ≥ 40%**					

Textbooks:

1. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 1st Edition, 2019.
2. Coiffet, P. Burdea, G. C., (2003), "Virtual Reality Technology," Wiley-IEEE Press, ISBN: 9780471360896

References:

1. Norman, K., Kirakowski, J., (2018), "Wiley Handbook of Human Computer Interaction," Wiley-Blackwell, ISBN: 9781118976135
2. Hassanien, A. E., Gupta, D., Khanna, A., Slowik, A., (2022), "Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications," Springer, ISBN: 9783030941017

B.E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS)
SEMESTER – VI

Intellectual Property Rights (3:0:0)3
(Effective from the academic year 2021 -22)

Course Code	**21ME651**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**3:0:0**	SEE Marks	50
Total Number of Contact Hours	**40**	Exam Hours	03

Course Objectives:

This course will enable students to:

1. Understand the patentability of the invention and creation of IP.
2. Demonstrate Industrial Design and Prior art search.
3. Prepare patent specification and claim drafting for new invention.
4. Explain patent filing process for the invention.
5. Develop patent strategy for patent transfer and infringements.

Preamble: Importance of intellectual property (IP): patents and industrial design. Need for patents, objectives of patent law and benefits of patents.

Module – 1

Introduction: History of intellectual property, basic principle of trading system under World Trade Organization (WTO), classification of properties and intellectual property. The changing R&D process and IPR, Evolving research modes and IPR. Approaches for industrial innovators. Incorporating IPR in Project Management, check posts on the innovation highway, IPR as part of project management.

Invention: Patentability of invention, what is invention, requirements of patentability of invention: Novelty, non obviousness and industrial applicability. what are not patentable inventions,

Innovation: Types of innovation, appropriation of IP, creativity and innovation,

(08 Hours)

Self-study component: Characteristics of innovating organizations.

Module – 2

Industrial Design Registration: Process for registration of Industrial design, Conditions for registration of Industrial Designs, Procedure for registration of Industrial Designs, Term of Industrial Designs, Register of Design, Infringement of Industrial Designs.

Prior art searches: The need for a search, objective of search, Searching method. Novelty search, Boolean search, manual search, patent number search, validity search, clearance search**.**, where and how to search prior art, field search**.** Data bases for prior arts.

(08 Hours)

Self-study component: Remedies against infringement of industrial designs.

Module – 3

International Treaties: WTO: Structure WTO**,** The major provisions of TRIPS with regard to the patent and its implications on Indian Patent Law.

Patent application: Provisional and complete specification. Content of the specification: title, field, background of the invention. Objectives of invention, statement and summary of invention. drawing, detailed discretion of the invention, claim and abstract. Procedure for grant of patent.

Patent Claim Drafting: Introduction to patent claim**,** basic structure of claims: preamble, transitional phrase and body of the claims. independent and dependent claims, product claim, process claim.

(08 Hours)

Self-study component: Pre grant opposition

Module -4

Filing process: Ordinary application, Patent of addition, patent of division, Procedure for grant of patents, Publication of Application, Examination, right of patentee. Term of patents and maintenance fees.

International Filing: Conventional countries, Convention application, PCT application. Indian International search authority, International search report, Indian International preliminary examination authority, International preliminary examination report.

IP protection: Inventions and protections under patent law, process patent and product patent.

CRI (computer related invention): Protecting Software and computer related innovation. IPR protection for CRI, Copyright and computer software, Guidelines for CRI in India.

(08Hours)

Self-study component: Parallel imports, ever greening of patents

Module -5

Transfer of rights: Transfer of patent rights, Assignment, license, cross licensing.

Infringement. Patent infringement, infringer, what constitutes infringement of a patent. Literal infringement, doctrine of equivalence, improvement infringement, willful infringement, remedies.

Different Schemes for IP: Schemes for Start-ups, small entities, other industries and organizations with respect to IP.

(08 Hours)

Self-study component: Patent strategy for company and organizations

Course Outcomes:

The students will be able to:

CO 1: Describe the patentability of the invention and CIP.

CO 2: Discuss Industrial design and Prior art search.

CO 3: Prepare patent specification and claim drafting.

CO 4: Summarize patent filing process.

CO 5: Describe IP management and infringement.

