Shri Shankaracharya Technical Campus, Bhilai

(An Autonomous Institute Affiliated to CSVTU Bhilai)

SCHEME OF TEACHING AND EXAMINATION

B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Effective from 2020-2021 Batch

Sl. No.	Board of Studies (BOS)	Courses (Subject)	Course Code	Period per Week			Scheme of Examination Theory/Lab			Total Marks	Credit
				L	T	P	ESE	CT	TA		
1	Mechanical Engineering	Refrigeration and Air-Conditioning	ME107601	2	1	-	100	20	30	150	4
2	Mechanical Engineering	Finite Element Methods	ME107602	2	1	-	100	20	30	150	3
3	Mechanical Engineering	CAD/CAM/CAPP	ME107603	2	1	-	100	20	30	150	3
4	Mechanical Engineering	Professional Elective-II*	Refer Table 1	2	1	-	100	20	30	150	3
5	Mechanical Engineering	Open Elective-1[#]	Refer Table 2	3	-	-	100	20	30	150	3
6	Mechanical Engineering	Refrigeration and Air-Conditioning Lab	ME107691	-	-	2	25	-	25	50	1
7	Mechanical Engineering	Finite Element Methods Lab	ME107692	-	-	2	25	-	25	50	1
8	Mechanical Engineering	CAD/CAM/CAPP Lab	ME107693	-	-	2	25	-	25	50	1
9	Mechanical Engineering	Minor Project-II	ME107694	-	-	2	50	-	25	75	1
10	Mechanical Engineering	Essence of Indian Knowledge Tradition	ME100596		-		-	-	25	25	-
Total				**11**	**4**	**8**	**625**	**100**	**275**	**1000**	**20**

L : Lecture, T: Tutorial P : Practical ESE : End Semester Exam CT : Class test

Table 1 : Professional Elective - II

Sl. No.	Board of Studies (BOS)	Courses (Subject)	Course Code
1	Mechanical Engineering	Quality Control and total Quality Management	ME107621
2	Mechanical Engineering	Energy Management and Audit	ME107622
3	**Mechanical Engineering**	**Internet of Things (IoT)***	**ME107623**
4	Mechanical Engineering	Product design and Development	ME107624

 # Refer : Table 2

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Chairman (AC)	Chairman (BoS)	Date of release	Version	

SYLLABUS

B.TECH. (MECHANICAL ENGINEERING)

SIXTH SEMESTER

		July 2022	1.00	Applicable for AY 2022-23 Onwards
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SYLLABUS

B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Subject Code ME107601	Refrigeration and Air Conditioning	L = 3	T = 2	P = 0	Credits = 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
The objective of the course to:	**Student will be able to:**
1. To introduce students to basic refrigeration cycles, systems and components.	**CO 1** Understand to introduce students to basic refrigeration cycles, systems and components.
2. To introduce students to Simple Air refrigeration cycle and air craft refrigeration system.	**CO 2** Compute identify analyze and design basic refrigeration cycle incorporating air and air craft refrigeration system.
3. To introduce students to Vapor compression and vapor absorption Refrigeration system.	**CO 3** Analyze Vapor compression and vapor absorption refrigeration system.
4. To introduce students to refrigerants.	**CO 4**Identify and name various refrigerants.
5. To introduce studentsair conditioning system and psychrometry.	**CO 5**Understand the principles of psychrometry and human comfort and will be able to design air conditioning system as per the cooling load.

UNIT I:

Introduction to Refrigeration: Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect & C.O.P. **[CO 1, 3Hrs.**

Air Refrigeration cycle: Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART) **[CO 2, 4 Hrs.**

UNIT II:

Vapor Compression System: Single stage system, Analysis of vapor compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapor on C.O.P of the cycle, Actual vapor compression refrigeration cycle, Multistage vapor compression system requirement, Removal of flash gas, Intercooling, Different configuration of multistage system, Cascade system. **[CO 3, 6Hrs.**

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UNIT III:

Vapor Absorption system; Working Principal of vapor absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water vapor absorption system, Lithium- Bromide water vapor absorption system, Comparison. Three fluid systems. **[CO 3, 6 Hrs.**

Refrigerants: Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants. Ozone layer depletion and global warming considerations of refrigerants **[CO 4, 4 Hrs.**

UNIT IV:

Air Conditioning: Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Air Washers, Cooling towers & humidifying efficiency **[CO 5, 6Hrs.**

