KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.E. MECHANICAL ENGINEERING
REGULATION – 2020
AUTONOMOUS SYLLABUS
CHOICE BASED CREDIT SYSTEM
VTO VI SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Mechanical Engineering the unique of its kind in the field of Research and Development activities in the prominent field of Mechanical Engineering in this part of the world.

MISSION:

To impart highly innovative and technical knowledge in the field of Mechanical Engineering to the urban and unreachable rural student folks through “Total Quality Education”.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Graduates of the Programme will excel in Technical knowledge and apply Innovative skills in the field of Mechanical Engineering.

PEO 2: Graduates will contribute to the Technological Development and Research Activities through “Total Quality Education”.

PEO 3: Graduates of the Programme will accomplish the Leadership Qualities and Social Responsibilities through “Life Long Learning”.

PROGRAM OUTCOMES:

After going through the four years of study, the Mechanical Engineering graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/evelopment of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : Graduates will be able to create and analyze the Research and Development activities related to Design and Manufacturing

PSO2 : Graduates will be able to design, develop need based products in Mechanical Engineering and Allied Industries

SEMESTER V

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	ME1501	Applied Hydraulics and Pneumatics	PC	3	3	0	0	3
2	ME1502	Artificial Intelligence in Manufacturing	PC	3	3	0	0	3
3	ME1503	Design of Machine Elements	PC	3	3	0	0	3
4	ME1504	Dynamics of Machines[#]	PC	4	2	0	2	3
5	ME1505	Conventional and Electric Vehicles	PC	3	3	0	0	3
6	ME1506	Metrology and Measurement Techniques[#]	PC	5	3	0	2	4
7		Open Elective – I *	OE	3	3	0	0	3
		Online Course**(12 week course)						
PRACTICALS								
8	ME1511	CAD Laboratory	PC	4	0	0	4	2
			TOTAL	28	22	0	8	24

SEMESTER VI

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	ME1601	Computer Integrated Manufacturing	PC	3	3	0	0	3
2	ME1602	Design of Transmission Systems	PC	3	3	0	0	3
3	ME1603	Heat and Mass Transfer	PC	3	3	0	0	3
4		Professional Elective – I (from Bucket)	PE	3	3	0	0	3
5		Professional Elective – II (from Bucket)	PE	3	3	0	0	3
6		Online course – 1** (12-week course)		0	0	0	0	3
PRACTICALS								
7	ME1611	Simulation and Analysis Laboratory	PC	4	0	0	4	2
8	ME1612	Thermal Engineering Laboratory	PC	4	0	0	4	2
9	ME1621	Design and Fabrication Project	EEC	4	0	0	4	2
			TOTAL	27	15	0	12	24

***** Course from the Curriculum of other UG programmes. [#] Theory cum Laboratory Course

** The students shall complete the online course in this semester and credits would be added in consolidated sheet

PROFESSIONAL ELECTIVES (PEs)

SEMESTER VI – ELECTIVE I&II (FROM BUCKET)

Students can select two courses from any one of the buckets given below

Bucket 1 : Design Stream

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	ME1631	Basics of Finite Element Analysis	PE	3	3	0	0	3
2	ME1632	Mechanical Vibrations and Noise control	PE	3	3	0	0	3
3	ME1633	Computer Aided Design	PE	3	3	0	0	3
4	ME1634	Design of Jigs, Fixtures and Press tools	PE	3	3	0	0	3

Bucket 2 : Manufacturing Stream

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	ME1635	Additive Manufacturing	PE	3	3	0	0	3
2	ME1636	Operation Research	PE	3	3	0	0	3
3	ME1637	Non Destructive Testing and Evaluation	PE	3	3	0	0	3
4	ME1638	Production Planning and Control	PE	3	3	0	0	3

Bucket 3: Thermal Stream

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	ME1639	Gas Dynamics and Jet Propulsion	PE	3	3	0	0	3
2	ME1640	Refrigeration and Air Conditions	PE	3	3	0	0	3
3	ME1641	Energy Conservation and Auditing	PE	3	3	0	0	3
4	ME1642	Renewable Energy Sources	PE	3	3	0	0	3

OPEN ELECTIVE III (SEMESTER V)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	OME151	Thermal Engineering	OE	3	3	0	0	3
2	OME152	Fundamentals of Manufacturing Process	OE	3	3	0	0	3
3	OME153	Non-Conventional Energy Sources	OE	3	3	0	0	3
4	OME154	World Class Manufacturing	OE	3	3	0	0	3

ME1501 APPLIED HYDRAULICS AND PNEUMATICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids- Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory– Pump Classification – Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT II HYDRAULIC SYSTEMS AND COMPONENTS 9

Sources of Hydraulic Power: Gear pump, Vane Pump, Piston pump Variable displacement pumps - construction and working of pumps – Pump performance – .Hydraulic cylinders – Single acting, Double acting special cylinders like tandem, Rod less, Telescopic, Cushioning mechanism - Construction of double acting cylinder, Hydraulic Motors - Gear, Vane and Piston motors.