Textbooks:

1. Neeraj Pandey, Khushdeep Dharani, “Intellectual Property Rights”, PHI Learning, 2014.
2. Dr. S R Myneni, “Patent Drafting & Specification Writing”, New Era Law Publication, 2020.

References:

1. Prabhuddha Ganguli, “Intellectual Property Rights”, Tata Mc-Graw –Hill, 2017.
2. M. Ashok Kumar, Mohd. Iqbal Ali, “Intellectual Property Rights”, Serials Publications, 2008.
3. Deborah E. Bouchoux, “Intellectual Property Rights”, Cengage Learning, 2011.

B.E.MECHANICALENGINEERING

Choice Based Credit System(CBCS)

SEMESTER -VI

Energy Auditing (3:0:0)3

(Effectivefromtheacademicyear2021-22)

Course Code	**21ME652**	CIE Marks	50
Teaching Hours/Week (L:T:P)	**3:0:0**	SEE Marks	50
Total Number of Contact Hours	**40**	Exam Hours	03

Course objectives:

This course will enable students to:

- Comprehend energy scenario and general aspects of energy audit.
- Analyze the methods and concept of energy audit.
- Enumerate the energy utilization pattern including wastage and its management.

Module –1

General Aspects: Review of energy scenario in India, General Philosophy and need of Energy Audit and Management, Basic elements and measurements - Mass and energy balances – Scope of energy auditing industries - Evaluation of energy conserving opportunities, Energy performance contracts, Fuel and Energy substitution, Need for Energy Policy for Industries.

(08Hours)

Self-study topic: National & State level energy Policies.

Module –2

Energy Audit Concepts: Need of Energy audit - Types of energy audit – Energy management (audit) approach - understanding energy costs - Bench marking – Energy performance - Matching energy use to requirement - Maximizing system efficiencies -Optimizing the input energy requirements - Duties and responsibilities of energy auditors- Energy audit instruments - Procedures and Techniques.

(08Hours)

Self-study topic: Case study on potential energy savings

Module –3

Principles and Objectives of Energy Management: Design of Energy Management Program - Development of energy management systems – Importance - Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Monitoring and targeting.

(08 Hours)

Self-study topic: Recent Energy management systems

Module –4

Thermal Energy Management: Energy conservation in boilers - steam turbines and industrial heating systems - Application of FBC - Cogeneration and waste heat recovery -Thermal insulation - Heat exchangers and heat pumps –HVC industries-Building Energy Management.

(08 Hours)

Self-study topic: Case study of HIV industry

Module –5

Electrical Energy Management: Supply side Methods to minimize supply-demand gap- Renovation and modernization of power plants - Reactive power management – HVDC- FACTS - Demand side - Conservation in motors - Pumps and fan systems – Energy efficient motors.

(08Hours)

Self-study topic: Advanced Energy Efficient motors

Course outcomes:

The students will be able to:

CO1: Understand the basic concepts of energy audit and energy management.
CO2: Explain different types of energy audit, maximizing and optimizing system efficiency.
CO3: Summarize energy management systems, prepare and present energy audit report 23
CO4: Identify energy saving potential of thermal and electrical systems.
CO5: Discuss Energy audit instruments, Procedures and Techniques.

Question paper pattern:

- SEE will be conducted for 100 marks.
- Part A: First question with 20 MCQs carrying 1 mark each.
- Part B: Each full question is for 16 marks. (Answer five full questions out of 10 question with intra modular choice).
  a. There will be a maximum of three sub-questions from each module.
  b. There will be a choice from two full questions from each module.

Textbooks:

1. 1.Energy Management Handbook by W C Turner and Steve Doty 6th edition (John Wiley and Sons, A Wiley a. Inter science publication)
2. Energy audit and management by L Ashok Kumar and Gokul Ganeshan , ISBN 9781032067797,CRC press,1st edition 2023

References:

1. Murphy, W. R., Energy Management, Elsevier/bsp Books Pvt. Ltd 2007
2.Energy Management, Audit and Conservation" by Barun Kumar De
3. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
4.Energy Management and Conservation by K V Sharma and P Venkataseshaiah, IK International publishing house,ISBN-13

B. E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER - VI

Industrial Safety and Maintenance Engineering (3:0:0) 3

(Effective from the academic year 2021-22)

Course Code	**21ME653**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**3:0:0**	SEE Marks	50
Total Number of lecture hours	**40**	Exam Hours	3

Course Objectives:

This course will enable students to:

- Provide knowledge of safety and environment aspects in industries.
- Understand maintenance objectives and evaluate various maintenance strategies for process plant application.
- Develop necessary planning and scheduling and control of preventive maintenance activities.
- Acquire basic knowledge of reliability, TPM and inventory control in maintenance.
- Apply the concepts such as safety and quality maintenance process.