UNIT V:

Refrigeration Equipment & Application: Elementary knowledge of refrigeration & air conditioning equipment, compressors, condensers, evaporators & expansion devices, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning. **[CO 1, 6 Hrs.**

Text Books:

S. No.	Title	Author(s)	Publisher
1	Refrigeration and Air conditioning	S.C. Arora & S Donkundwar,	S Dhanpat Rai, Delhi
2	A Text book of Refrigeration and Air conditioning	R K Rajpoot	S K Kataria and sons

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Refrigeration and Air conditioning	C.P Arora	McGraw-Hill
2	Principles of Refrigeration	J. Dossat	Pearson Education
3	Refrigeration and Air conditioning	Stoecker& Jones	McGraw-Hill
4	Refrigeration and Air conditioning	Manohar Prasad	NewAge, Delhi

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SYLLABUS

B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Course Code ME107602	Finite Element Methods	L =2	T=1	-	Credits=3
Examination Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
1. The aim of the course is to provide the participants an overview on Finite Element Method, Material models, and Applications in Mechanical Engineering. **2.** To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools. **3.** It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states. **4.** To study approximate nature of the finite element method and convergence of results are examined. **5.** It provides some experience with a commercial FEM code and some practical modeling exercises.	At the end of this course, the students are expected to be able to: **CO1:** Apply knowledge of finite element method for understanding, formulating and solving engineering problems. **CO2:** Identify the application and characteristics of FEA/FEM elements such as one-dimensional bars, beams elements. **CO3:**Derive and develop element characteristic equation and generation of global equation. **CO4:** Able to apply suitable boundary conditions to a global equation for plate and shell element. **CO5:** Identify, analysis, and solve dynamic problems and solve them displacements, vibration or frequency induced.

Unite I: Fundamentals Concepts of FEM

[CO 1]

Brief History of FEM, Finite Element Terminology (nodes, elements, domain, continuum, Degrees of freedom, loads & constraints), General FEM procedure, Applications of FEM in various fields, Advantages and disadvantages of FEM, Consistent unit system, FEM displacement approach, Stiffness matrix, Domain residual and minimization, Weighted residual method, Weak form of weighted residual method, Total potential energy, Galerkins approach and Raleigh Ritz approach. Solution of problems from structure mechanics and heat transfer.

[8 hrs.]

Unite II: One-Dimensional Finite Element Analysis

[CO 1]

One dimensional second order equations, Discretization, Element types, Generic form of Finite Element Equations, Linear bar element, Quadratic bar elements, Beam element, Determination of Shape functions and Stiffness matrices and force vectors for Linear, Quadratic bar and beam elements, One dimensional heat transfer.**[7 hrs.]**

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Unite III: Two-Dimensional Finite Element Analysis

[CO 1]

Second order 2D equations, Variational formulation, Approximation of geometry and field variable: Simple Three-noded triangular elements, Four-noded rectangular element, Six-noded triangular element, Determination of Shape functions and Stiffness matrices and force vectors: Simple Three-noded triangular elements, Four-noded rectangular element, Six-noded triangular element, Gauss Quadrature Technique.**[7 hrs.]**

Unite IV: Finite Element Analysis for Plain Stress

[CO 1]

Equations of elasticity, Plane stress, Plane strain and Axis-symmetric problems, Shape function and Stiffness matrix Body forces effects, Stress calculations, Plate and shell elements.**[7 hrs.]**

Unite V: Finite Element Analysis for Dynamic Analysis

[CO 1]

Vibration problems, Equation of motion based on weak form for Axial vibration of a rod and Transverse vibration of a beam, Consistent and Lumped mass matrices.**[7 hrs.]**

S. No.	Title	Author(s)	Publisher
1	Textbook of Finite Element Analysis	P. Seshu	PHI Learning Pvt. Ltd.
2	Finite Element Analysis	S. S. Bhavikatti	New Age International
3.	Finite element method in engineering, 5th Edition	S. S. Rao	Pergaman Int. Library of Science
4.	Finite Elements in Engineering, 2nd Edition	T. R. Chandrupatla and Belegundu	PHI Learning Pvt. Ltd.