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements –

Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Explain the concepts of Fluid power systems, types, working principle of hydraulics, pump classifications and their performance

CO2: Interpret the features and functions of hydraulics pumps, actuators and flow control valves

CO3: Design simple hydraulic and electro hydraulic circuits used in industrial applications

CO4: Design simple pneumatic and electro pneumatics circuits used in industrial applications

CO5: Discuss the various trouble shooting methods and applications of hydraulic & pneumatics systems

TEXT BOOKS

1. Anthony Esposito., 2005. *Fluid Power with Applications*, Pearson Education.
2. Majumdar S.R., 2011, *Oil Hydraulics Systems- Principles and Maintenance*, Tata McGrawHill,

REFERENCE BOOKS

1. Anthony Lal., 1982, *Oil hydraulics in the service of industry*, Allied publishers.
2. Dudelyt.A., Pease and John T. Pippenger 1987, *Basic fluid power*, Prentice Hall.
3. Michael J, Prinches and Ashby J. G,, 1989, *Power Hydraulics*, Prentice Hall.

ME1502 ARTIFICIAL INTELLIGENCE IN MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.
- Formulate a real-world problem as a mathematical programming model.
- To provide idea for optimizing and approximating industrial problems to the Managers and decision makers.
- To devise appropriate measures for modeling and solving engineering problems of different fields.
- Apply scientific techniques to monitor the organizations ongoing activities such as production mix, transportation and assignment problem.

UNIT I INTRODUCTION 9

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II PROBLEM SOLVING METHODS 9

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems -Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games.

UNIT III KNOWLEDGE REPRESENTATION 9

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories -Reasoning with Default Information.

UNIT IV PLANNING AND MACHINE LEARNING 9

Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations - Why, Why not and how explanations. Learning- Machine learning, adaptive Learning

UNIT V APPLICATIONS OF ARTIFICIAL INTELLIGENCE 9

Applications of AI in Inventory management, Supply chain management, risk management, predictions on sales volume, Price and Demand forecasts - Case studies. Automobile Industries - Vehicle Maintenance Recommendations – Driver behaviour Analytics/ self-driving cars – Analyzing road conditions – Smart battery management system

TOTAL: 45 PERIODS

OUTCOMES

CO1: Select the constraints on the availability of resources, develop a model and render an optimal solution during the given circumstances.

CO2: Solve the dual problems, appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits.

CO3: Analyze different types of optimum Inventory levels for practical problems.

CO4: Apply various queue disciplines according to respective environments.

CO5: Determine appropriate network models for practical applications

TEXT BOOKS

1. S. Russell and P ., 2020, Norvig, *Artificial Intelligence: A Modern Approach* ǁ, Prentice Hall, Third Edition, Fourth edition.
2. Elaine Rich and Kevin Knight., 2008, *Artificial Intelligence*, Tata McGraw-Hill,3rd Edition.

REFERENCE BOOKS

1. Mary Kathryn Allen, 1986, *The Development of an Artificial Intelligence System for Inventory Management,* Council of Logistics Management.
2. Wolfgang Kersten., 2019, *Artificial Intelligence and Digital Transformation in Supply Chain Management* : Innovative Approaches for Supply Chains.
3. Hanne, Thomas, Dornberger., 2017, Rolf, *Computational Intelligence in Logistics and Supply Chain Management*, springer.
4. Saqib AzizMichael Dowling, *Machine Learning and AI for Risk*

Management, Disrupting Finance, pp 33-50.

5. Archie Addo, Srini Centhala, Muthu Shanmugam., 2020, *Artificial Intelligence for Risk Management.*

ME1503 **DESIGN OF MACHINE ELEMENTS**
(Use of PSG Design Data Book is permitted)

L	T	P	C
3	0	0	3

OBJECTIVES:

- To familiarize the various steps involved in the Design Process
- To understand the principles involved in evaluating the shape and dimensions

of a component to satisfy functional and strength requirements.