Module-1

Preamble: Introduction to safety, significance and sustain world-class performance through the implementation of maintenance and reliability engineering principles.

Safety Rules and Principles:

Need for safety, General safety rules and principles, Accident and its causes, Types, Mechanical and Electrical hazards and its causes, Preventive steps/procedure, Salient features of factories act 1948 for Health and Safety, Wash rooms, Drinking water Layouts, Light, Cleanliness, Safety color codes. Fire prevention and Firefighting equipment and Methods.

(08 Hours)

Self-Study Component: Hazard Symbols.

Module-2

Personal Protection and Safety Management:

Concepts of Personal protective equipment, Types, selection of PPE, Invisible protective barriers – Procurement, Storage, Inspection and Testing, Quality and Standards. Principles of Ergonomics, Types of Ergonomics and its applications, Safety management and its responsibilities, planning for safety and safety organization.

(08 Hours)

Self-Study Component: Safety Education and Periodic Training

Module-3

Maintenance Engineering:

Introduction, Types of Maintenance, Concept of Reliability in Maintenance, Reliability centered maintenance (RCM), Benefits of RCM, Maintenance Planning, Scheduling and Scheduling techniques. Goals of Total Productive Maintenance (TPM) and methodology, Fishbone diagram, Failure Mode Effect Analysis (FMEA), Six-Sigma process and 5s.

(08 Hours)

Self-Study Component: Predictive Maintenance versus Periodic Maintenance.

Module-4

Computerized Maintenance Management systems (CMMS):

Definition, advantages and capabilities of CMMS, CMMS implementation flow chart, Components of a CMMS, Work order systems & plant registers; Maintenance reports, analysis and monitoring, Commercial packages Equipment maintenance, AI for Predictive Maintenance -

AI for Manufacturing Industry, Difference between CMMS and ERP, CMMS requirements in IR4.0 adaptation.

(08 Hours)

Self-Study Component: CMMS software.

Module-5

Quality and safety in Maintenance:

Need for quality maintenance process, Maintenance work Quality, Important reasons for safety problems in Maintenance, Quality control chart using C-chart. Maintenance budget type, Preparation approaches and Steps, Maintenance labour cost estimation and Numerical problems.

(08 Hours)

Self-Study Component: Challenges of Maintenance and Safety Engineering in Industry 4.0

Course Outcomes:

The student will be able to:

CO1: Understand the safety and maintenance practices adapted in industry.

CO2: Apply their liability-centered maintenance methodologies for safety of machine or device.

CO3: Analyze the safety, quality and Maintenance cost

CO4: Illustrate some of the simple method used for safety and maintenance in industry.

Text Books:

1. Srivastava S.K., "Industrial Maintenance Management" S. Chand and Co., 1981.
2. Engineering Maintenance, Dhillon, B.S, CRC Press LLC, 2002.

Reference books:

1. Venkataraman. K, "Maintenance Engineering and Management", PHI Learning, Pvt. Ltd., 2007.
2. Higgins L.R., "Maintenance Engineering Hand book", McGraw Hill,5th Edition, 1988.
3. Garg M.R., "Industrial Maintenance", S. Chand & Co., 1986.
4. R. Keith Mobley, "Maintenance Engineering Handbook", 7th Edition McGraw Hill, 2008.

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B.E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER –VI

Micro and Nano Electromechanical Systems (3:0:0)3

(Effective from the academic year2021-22)

Course Code	**21ME654**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**3:0:0**	SEE Marks	50
Total Number of Contact Hours	**40**	Exam Hours	03

Course objectives:

This course will enable students to:

4. To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
5. To educate on the rudiments of Micro fabrication techniques.
6. To introduce various sensors and actuators, different materials used for MEMS.
7. Understand the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.

Preamble: Importance of micro electromechanical systems in automobile, aeronautical, marine, biomedical and manufacturing sectors.