Reference Books

S. No.	Title	Author(s)	Publisher
1.	Finite Element Method	J.N.Reddy	McGraw -Hill International Edition
2.	A first Course in the Finite Element Method,6th Edition	D. L. Logan	Cengage Learning
3.	Concepts and Applications of Finite Element Analysis	Cook, Robert	John Wiley
4.	Finite Element Method	O. C. Zienkiewicz	McGraw -Hill International Edition

NPTEL

S. No.	Link
1.	https://nptel.ac.in/courses/112104116

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SYLLABUS

B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Subject Code ME107603	CAD/CAM/CAPP	L = 3	T = 1	P = 0	Credits = 4
Examination Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours
	Minimum number of class tests to be conducted=02			Minimum Assignments=02	

Course Objectives	Course Outcomes
• To introduce the student to be familiar with CAD/CAM/CAPP terminology & its capabilities. • To master basic knowledge of numerical control machine tool working principle and composition. • To master CNC programming and computer aided part programming with CAM systems. • To analyze information requirements in computer aided process planning along with control. • To analyze the automated material handling in relation with computer integrated manufacturing.	At the end of this course, the students are expected to be able to: **CO1:** Understand the various CAD/CAM/ and CAPP processes. **CO2:** Acquire knowledge and hands-on competence in applying the concepts of CNC machine tools and its control systems. **CO3:** Acquire knowledge and hands-on competence in applying the concepts of CNC programming and computer aided part programming. **CO4:** Demonstrate creativeness in flow of information in a production organization using CAPP **CO5:** Identify and analyze various automated material handling systems using the concept of CIM

Unit – I: **CO1**

Introduction: Computers in industrial manufacturing, Design process, Computer aided design (CAD), Computer aided manufacturing (CAM), Computer integrated manufacturing (CIM). **Modeling Systems:** Introduction, Constraint-based modeling. **[8 Hrs]**

Unit – II: **CO2**

Computer Numerical Control: Introduction, Numerical control, Numerical control modes, Numerical control elements, NC machine tools.**CNC Machine Tools and Control Systems:** CNC machine centers, CNC turning centers, High-speed machine tools, Machine control unit, Support systems, Touch-trigger probes. **[10 Hrs]**

Unit – III: **CO3**

CNC Programming: Part-programming fundamentals, Manual part-programming methods, Preparatory functions, Miscellaneous functions (M), Program number, Tool-length compensation, Canned cycles, Cutter-radius compensation. **Computer-Aided Part Programming:** Concept of CAP, APT language structure, Geometry commands, Motion commands, Postprocessor commands, Compilation control commands, Repetitive programming, Complete part program in APT, CAM systems.**[10 Hrs]**

Unit – IV **CO4**

Information Requirements of Manufacturing: Discrete part manufacture, Information requirements of a

production organization, Manufacturing strategies, Integration requirements.
Group Technology and Computer Aided Process Planning: Group technology, Classification and coding, Production flow analysis, Cellular manufacturing, Computer aided process planning, Implementation techniques.
Production Planning and Control: Introduction, Production planning, Capacity planning, Master production schedule, Material requirement planning (MRP), Production activity control (PAC), Optimized production technology (OPT), Manufacturing resource planning (MRP II), Just in time (JIT). **[10 Hrs]**

Unit – V **CO5**
Material Handling Systems: Introduction, Automatic guided vehicles (AGV), Robots, Automated storage and retrieval system.
Flexible Manufacturing Systems: Introduction to FMS, FMS equipment, Tool management systems, System layouts, FMS Control, Development of the concept.
Computer Integrated Manufacturing: Integration, CIM implementation, Benefits of CIM, Lean manufacturing. **[10Hrs.]**

Text Books:

S. No.	Title	Author(s)	Publisher
1	CAD/CAM: Principle and Applications	P. N. Rao	McGraw-Hill
2	CAD/CAM/CIM	P. Radhakrishnan, S. Subramanyan and V. Raju	New Age International (P) Limited
3	CAD/CAM: Computer Aided Design & Manufacturing	M. P. Groover and E. Zimmers	Pearson Education India

Reference Books:

S. No.	Title	Author(s)	Publisher
1	CAD/CAM: Theory & Practice	Ibrahim Zeid	McGraw-Hill
2	Automation Production systems and Computer Integrated Manufacturing	M.P. Groover	Prentice Hall of India
3	CNC: Fundamentals and Programming	P. M. Agrawal &V. J. Patel	Charotar Publishing House Pvt. Ltd.
4	Numerical Control & Computer Aided Manufacturing Tata McGraw Hill	T.K. Kundra, P.N. Rao and N.K. Tewari	Tata McGraw Hill
5	Integration of CAD/CAPP/CAM	J. Xue	De Gruyter