- To learn to use standard practices and standard data
- To learn to use catalogues and standard machine components

UNIT I **STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS** **9**

Introduction to the design process - factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equation – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – stress concentration – Design for variable loading.

UNIT II **DESIGN OF SHAFTS AND COUPLINGS** **9**

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines - Rigid and flexible couplings – Fundamentals of crank shaft design.

UNIT III **DESIGN OF TEMPORARY AND PERMANENT JOINTS** **9**

Threaded fasteners - Bolted joints including eccentric loading – - Knuckle joints-Cotter joints - Welded joints - Riveted joints for Structures – Introduction to Theory of bonded joints.

UNIT IV **ENERGY STORING ELEMENTS AND ENGINE COMPONENTS** **9**

Various types of springs, optimization of helical springs - rubber springs - Flywheels Considering stresses in rims and arms for engines and punching machines- Connecting Rods.

UNIT V **DESIGN OF BEARINGS** **9**

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings,Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the various steps involved in the design process, identification of the steady stresses and variable stresses in machine

members.

CO2: Calculate the design parameters of Shafts, keys and couplings

CO3: Design the threaded fasteners, bolt, knuckle joint, cotter joint, welded joint and riveted joint.

CO4: Design the various types of springs and to examine the Flywheels

CO5: Develop the design of sliding contact and selection of rolling contact bearing for machine members

TEXT BOOKS

1. Bhandari V., 2016, *Design of Machine Elements,* 4th Edition, Tata McGraw-Hill Book Co.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, 2011, *Mechanical Engineering Design*, 9th Edition, Tata McGraw-Hill.

REFERENCE BOOKS

1. Alfred Hall, Halowenko, A and Laughlin,H., 2010, *Machine Desig*n, Tata McGraw-Hill Book Co.(Schaum's Outline).
2. Ansel Ugural., 2003, *Mechanical Design – An Integral Approach,* 1st Edition, Tata McGraw-Hill Book Co.
3. P.C.Gope., 2012, *Machine Design – Fundamental and Application,* PHI learning private ltd, New Delhi.
4. Robert C, Juvinall and Kurt M.Marshek., 2005, *Fundamentals of Machine Design,* 4th Edition, Wiley.
5. Sundararajamoorthy, T.V. Shanmugam.N., 2015, *Machine Design,* Anuradha Publications, Chennai.

ME1504 **DYNAMICS OF MACHINES**

L	T	P	C
2	0	2	3

OBJECTIVES:

- To understand the force-motion relationship in components subjected to externalforces and analysis of standard mechanisms.
- To understand the undesirable effects of unbalances resulting from prescribedmotions in mechanism.

- To understand the effect of dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stabilitycontrol

UNIT I FORCE ANALYSIS 6

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses.

UNIT II BALANCING OF MASSES 6

Basic concepts of balancing of rotating masses and balancing of reciprocating engines.Fundamental problems.

UNIT III FREE VIBRATION 6

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration– Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION 6

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion – transmissibility – Vibration isolation vibration measurement.

UNIT V CONTROL MECHANISMS 6

Basic concepts of various types of governors – Governer characteristics-gyroscopic effects in automobile, ships and airplanes (theoretical approach only)

Experiments 30 Hours

1. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
2. Determination of Mass moment of inertia of Fly wheel and axisymmetric bodies using Turn Table apparatus.
3. Determination of Mass moment of inertia of axisymmetric bodies using Turn Table apparatus

4. Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
5. Exercise on Balancing of four rotating masses placed on different plane.
6. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors
7. Transverse vibration of Free-Free beam – with and without concentrated masses
8. Determination of torsional natural frequency of single and Double Rotor systems.- Undamped and Damped Natural frequencies.
9. Forced Vibration of Cantilever beam – Mode shapes and natural frequencies
10. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.

Total : 60 PERIODS

OUTCOME FOR THEORY

CO1: Explain the dynamic analysis of simple mechanism and design of flywheel

CO2: Estimate the balancing mass for rotating and reciprocating masses by using the force and couple polygon

CO3: Evaluate the natural frequency of single degrees of freedom system subjected to free and forced vibration

CO4: Calculate the natural frequency of transverse and torsional vibration of single , two rotor systems

CO5: Compute the range of speed for governor and Study of motorized gyroscopic effect and couple

OUTCOME FOR LABORATORY

CO1: Analyze the kinematics principles of gears, mechanisms, cam profile.