Module –1

Overview of MEMS and Microsystems: Definition of MEMS, MEMS and Micro system, MEMS devices, Silicon as a MEMS material – structure and bonding, and mechanical properties of silicon. Mechanical components in MEMS. Comparison of microelectronics and micro systems, Design concepts of mechanical components. Evolution of Micro fabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization.

(08Hours)

Self-study: BioMEMS - Retinal Prosthesis

Module –2

Working Principles of Microsystems: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, Micro fluidics. Acoustic Wave Sensors, Biomedical Sensors and Biosensors, Chemical Sensors, Optical Sensors, Pressure Sensors, Thermal Sensors.

Engineering Science for Microsystems Design and Fabrication: Introduction, Molecular Theory of Matter and Inter-molecular Forces, Plasma Physics, Electrochemistry.

(08Hours)

Self-study: Applications in Pressure, and Temperature measurement.

Module –3

Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics.

(08Hours)

Self-study: Overview on Finite Element Stress Analysis.

Module –4

Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Fluid Mechanics,

(08Hours)

Self-study: Scaling in Heat Transfer.

Module –5

Overview of Micro manufacturing: Introduction, Bulk Micro manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro manufacturing.

Nano scaling system: The Importance of Nano scale Science and Technology, Manufacturing at Nano scale: Top-Down, Bottom-up.

(08Hours)

Self-study: Challenges in Micro manufacturing.

Course outcomes:

The students will be able to:

CO1: Appreciate the technologies related to Micro Electromechanical Systems.
CO2: Understand design and fabrication processes involved with MEMS De- vices.
CO3: Analyze the MEMS devices and develop suitable mathematical models.
CO4: Know various application areas for MEMS device..
CO5: Describe the Micro manufacturing.

Textbooks:

4. Dirk Zielke, MEMS: Micro-Electro-Mechanical Systems, independently published, May 1, 2021.
5. Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nano scale Engineering, 2nd Ed, Wiley.

References:

1. Hans H. Gatzen, VolkerSaile, Jurg Leuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
2. Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Microelectromechanical Systems (MEMS), Cengage Learning.
3. Mahalik, Nitaigour Premchand, Microelectromechanical Systems (MEMS), McGraw Hill Education, 2017.
4. Choudhary, Vikas, MEMS: Fundamental technology and applications, Boca Raton CRC Press, 2013.
5. Adams, Thomas M, Introductory MEMS: fabrication and applications, Springer (India) 2010.

B.E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS)
SEMESTER - VI

Finite Element Method (3:2:0) 4
(Effective from the academic year 2021-22)

Course Code	**21ME67**	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	50
Total Number of Contact Hours	50	Exam Hours	03

Course objectives:

This course will enable students to:

1. Illustrate the basic concepts involved in finite element method.
2. Determine stresses and strains in bar and beam for different loading conditions and boundary conditions
3. Analyze trusses for different boundary loading conditions and loading conditions.
4. Examine heat transfer and fluid flow problems using finite element method.
5. Determine stresses and strains torsional and dynamic loading problems using finite Element method.

Preamble: Historical background, importance of FE Analysis for Mechanical, aerospace, automotive industry.

Module – 1

Introduction to Finite Element Method: General steps of the finite element method. Engineering applications of finite element method. Advantages and disadvantages of the Finite Element Method. Discretisation process, Convergence criteria, 1-D elements. Simplex, complex and multiplex elements, Plain stress and Plain strain conditions,

Bar element: Derivation of stiffness matrix for bar element, linear shape function in terms of natural coordinates for linear 1D bar elements. Lagrange interpolation functions, Linear interpolation polynomials in terms of natural coordinate's for1D bar elements: 2 noded 3 noded bar elements.

Numerical Problems on solution for displacement, stress and strain in 1D straight and stepped bar for point loads, thermal loads and uniformly distributed loads using elimination approach and penalty approach.

(11 Hours)

Self-study component: Commonly used finite element packages and their important features.

Module – 2

2-Dimensional elements: Degrees of freedom, displacement vector for three noded triangular & four noded quadrilateral elements. Derivation of shape functions for 3 noded triangular elements and 4 noded quadrilateral elements in terms of natural co-ordinates. 2D iso-parametric element

Beams: Different types of beams, Boundary conditions, load vectors, Hermite shape function, and derivation of Hermite shape function of beam element, Displacement functions, derivation of Element stiffness matrix for beam. Derivation of load vector for uniformly distributed load, finite element formulation, Numerical problems on simply supported, fixed beam with concentrated and uniformly distributed loads.