SYLLABUS

B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Course Code ME107691	Refrigeration and Air-Conditioning Lab	-	-	P=2	Credits=1
Examination Scheme	ESE	CT	TA	Total	ESE Duration
	25	-	25	50	3 Hours

Course Objectives	Course Outcomes
1. To introduce the concept of HVAC, and mediums through which heat is transferred. **2.** To learn working principles of different instruments used to measure different quantities during labs **3.** To gain hands on practice with refrigerating circuits and develop air-conditioning systems.	At the end of the course, students will be able to: **CO 1** Conduct test on Refrigeration and air conditioning test units to study their performance. **CO 2** Draw performance curves of these machines/systems. **CO 3** Analyze the results obtained from the tests. **CO 4** Draw conclusions based on the results of the experiments

Suggested list of experiments/activities (minimum 10 to be performed)

1. Study of various elements of a vapor compression refrigeration system through cut sections models / actual apparatus.
2. To study different types of expansion devices used in refrigeration system.
3. To study different types of evaporators used in refrigeration system
4. To study basic components of air-conditioning system.
5. Study of hermetically sealed compressor
6. Experiment on refrigeration test rig to calculate various performance parameters.
7. Experiment on air-conditioning test rig & calculation of various performance parameters
8. Study and performance testing of an Ice plant.
9. To find the performance parameter of Cooling Tower.
10. To study and perform experiment on Vapor Absorption Apparatus.
11. To find RH of atmosphere air by using slings Psychometric and Psychometric
12. To calculate cooling load of an automobile.
13. Study and performance testing of water cooler.
14. Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning

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B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Course Code ME107692	Finite Element Methods Lab	-	-	P=2	Credits=1
Examination Scheme	ESE	CT	TA	Total	ESE Duration
	25	-	25	50	3 Hours

Course Objectives	Course Outcomes
1. To acquire basic understanding of Modeling and Finite Element Analysis software. 2. To understand the structure analysis and apply the basic principles to find out the deflection, stress strain and other related parameters of bars loaded with loading conditions. 3. To understand the structure analysis and apply the basic principles to find out the deflection, stress strain and other related parameters of beams loaded with loading conditions. 4. To understand the thermal analysis and apply the basic principles to find out the temperature, thermal deflection, thermal stress, heat flux etc. of 1D and 2D problems with different boundary conditions. 5. To lean to apply the basic principles to carry out dynamic analysis to know the natural frequency.	Upon successful completion of this course, the student should be able to: **CO1:** Understand the concepts behind formulation methods in FEM and apply finite element simulation tool to solve practical problems. **CO2:**Demonstrate the deflection of bar subjected to axial load to use the available of results to draw shear force and bending moment diagrams. **CO3:** Demonstrate the deflection of beams subjected to point, uniformly distributed and varying loads further to use the available of results to draw shear force and bending moment diagrams. **CO4:** Analyze the given problem by applying basic principle to solve and demonstrate 1D and 2D heat transfer with conduction and convection boundary conditions. **CO5:**Predict the dynamic Characteristics and nature frequency of 2D components for various boundary condition and also analyze with forcing function.

S. No.	Experiments
	Part- A (Minimum 5 exercises of different type)
1.	Bars of constant cross section area, tapered cross section area and stepped bar
2.	Trusses
3.	Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc.
4.	Stress analysis of a rectangular plate with a circular hole.
	Part- B (Minimum 3 exercises of different type)
1.	Thermal Analysis – 1D problem with conduction and convection boundary conditions.
2.	Thermal Analysis – 2D problem with conduction and convection boundary conditions.

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Part- C (Minimum 2 exercises of different type)	
1.	Dynamic Analysis to find: Fixed – fixed beam for natural frequency determination
2.	Dynamic Analysis to find: Bar subjected to forcing function
3.	Dynamic Analysis to find: Fixed – fixed beam subjected to forcing function

Note: Minimum 10 experiments are to be done by the students.