CO2: Understand the mass moment of inertia of connecting rod and turn table apparatus

CO3: Analyze the balancing of rotary masses.

CO4: Gain hands on experience in motorized gyroscopic effect, couple, whirling of shaft & governors

CO5: Determine the frequency of free and forced vibration, torsional vibration and transverse vibration for shaft and spring.

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Cam follower setup.	5
2	Motorized gyroscope.	5
3	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	2
4	Whirling of shaft apparatus.	2
5	Dynamic balancing machine.	1
6	Two rotor vibration setup.	1
7	Spring mass vibration system.	1
8	Torsional Vibration of single rotor system setup.	1
9	Gear Models	1
10	Kinematic Models to study various mechanisms.	1
11	Turn table apparatus.	1
12	Transverse vibration setup of cantilever	1

TEXT BOOKS

1. Rattan, S.S., 2014, *Theory of Machines*,4th Edition, Tata McGraw-Hill.
2. Uicker J.J, Pennock G.R and Shigley, J.E., 2014, *Theory of Machines and Mechanisms*,4th Edition, Oxford University Press.

REFERENCE BOOKS

1. Khurmi, R.S., 2005, *Theory of Machines*, 14th Edition, S Chand Publications.
2. Thomas Bevan., 2005, Theory of Machines, 3rd Edition, CBS Publishers and Distributors.
3. Robert L. Norton., 2009, *Kinematics and Dynamics of Machinery*, Tata McGraw-Hill.

ME1505 **CONVENTIONAL AND ELECTRIC VEHICLES**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce about the automobile types and its layouts.
- To discuss the power transmission systems, braking and steering geometry.
- To brief about the basics of electrical vehicles.
- To impart knowledge about electric vehicle operations and its respective control

elements.

- To discuss the vehicle advanced management systems employed in recent days in automobiles.

UNIT I INTRODUCTION 9

Types of Automobiles - Vehicle construction and different layouts, Chassis, frame and Vehicle body aerodynamics - resistances and moments - IC engines – components- Functions and materials – MPFI – turbocharging – supercharging - Emission norms and standards.

UNIT II POWER TRASNMISSION, STEERING AND BRAKING SYTSEMS 9

Clutch-types and construction, Gear boxes- manual and automatic, Gear shift mechanisms, Propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive. Steering geometry and steering gear box, Pneumatic and Hydraulic Braking Systems

UNIT III ELECTRIC VEHICLES AND CONVERSION 9

History of electrical vehicles, Electric and hybrid vehicles, flexible fuel vehicles (FFV), solar powered vehicles, fuel cells vehicles. fuel cells, flexible fuel systems. Series and parallel hybrid vehicles. High energy and power density batteries. Conversion of conventional vehicles as hybrid vehicles – Conversion kit and economics of conversion.

UNIT IV ELECTRIC VEHICLE OPERATION CONTROL 9

Dynamics and architecture of hybrid and electrical vehicles, DC-DC converters, DC-AC converters, AC electrical machines and permanent magnet for hybrid and electrical vehicles, Control system for electrical and hybrid electric vehicles – Energy management strategies and its general architecture, Rule and optimization-based energy management strategies (EMS), EMS based on deterministic rule

UNIT V VEHICLE MANAGEMENT SYSTEMS 9

ABS system, Regenerative braking, layout – working and Electronic control of suspension – Damping control, Electric power steering, Cruise control. Vehicle security systems- alarms, vehicle tracking system. On board diagnostics. Collision avoidance Radar warning system – E-charging solutions

TOTAL: 45 PERIODS

OUTCOMES

CO1: Classify the automobiles and its types

CO2: Infer the transmission parts along with the steering column and braking.

CO3: Outline the basic knowledge of Electric vehicles.

CO4: Acquire the understanding about the electric vehicle operation control elements and its respective working procedures

CO5: Familiarize about the recent vehicle management control systems.

TEXT BOOKS

1. Kirpal Singh., 2021, *Automobile Engineering* – Vol. 1 & 2, Standard Publishers, New Delhi
2. Bosch Hand Book., 2000, SAE Publication.
3. Eric Chowanietz., 1994, *Automobile Electronics,* SAE Publications.