(09 Hours)

Self-study component: potential energy functional for beam element

Module – 3

Truss: Introduction, different types of trusses, plane trusses, direction cosines, practical applications of truss elements, derivation of transformation matrix and stiffness matrix for 2-D plane truss element. Element stresses and strains. Finite Elements Formulations for truss element. Displacements vectors, force vector. Numerical problems of two element trusses with different boundary and loading conditions.

3-Dimensional elements: Degrees of freedom and displacement vector for eight noded hexahedral element and four noded tetrahedral elements. Interpolation functions in terms of natural coordinates for four noded tetrahedral and eight noded hexahedral elements.

(09 Hours)

Self-study component: Local and global co-ordinate system for truss element.

Module – 4

Heat Transfer: Introduction to finite element analysis of heat transfer problems, rate equation, differential equation for a 1-D heat conduction. Boundary conditions, 1-dimension finite element formulation for heat transfer, derivation of thermal conductivity matrix. Numerical problems on heat transfer through composite sections with temperature gradient and heat fluxes.

Fluid Flow: Basic differential equation for fluid flow in pipes and porous media. Finite element formulation for flow through a porous medium and flow through pipes of uniform cross sections. Numerical problems on fluid flow.

(10 Hours)

Self-study component: Basic heat transfer equation, energy balance equation.

Module – 5

Torsion of Shafts: Introduction, torsional equation**,** derivation of torsional stiffness matrix, shear stresses and strain torsion of shafts, finite element formulation of torsion of circular shafts Numerical problems on determination of stress and twists in the circular shafts.

Dynamic Analysis: Introduction to Finite element analysis for vibration problems, consistent mass matrix for bar element, derivation of consistent element mass matrix for one dimensional bar element.

Non-linear vibration: Differences between linear and non-linear vibrations. Examples of non-linear vibration: Simple pendulum, vibration of a spring, hard and soft spring, belt friction, variable mass system, abrupt linearity.

Numerical problems on dynamic analysis of one-dimensional bar and stepped bars using finite element method.

(11 Hours)

Self-study component: Natural frequency and mode shape for bar element, practical examples for vibration analysis.

Course outcomes:

The students will be able to:

CO 1: Illustrate the basic concepts involved in finite element method.
CO 2: Analyse bar and beam problems for different loading conditions.
CO 3: Analyze truss problems for different boundary loading conditions.
CO 4: Examine heat transfer and fluid flow problems using finite element method.
CO 5: Estimate stresses and strains in torsional and dynamic loading problems using finite element method.

Textbooks:

1. Robert. D., Cook MalkusPlesha Witt., "Concepts and Application of Finite Elements Analysis", 4th Edition, Wiley & Sons, 2007.
2. S. B. Halesh., "Finite Element Method", 1st Edition, Sapna Book House, 2018.

References:

1. K. J. Bathe., “Finite Element Procedures”, Prentice Hall, 2006.
2. Tirupathi. R., Chandrupatla. Ashok. D., Belegundu. “Introduction to Finite Elements in Engineering”, 4th Edition, Pearson, 2015.
3. Seshu. P., “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd, 2013.

B.E. MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER – VI

COMPUTER INTEGRATED MANUFACTURING (3:0:0) 3

(Effective from the academic year 2021-22)

Course Code	**21ME68**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**3:0:0**	SEE Marks	50
Total Number of Contact Hours	**40**	Exam Hours	03

Course Objectives:

This course will enable students to:

1. Illustrate the need for the adoption of advanced manufacturing technology.
2. Examine the automated flow lines and methods to balance the flow line for improving the performance of the manufacturing process.
3. Analyze the part profiles and write the CNC part programming.
4. Categorize the methods required to ascertain the quality of the product produced using CNC machines.

Preamble: Impact of CIM in modern manufacturing sector, Societal relevance of computerizing the factory environment.

Module – 1

Introduction to CIM and Automation: Definition of CAD, CAM and CIM. Production systems, Manufacturing support systems, Automation: Definition, Types and Reasons for Automation. Computer Integrated Manufacturing, Mathematical models and matrices: Manufacturing lead time, production rate, production capacity, utilization and availability, work-in- process ratio and time -in- process ratio. Numerical problems.