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Subject Code: ME107693	CAD/CAM/CAPP Lab	L = 0	T = 0	P = 2	Credits = 1
Evaluation Scheme	ESE	CT	TA	Total	Lab Period
	25	00	25	50	24Hrs

Course Objective	Course Outcomes
• To introduce the student to be familiar with CAD/CAM/CAPP terminology & its capabilities. • To master basic knowledge of numerical control machine tool working principle and composition. • To master CNC programming and computer aided part programming with CAM systems. • To analyze information requirements in computer aided process planning along with control. • To analyze the automated material handling in relation with computer integrated manufacturing.	**CO1.** Understand the changes brought in the product cycles with the advent of CAM systems. **CO2.** Understand emerging trends in CNC and Automation. **CO3.** Apply their knowledge to prepare part program for machining processes. **CO4.** Understand advance philosophy in the field of manufacturing. **CO5**. Outline the working behind readily available Computer Aided Manufacturing software

List of Experiments: (At least Ten experiments are to be performed by each student),Eight experiments from CAM &CPP and two experiments from CAD

CAM & CPP Experiments

1. Construction and Working of NC/CNC Machine Tools CO1
2. Configuration of CNC Machines CO1, CO2
3. Manual Part Programming for CNC Milling & Lathe CO3
4. Computer Assisted Part Programming CO3
5. Programming For Machining Centre Using Cam Software CO3, CO5
6. Study of tool paths for Milling and Turning cycles CO3, CO5
7. Rapid Prototyping CO4
8. FMS – Introduction & System Elements CO4
9. Group Technology – Matrix Formation Algorithms CO4
10. CIM – Emerging Technologies

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CAD Experiments

1. Line Drawing or Circle Drawing experiment: Writing and validation of computerprogram.
2. Design of machine component or other system experiment: Writing and validation ofcomputer program.
3. Understanding and use of any 3-D Modeling Software commands.

Reference Books:

1. Computer Aided Manufacturing by P N Rao, N K Tewari & T K Kundra
2. CAD/CAM/CIM by P. Radhakrishnan & S. Subranarayan
3. CNC Machines by P. Radhakrishnan

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Subject Code ME107621	Quality Control &Total Quality Management	L = 3	T = 2	P = 0	Credits = 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: The objectives of the course are: to define and understand various terms associated with quality control, enhance the students understanding of the complexity of statistical analysis and interpretation, provide an introduction to the fundamental concept of SPC, total quality management, six sigma, quality function deployment and applications of these concepts, understanding the philosophies of TQM in order to better evaluate the TQM implementation proposals and access exactly where an organization stands on quality management with respect to ISO 9000 quality management.	**Student will be able to:** **CO1**Explain the basic concept of quality &statistical Concept of variation. **CO2** Demonstrate the understanding of basic concepts of quality assurance & use of the control charts. **CO3** Apply the principles of acceptance sampling to solve practical problems. **CO4** Demonstrate an understanding on quality management philosophies and frameworks **CO5**Demonstrate an in-depth understanding of Quality System.

UNIT I: **CO 1, 4Hrs.**

Basic Concept of Quality: Quality and quality control, concept of quality, quality characteristics, Quality of design and quality of conformance ,History of quality control, Quality policy and objectives, Economics of quality.

Quality Assurance: Concept, advantages, field complaints, quality rating, quality audit, inspection planning, quality mildness, quality budget, vendor quality rating (VQR), vendor rating (VR), manufacturing planning for quality, Quality function deployment (QFD).

UNIT II: **[CO 2, 5Hrs.**

Statistical Concept of Variation: Concept of variation frequency distribution, continuous and discrete, probability distributions viz. Normal, Exponential and Weibull distribution ,pattern of variation, significance tests, Analysis of variance, statistical aids in limits and tolerances.

Acceptance Sampling: Fundamental concept in acceptance sampling, operating characteristics curve. Acceptance plans, single, double and introduction of multiple plans.

UNIT III: **[CO 3, 6Hrs.**

Statistical Quality Control: Objectives, Growth and applications of S.Q.C., S.O.C, Techniques in manufacturing planning. Process capability analysis, Control charts for variables and attributes and their analysis, six sigma concept.

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UNIT IV: **[CO 4, 4Hrs.**

Total Quality Management: Total Quality Control (TQC), Concept of Total Quality Management (TQM), TQM philosophies, Deming approach to TQM, Taguchi Philosophy, Crosby fourteen steps, TQM models, Tools and techniques of TQM.

UNIT V: **[CO 5, 6Hrs.**

Quality system: Quality system, need for quality system, ISO 9000 Quality Management Standards, ISO 9000:2000 requirement, Quality Auditing, ISO 14000, Benefits of ISO 14000 .

Benchmarking: Definition of Benchmarking, Reasons for Benchmarking, Types of Benchmarking, Advantages of Benchmarking, and Limitations of Benchmarking.