REFERENCE BOOKS

1. Advance hybrid vehicle power transmission, SAE.
2. Ron Hodkinson and John Fenton., 2000, *Light weight electric for hybrid vehicle design,* Elsevier.
3. Branek L.L., 1993, *Noise reduction*, McGraw Hill Book company, New York.
4. Heinz., 2002, *Modern Vehicle Technology* Second Edition, Butter worth- Heinemann, Elsever.

ME1506 METROLOGY AND MEASUREMENT TECHNIQUES

L	T	P	C
3	0	2	4

OBJECTIVES:

- To provide knowledge on various Metrological equipment's available for measuring the dimension of the components.
- To provide knowledge and procedure to be adopted in measuring the dimensions of the components.
- To familiar with different measuring equipment's.

- To make use measuring instruments and how it is been used in industry for quality and inspection.

UNIT I BASIC PRINCIPLES OF ENGINEERING METROLOGY 9

Introduction to Metrology – need – generalized measurement system - Elements – Work piece, instruments, persons and Environment. Characteristics of measuring instruments - Precision & Accuracy and their effect. Error – types of errors in measurements - Methods of measurement and standards of measurement.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear Measuring Instruments – evolution – types – classification. Limit, Fits and Tolerances - Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Autocollimator - Angle Dekkor - Angle alignment telescope – Applications.

UNIT III FORM MEASUREMENT 9

Principles and methods of straightness – flatness measurement – Roundness measurement - thread measurement, gear measurement, surface finish measurement – Applications.

UNIT IV ADVANCES IN METROLOGY 9

Basic concept of lasers - Advantages of lasers, Laser Telemetric System. Laser Interferometers – DC and AC Lasers interferometer – NPL flatness Interferometer – Michelson Interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – constructional features – probes – accessories – software – applications – Basic concepts of machine Vision System – Element – Applications

UNIT V MECHANICAL MEASUREMENTS 9

Force measurement – Analytical Balance, Platform balance, Load Cell - Mechanical, Electrical strain Gauge, proving rings. Torque Measurement – Torsion bar Dynamometer, Servo controlled Dynamometer & Absorption Dynamometer. Level Measurement - Float system, Hydrostatic systems, capacitive and ultra-sonic type. Temperature: bimetallic strip, thermocouples, electrical resistance thermometer. Introduction to Nanometrology.

LISTOF EXPERIMENTS **30 Hours**

1. Measurement of various components by using – Vernier caliper, micrometer, Vernier height gauge and Vernier Depth Gauge
2. Measurement of Bore diameter by using telescope gauge
3. Checking the Limits of Dimensional Tolerances using Mechanical Comparator
4. Measurement of angles using bevel protractor and sine bar
5. Measurement of thread Parameters by using Floating Carriage Micrometer
6. Measurement of Gear Parameters using Gear Tooth Vernier
7. Measurement of features of a given component using Coordinate Measuring Machine (CMM)
8. Measurement of thread parameters using Toolmaker's microscope / Profile projector
9. Measurement of surface roughness using talysurf instruments.
10. Measurement of straightness using Auto Collimator
11. Measurement of force, torque and temperature

TOTAL : 60 Hours

OUTCOME FOR THEORY

CO1: Describe the concepts of measurements, precision and accuracy in various metrological instruments.

CO2: Outline the principles of linear and angular measurement tools used for industrial applications.

CO3: Demonstrate the techniques of form measurement used for industrial components.

CO4: Explain the procedure for conducting computer aided inspection.

CO5: Discuss various measuring techniques of mechanical measurement in industrial applications.

OUTCOME FOR LABORATORY

CO1: Apply the fundamental principles of measuring techniques for the measurement of various dimensional tolerances.

CO2: Measure the various dimensions of linear and angular components using linear and angular measuring instruments.

CO3: Find the parameters of thread and gear profile using Projection

technique.

CO4: Calculate shear force and moment induced in a cantilever beam by varying load conditions.

CO5: Measure the temperature, Speed, vibration and dimensional parameters of a given component.

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Micrometer	5
2	Vernier Caliper	5
3	Vernier Height Gauge	2
4	Vernier depth Gauge	2
5	Slip Gauge Set	1
6	Gear Tooth Vernier	1
7	Sine Bar / Bevel Protractor	1
8	Floating Carriage Micrometer	1
9	Profile Projector / Tool Makers Microscope	1
10	Mechanical Comparator	1
11	Autocollimator	1
12	Temperature Measuring Setup	1
13	Force Measuring Setup	1
14	Torque Measuring Setup	1
15	Coordinate measuring machine	1
16	Surface finish measuring equipment	1
17	Bore gauge	1
18	Telescope gauge	1
19	Speed and Vibration Measuring Setup	1

TEXT BOOKS

1. Raghavendra.N.V, Krishnamurthy.L., 2013, *Engineering Metrology & Measurements,* Oxford Univ. Press.
2. Jain R.K., 2009, *Engineering Metrology*, Khanna Publishers.