Automated Flow Lines and Assembly Systems: Introduction, Fundamentals, symbols used to represent automated flow line, system configurations/types of automated flow lines, Objectives and applications. Buffer storage, control of automated flow line. Analysis of transfer lines: With storage buffer and Without storage buffer. Numerical problems.

(09 Hours)

Self-study component: Importance of Computers in Design and Manufacturing.

Module – 2

Computerized Manufacture Planning and Control System: Computer Aided Process Planning (CAPP), Retrieval and Generative CAPP Systems, benefits of CAPP, Material Requirement Planning (MRP): Introduction, Fundamental concepts of MRP, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning.

Computer Aided Quality Control: Introduction, Objectives, Advantages, Inspection procedure, Inspection accuracy, Automated inspection, Techniques of automated inspection – Contact and non-contact, Co-ordinate Measuring Machine (CMM): Constructional features, Types of mechanical structure, Application and benefits. Machine Vision, Components of machine vision system and applications.

(07 Hours)

Self-study component: Role of computers in Inspection. Flexible inspection systems.

Module – 3

Line Balancing: Introduction, Terminologies used in line balancing procedure, Methods of line balancing, Numerical problems on largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights method.

Computer Numeric Control: Introduction, Basic Components of CNC Systems, General configurations of CNC and DNC systems, Features of CNC, Classification of CNC

Systems, CNC Co-Ordinate System, Advantages and Disadvantages. CNC Machining Centres, CNC Turning Centres, Machine Control unit.

(07 hours)

Self-Study Component: High Speed machining.

Module – 4

CNC Programming: Introduction, Part Program Fundamentals, Manual part programming, Programming formats, Axes standards for turning and milling, NC block, Preparatory functions, Miscellaneous functions, Tool-length Compensation, Cutter-Radius compensation, Canned Cycles in Turning and Milling, Simple programming exercises in turning using canned cycles for rough turning, finish turning, axial drilling, grooving and thread cutting. Simple programming exercises in Milling for operations like Face milling and end milling. Use of Canned cycles in milling for Drilling, Peck drilling, Reaming, Boring and tapping operations. Computer Assisted Part Programming, Steps in Computer Assisted Part Programming, Introduction to APT programming, APT statements, Basic APT programming.

(08 hours)

Self-study component: Study on various CAM software's.

Module – 5

Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Robot programming methods: on-line and off-line methods. Robot industrial applications: material handling, processing and assembly and inspection.

Industry 4.0: Introduction, functions, applications and benefits. Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.

(09 hours)

Self-Study Component: Impact of advanced manufacturing technology on the economic growth.

Course Outcomes:

The students will be able to:

CO1: Apply the manufacturing concepts to compute the automation system parameters through mathematical models.

CO2: Analyze the automated flow lines to reduce down time

CO3: Develop CNC programs for machining operations using the software and prepare a report.

Textbooks:

1. Mikell P Groover, "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Publications, 4th Edition, 2015.
2. P. N. Rao, "CAD/CAM Principles and Application", Tata McGraw Hill, International, 3rd Edition, 2014.

References:

1. Ibrahim Zeid, "CAD/CAM", 3rdEdition, TataMcGrawHill, 2015.
2. S. Kant Vajpayee., "Principles of Computer Integrated Manufacturing", 3rdEdition, Prentice Hall of India, 2006.
3. Dr.P.Radhakrishnan.,"CAD/CAM/CIM",3rd Edition,NewAgeInternationalPublishers, 2004.

B.E., MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

SEMESTER – VI

COMPUTER INTEGRATED MANUFACTURING LAB (0:0:1) 1

(Effective from the academic year 2021-22)

Course Code	**21MEL69A**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**0:0:2**	SEE Marks	50
Total Number of Contact Hours	**40**	Exam Hours	03

Course Objectives:

This course will enable students to:

1. Apply the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
2. Illustrate the usage of CAM Software for the effective tool path generation.
3. To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

Preamble: Importance of CAM Software, Applications in the Industry and Research domain.

Part A

1. **Manual CNC Programming**: Introduction, Part Program Fundamentals, Manual part programming, Programming formats, NC block, Preparatory functions, Miscellaneous functions, Tool-length Compensation, Cutter-Radius compensation.
2. **Manual CNC part programming for Turning operations:** Canned Cycles in Turning, Simple Programming Exercises in Turning using canned cycles for Rough turning, finish turning, axial drilling, Grooving and Thread cutting.(Minimum5Exercises).
3. **Manual CNC part programming for milling operations:** Canned Cycles in Milling, Simple programming exercises in milling for operations like Face milling and end milling. Use of Canned cycle sin milling for Drilling, Peck drilling, Reaming, Boring and tapping operations. (Minimum 5 Exercises) .Simulation stobe carried out using simulation packages.