Text Books:

S. No.	Title	Author(s)	Publisher
1	Quality Planning and Analysis	Juran & Gryana	McGraw Hill, New York
2	Statistical Quality Control	R.C. Gupta	Khanna Publishers, Delhi

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Statistical quality control	Grant and Leavenworth	McGraw Hill, New York
2	Statistical Quality Control	M. Mahajan	Dhanpat Rai – New Delhi
3	Total Quality Management	K.C. Arora - S.K. Kataria	New Delhi
4	Total Quality Management	Suganthi & Samuel	PHI, Delhi

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Subject Code ME107622	Energy Management & Audit	L = 3	T = 2	P = 0	Credits = 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
The objective of the course to:	**Student will be able to:**
The student should be made to impart knowledge on sources of energy, energy utilization and energy conversion system, energy balance, energy action planning, energy audit, economics and finance.	CO1 Describe sources of energy and energy storage systems. CO2 Describe energy utilization and energy conversion system. CO3 Explain material and energy balance and describe energy action planning. CO4 Demonstrate the significance of energy audit, types of instruments required for energy audit and procedure to Conduct energy audit. CO5 Apply different methods used for the economic analysis of energy projects.

UNIT I: **CO 1, 4Hrs.**

Energy Sources: Introduction, Sources of energy – conventional and non-conventional, elasticity of demand and application, concepts to energy, Indian energy scene, energy storage, solar energy, water, battery and mechanical storage Systems.

UNIT II: **CO 2, 5Hrs.**

Energy Utilization and Conversion System: Classification of furnaces, controlled atmosphere in furnaces, furnace fuels, efficient use of energy in furnaces, thermal efficiency, reducing heat losses.

Combined Power and Heating System: Characteristics of prime movers, heat and Power requirements, economics of a CHP System.

UNIT III: **CO 3, 6Hrs.**

Energy Audit: Energy Management information system, thirty nine steps for energy management, types of energy audit, preliminary energy audits, and technical assistance in energy audit, energy accounting and analysis, Instruments used in Energy auditing.

UNIT IV: **CO 4, 4Hrs.**

Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

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UNIT V: **CO 5, 6Hrs.**

Economics and Finance: Introduction, economics, discounted cash flow, loans, investments, option identification and analysis, optimization, conflict correction, constructing the optimal target investment schedule, project management, monitoring against the target financial schedule.

Text Books:

S. No.	Title	Author(s)	Publisher
1	Engineering Economics & Engineering Management	R. Raju	Anuradha Agencies
2	Energy Engineering & Management	Chakrabarti	PHI, Delhi

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Energy Management	W.R. Murphy, G. Mckay – Elesvier	Gudgaon.
2	Energy Management	Paul O'Callaghan	McGraw Hill – New Delhi
3	Principles of Energy Conversion	Archie W. Culp	McGraw Hill, Delhi.
4	Industrial Energy Recovery	D.A. Reay	Wiley Publishers

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Subject Code ME107623	Internet of Things (IoT)	L = 3	T = 2	P = 0	Credits = 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
The objective of the course to:	**Student will be able to:**
To introduce the fundamental concepts of IoT and physical computing . **1.** To expose the student to a variety of embedded boards and IoT Platforms. **2.** To create a basic understanding of the communication protocols in IoT communications. **3.** To familiarize the student with application program interfaces for IoT. **4.** To enable students to create simple IoT applications.	**CO 1** Students would have learn fundamental concept of IoT and physical computing. **CO 2 S**tudents will have knowledge about various embedded boards and IoT Platforms. **CO 3** Students would have sufficient knowledge about the communication protocols in IoT communications. **CO 4** Students will understand the application program interfaces for IoT. **CO 5** Students would be able to create simple IoT applications. .

UNIT I:

Overview of IoT The Internet of Things : An Overview, The Flavor of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?, Design Principles for Connected Devices, Calm and Ambient Technology, Privacy, Keeping Secrets, Whose Data Is It Anyway?, Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens On The Internet, Graceful Degradation, Affordances. **[CO 1, 3 Hrs.**

UNIT II:

Embedded Devices - I: Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, Developing on the Arduino, Some Notes on the Hardware, Openness. **[CO 2, 6 Hrs.**

UNIT III:

Embedded Devices - II: Raspberry Pi , Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness, Other notable platforms, Mobile phones and tablets, Plug Computing: always-on Internet of Things. **[CO 3, 6 Hrs.**

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UNIT IV:

Communication in the IoT: Internet Principles, Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP), UDP, IP Addresses, DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, An Example: HTTP Ports, Other Common Ports, Application Layer Protocols- HTTP, HTTPS: Encrypted HTTP, Other Application Layer Protocols.
[CO 4, 6 Hrs.