REFERENCE BOOKS

1. Gupta. I.C., 2005, *Engineering Metrology,* Dhanpatrai Publications.
2. Alan S. Morris., 1996, *The essence of Measurement*, Prentice Hall of India.
3. Beckwith, Marangoni, Lienhard., 2014, *Mechanical Measurements*, Pearson Education.
4. Charles Reginald Shotbolt,1990, *Metrology for Engineers,* 5th edition, Cengage Learning EMEA.
5. Charles Reginald Shotbolt, 1990, *Metrology for Engineers,* 5th edition, Cengage Learning EMEA.

ME1511 **CAD LABORATORY**

L	T	P	C
0	0	4	2

OBJECTIVES:

- To impart fundamental knowledge and basic skills to the students in drafting and modelling techniques.
- Ability to create 2D and 3D models in relevance to the given drawing using modelling and Analysis packages.

LIST OF EXPERIMENTS

1. Introduction to 3D CAD Modelling Software.
2. Importance of Detailing in Engineering Drawing.
3. 3D Modelling of Machine Component using Extrude Feature.
4. 3D Modelling of Machine Component using Revolve Feature.
5. 3D Modelling of parts with Loft Feature.
6. 3D Modelling of parts with Helix and Spiral/Sweep Feature.
7. Parametric Modelling of a Machine Components using 3D CAD Software.
8. 3D Modelling of Sheet Metal Parts using any 3D CAD Software.
9. Assembly of Plummer Block using any 3D CAD Software.
10. Assembly of Piston of an I.C. engine using any 3D CAD Software.
11. Mechanism Simulation of an automotive assembly using CAD Software.
12. Lathe Simulation and Generating G & M Codes for turning using CAM Software.
13. Milling Simulation and Generating G & M Codes for milling using CAM Software.
14. Design Project and Presentation.

TOTAL: 60 PERIODS

Note: Design Project can be done as a part of teams with the maximum of three members.

OUTCOMES

Students will be able to

CO 1 : Understand the basics features of 3D modelling software and importance of fine detailing in engineering drawing.

CO 2 : Model 3D components using 3D modelling software.

CO 3 : Assemble the components using 3D Modelling Software.

CO 4 : Perform simulation and make animation videos from assembly.

CO 5 : Evaluate the design project in engineering applications using 3D modelling software.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.NO	EQUIPMENT	QUANTITY
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 2 GB main memory) networked to the server	30

3.	Laser Printer	1
SOFTWARE		
4.	Any 3D Modelling Softwares	30 licenses
5.	Any High-end integrated modeling and manufacturing CAD / CAM software	15 licenses
6.	Licensed operating system	30

REFERENCES

1. Gopalakrishna.K.R., 2017, *Machine Drawing*, 22nd Edition, Subhas Stores Books Corner, Bangalore.
2. https://www.youtube.com/channel/UC38EzpQ0QpmsRg2g9HUGaGw
3. https://www.youtube.com/channel/UCjd_zIvYtQymk0dPx3vTJcA

ME1601 COMPUTER INTEGRATED MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To develop an understanding of the role of computers in manufacturing.
- Applying the Manufacturing knowledge in Process Planning and will gain Confidence in controlling production.
- Converting conventional system to FMS.

- To provide an in-depth understanding of shop floor control and virtual organization and control of manufacturing processes.
- Improve communications through documentation and to create a database for manufacturing.
- To enable the students to apply the knowledge of information technology in the field of automation for better enhancement.

UNIT I INTRODUCTION 9

Various phases in Product Design and CAD, CAM, Concepts of CAD/CAM – CIM concepts and elements – Types of production – Manufacturing Metrics and Economics – Production Performance Metrics – Manufacturing Cost - Simple problems – Basic Elements of an Automated system – Advanced Automation Functions - Levels of Automation – Lean Production and Just-In-Time Production – Introduction to Industrial Robotics.