Module – B

1. **Robot programming:** Demoon using Teach Pendent & Offline programming to perform pick and place, stacking of objects.
2. **Pneumatics and Hydraulics:** Demoon building the circuit using the elements of hydraulic and pneumatic systems to be conducted.

Course Outcomes:

The students will be able to:

CO1: Illustrate the procedure to write a CNC program to produce the components.

CO2: Estimate to determine the cutting speed, feed and depth of cut required for various operations for various tool and work material combinations.

CO3: Demonstrate the operations of a robot for pick & place operations.

Assessment methods:

I. Continuous Internal Evaluation (CIE): 50 Marks

The marks for the record write-up and internal assessment will be in the ratio of 60:40.Record will be continuously evaluated for each experiment with regard to conduction, write-up and viva-voce: 30Marks.Internal Test will be conducted for 100 Marks and reduced to 20 Marks

II. Semester End Examination (SEE): 50 Marks

SEE is conducted for 100 Marks and reduced to 50 Marks.

Question paper pattern:

One question on Turning related programming: 40 marks
One question on Milling related programming: 40 marks
Viva Voce: 20 marks
Maximum Marks: 100

B.E MECHANICAL ENGINEERING

(**Choice Based Credit System (CBCS)**

SEMESTER - VI

FINITE ELEMENT ANALYSIS AND MAT LAB (0:0:1) 1

(Effective from the academic year 2021-22)

Course Code	**21MEL69B**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**0:0:2**	SEE Marks	50
Total Number of Contact Hours	**26**	Exam Hours	03

Course Objectives:

This course will enable the students to:

1. To acquire basic understanding of Modeling and Analysis software
2. To understand the concepts of different kinds of loading on bars, trusses and beams, and analyze the results pertaining to various parameters like stresses and deformations.
3. To lean to apply the basic principles to carry out dynamic analysis to know the natural frequencies of different kind of beams.
4. To learn the simulation of stress, strain and vibration characteristics using MAT Lab.

Preamble: Application of FEM and MATLAB in various field based on the requirement

PART - A

Modelling and analysis of:

1. Bars of constant cross-sectional area, tapered cross section area and stepped bars.
2. Trusses – Different types of trusses (Minimum 2 exercises)
3. Beams – Simply supported, cantilever, beams with point load, Uniformly Distributed Load (UDL), beams with varying load etc. (Minimum 6 exercises)
4. Stress analysis of a rectangular plate with a circular hole.
5. Thermal Analysis – 1D & 2D problems with conduction and convection boundary conditions (Minimum 4 exercises of different types).
6. Dynamic Analysis to find the Natural frequency of a beam with fixed – fixed end condition

PART - B

Study of a MAT LAB package and Simulation of:

1. Invariants, Principal stresses and strains with directions
2. Maximum shear stresses and strains and planes, Von- Mises stress
3. Stress analysis of rectangular plate with circular hole under uniform Tension
4. Vibration Characteristics of a Spring Mass Damper System

Course Outcomes: The student will be able to:

CO1: Apply the fundamental concepts of FEM in problem characterization.

CO2: Analyze the stresses of bars, truss, beams, and plate with different loading conditions.

CO3: Carry out dynamic analysis and finding natural frequencies of beams for various boundary conditions.

CO4: Simulate the stress, strain and vibration characteristics using MAT Lab.

Assessment methods:

I. Continuous Internal Evaluation (CIE): 50 Marks

- The marks for the record write-up and internal assessment will be in the ratio of 60:40.
- Record will be continuously evaluated for each experiment with regard to conduction, write-up and viva-voce: 30Marks.
- Internal Test will be conducted for 100 Marks and reduced to 20 Marks.

II. Semester End Examination (SEE): 50 Marks

SEE is conducted for 100 Marks and reduced to 50 Marks.
Question paper pattern:
One question from Part-A : 40 Marks
One question from Part-B : 40 Marks
Viva – Voce : 20 Marks
TOTAL : 100 Marks