UNIT V:

Prototyping Online Components: Getting Started with an API, Mashing Up APIs, Scraping, Legalities, Writing a New API, Clockodillo, Security, Implementing the API, Using Curl to Test, Going Further, Real-Time Reactions, Polling, Comet, Other Protocols, MQ Telemetry Transport, Extensible Messaging and Presence Protocol, Constrained Application Protocol. **[CO 5, 6 Hrs.**

Text Books:

S.No.	Title	Author(s)	Publisher
1	Designing the Internet of Thing	Adrian McEwen, Hakim Cassimally	Wiley Publications, 2012.

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Internet of Things: A Hands-On Approach	Arshdeep Bahga, Vijay Madisetti	Universities Press, 2014.
2	The Internet of Things, Enabling technologies and use cases	Pethuru Raj, Anupama C. Raman	CRC Press 2017

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Subject Code ME107624	Product Design and Development	L = 3	T = 2	P = 0	Credits = 4
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	20	140	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To introduce design concepts and techniques to develop design ability in a product design. 2. To provide knowledge about estimating and evaluating the feasible manufacturing design. 3. To make aware of legal issue pertaining to product design. 4. To provide knowledge of management of product development projects	**Student will be able to:** **CO1**The course enhances students understanding of new product development processes as well as useful tools, techniques and organizational structures. **CO2** Understands the legal issue pertaining to patent of product design. **CO3** Understand professional, ethical and social responsibilities resulting in a commitment to quality, timeliness, and continuous improvement. **CO4** Demonstrate an understanding on new product development and practice **CO5** Demonstrate an in-depth understanding of Product development & project management.

UNIT I: **CO 1, 4Hrs.**

Product Development Process: Background for design, design theory, design materials, human factors in design applied ergonomics, product development processes and organization, identifying customer needs, establishing product specifications, concept generation and selecting product architecture.

UNIT II: **CO 2, 5Hrs.**

Product Design Methods: Generating concepts, selection of a concept, Testing of concept, product architecture, Creative and rational clarifying objectives- the objective trees methods, establishing functions – the function analysis methods, setting requirement- requirements specification methods determining characteristics – the QFD method.

UNIT III: **CO 3, 6Hrs.**

Industrial Design: Its need - Ergonomic needs, Aesthetic needs, impact, accessing the quality, steps involved in Industrial design process, Management of Technology & user driven products.

UNIT IV: **CO 4, 4Hrs.**

Patents, Product Development: Legal issues in product design, trademarks, trade-secret, copy rights, patents – types, steps for disclosure, design resources, economics – quantitative & qualitative analysis, management of product development projects.

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UNIT V: **CO 5, 6Hrs.**

Project Management: Design Structure Matrix, Gantt Chart, Project schedule, budget, risk plan, accelerating project, execution, assessing and correction, Intellectual property rights.

Design for Manufacture: design for disassembly, design for environment, design for graphics and packaging, effective prototyping – principle and planning.

Text Books:

S. No.	Title	Author(s)	Publisher
1	Product Design & Development	Karl. T. Ulrich and Steven D. Eppinger	TMH, Delhi.
2	Product Design.	Kevin Otto and Kristin wood	Pearson Education

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Product Development	Chitale& Gupta	Tata McGraw Hill
2	Product Design and Manufacturing	Chitale& Gupta	PHI, Delhi.
3	Product Design: Creativity, Concepts and Usability.	Kumar	PHI, Delhi
4	Operations Management	Monks, J.G	McGraw Hill.

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B. Tech. Sixth Semester-MECHANICAL ENGINEERING

CourseCode ME100660	Engineering Economics	L =2	T=1	P=2	Credits=3
Examination Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	50	3 Hours

Course Objectives	Course Outcomes
The main objective of the course is to prepare engineering student to analyze cost/revenue data and carry out economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis and acquire necessary skills to function in the business and management side of professional engineering practice	Students will be able to: **CO1** Understand the basic terms and theories of engineering economics. **CO2** Understand pricing, market competition and industrial establishments. **CO3** Understand economy, monetary & Fiscal policy. **CO4** Understand cost and costing factors. **CO5** Understand depreciation& capital budgeting.

UNIT I **[CO1, 6 Hrs**

Introduction & Scope: Engineers and Economics, Utility of its study, Managerial Economics, Nature and scope, basic terms and concept of economics like goods, kinds of goods, utility, value and wealth. Theory of Demand and supply, Elasticity of demand. Meaning, Characteristics, Objectives of Firm, Managerial and behavioral theories of a firm.

UNIT II **[CO2, 6 Hrs**

Pricing and Market Competition: Industrial Establishments, various types of industrial establishments, Sole traders, partnership, Joint Stock Company, types of shares, financial goals of organization. Pricing Perspective approach: Pricing policy and price influencing factors, Basic data for price fixation. Market forms & Competition – Pure and perfect competition, monopoly, monopolistic competition, price determination under perfect and monopolistic competition.

UNIT III **[CO3, 6 Hrs**

Economy, Monetary & Fiscal Policy: Balance of payments – money and monetary policy, fiscal policy, Inflation, measuring employment and unemployment. Credit policies Concept and measurement of national income. Working Capital, Factors deciding Working capital, Return on investment, Financial Planning.

UNIT IV **[CO4, 6 Hrs**

Cost and Costing Factors: Cost Analysis – Types and Elements of cost, cost planning and control. Relationship between Average cost & Marginal cost, Short run and long run average cost curves.

UNIT V **[CO2, 6 Hrs**

Depreciation & Capital Budgeting: Depreciation and its methods of calculation, marginal costing, break – even analysis, profit planning and forecasting, Capital budgeting, cost of capital, Appraising projects profitability.

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Text Books:

S. No.	Title	Author(s)	Publisher
1	Managerial Economics	P.L. Mehta	S. Chand and sons
2	Economics	Michael Parkin	

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Economics	Samuelson, Pauls& W.D. Nordhan	McGraw Hill
2	Advanced Cost Accounting	Nigam, Sharma	Himalaya Publishing House
3	Managerial Economics	Mote and Paul	Tata McGraw Hill
4	Macro Economics for management Students	A. Nag	Macmillan India Ltd
5	Cost Accounting	Jain &Narang	Kalyan Publishers

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B. Tech. Sixth Semester-MECHANICAL ENGINEERING

Subject Code :- ET100658	3D Printing & Product Design	L = 2	T = 1	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
• To Know the importance of 3D printing in Manufacturing. • To know the different 3D Printing Technologies. • Able to understand the method of manufacturing of liquid based and solid based techniques. • To observe the different methods for post-processing of 3D Printing parts • To Understand the applications of 3D Printing in Automobile, Aerospace, Bio-medical etc.	At the end of this course, the students are expected to be able to: **CO1:** Understand the fundamentals of Additive Manufacturing Technologies for engineering applications. **CO2:** Different 3D Printing Technologies. **CO3:** Understand the methodology to manufacture the products using SLA and SGC technologies and study their applications, advantages and case studies. **CO4:** Able to apply different methods for post-processing of 3D Printing parts. **CO5:** Understand the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages and case studies.

Unite I: Introduction and Basic Principles **[CO 1]**

3D Printing, Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Other Related Technologies Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World. **[8 hrs.]**

Unite II: Liquid Based Systems **[CO 2]**

Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.**[7 hrs.]**

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Unite III: Solid Based Systems **[CO 3]**

Laminated object manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and disadvantages, Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration, case studies.**7 hrs.]**

Unite IV: Powder Based Systems **[CO 4]**

Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three-dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies. **[7 hrs.]**

Unite V: Medical Applications & Future Directions For 3d Printing **[CO 5]**

Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions. **[7 hrs.]**

Text Books

S. No.	Title	Author(s)	Publisher
1	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W Rosen, Brent Stucker	Springer, 2010
2	Rapid Prototyping: Principles & Applications	Chua Chee Kai, Leong Kah Fai	World Scientific, 2003

Reference Books

S. No.	Title	Author(s)	Publisher
1.	Rapid Manufacturing	D.T. Pham and S.S. Dimov	Springer, 2001
2.	Rapid Prototyping and Manufacturing	Paul F. Jacobs	ASME Press, 1996
3.	Rapid Prototyping: Theory & Practice	Ali K. Kamrani, EmandAbouel Nasr	Springer, 2006

NPTEL

S. No.	Link
1.	https://nptel.ac.in/courses/112103306

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