UNIT II PRODUCTION PLANNING, PROCESS PLANNING & CONTROL SYSTEM 9

Production planning and Control System - Aggregate Production Planning and Master Production Schedule – Material Requirement Planning (MRP I) – Capacity Planning – Shop Floor Control – Introduction to Manufacturing Resource Planning (MRP II) & Enterprise Resource Planning (ERP) - Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning.

UNIT III GROUP TECNOLOGY AND CELLULAR MANUFACTURING 9

Group Technology(GT) - Part Families – Parts Classification and coding – Simple Problems in OPITZ Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems – Performance Metrics in Cell Operation – Simple Problems.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 9

Types of FMS & Flexibility – FMS Components – FMS Application & Benefits – FMS Planning and Implementation Issues – Quantitative analysis of Bottleneck Model in FMS - Automated Guided Vehicle System (AGVS) – Types of AGVS - Applications – Vehicle Guidance technologies –Vehicle Management & Safety.

UNIT V INTELLIGENT MANUFACTURING SYSTEMS 9

Smart Factory – Standard, Real-time production monitoring techniques with smart sensors, Configuration of smart shop floor, traceability and call back of defective products – Cloud storage for wireless data - Robotics in Automation - Artificial Intelligence based Manufacturing systems, Global Manufacturing Networks, Digital enterprise technologies, IOT in Manufacturing. Contemporary issues.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply the concept of CIM and Automation in the Manufacturing process.

CO2: Develop suitable manufacturing plan for MRP/CAPP for a given manufacturing scenario.

CO3: Apply group technology concept in manufacturing product.

CO4: Analyze the planning and implementation issues of FMS in the applications like AGV, Vehicle Management.

CO5: Implement the concept of IOT in manufacturing and monitor production using smart sensors.

TEXT BOOKS

1. Mikell.P.Groover., 2018, *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson Education.
2. Kant Vajpayee S., 2003, *Principles of Computer Integrated Manufacturing*, Prentice Hall of India.

REFERENCE BOOKS

1. Gupta A.K., Arora S.K., 2013, *Industrial Automation and robotics*, Third Edition, University Science Press, New Delhi.
2. Radhakrishnan P., Subramanyan S, Raju V., 2000, *CAD/CAM/CIM*, 2nd Edition, New Age International (P) Ltd, New Delhi
3. Yusuf Altintas., 2012, *Manufacturing Automation*, Cambridge University Press, USA.
4. James A. Regh, Henry W. Kreabber., 2004, *Computer Integrated Manufacturing*, 3rd Edition, Pearson Education

5. David Bedworth D., Henderson M.R., 1991, *Computer Integrated Design and Manufacturing*, Tata McGraw-Hill Companies, New Delhi.

ME1602 **DESIGN OF TRANSMISSION SYSTEMS**
(Use of P S G Design Data Book is permitted)

L	T	P	C
3	0	0	3

OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues. (Use of P S G Design Data Book

permitted)

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

Kinematics of belt drives - Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

UNIT III BEVEL,WORM AND PARALLEL AXIS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits- terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV DESIGN OF GEAR BOXES 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout –Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box – Fluid Couplings - Torque convertors for automotive applications.

UNIT V SELECTION OF ELECTRICAL MOTORS 9

Types of electric motor – factors to consider in selecting the electric motor –- Speed, torque and power sources requirements – motor size and capacity – starting load – Battery capacity - Bearing & Base type – Drive arrangements - Environmental considerations – Economical aspect.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Select the flexible elements such as V-Belts flat belts, ropes, chains for power transmission.

CO2: Calculate the design parameters of spur gear and helical gears

CO3: Design the bevel worm, and helical gears used in transmission systems

CO4: Develop the design the constant speed and variable speed gear boxes

CO5: Select the electrical motors for power transmissions

TEXT BOOKS

1. Bhandari V, 2016, *Design of Machine Elements,* 4th Edition, Tata McGraw-Hill Book Co.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett ., 2011, *Mechanical Engineering Design*, 9th Edition, Tata McGraw-Hill.

REFERENCE BOOKS

1. Merhyle F. Spoots, Terry E.Shoup and Lee E. Hornberger, 2003, *Design of Machine Elements,* 8th Edition, Prentice Hall.
2. Prabhu.T.J., 2000, *Design of Transmission Elements,* Mani Offset, Chennai.
3. Robert C. Juvinall and Kurt M.Marshek., 2005, *"Fundamentals of Machine Design",* 4th Edition, Wiley.
4. Wei Tong., 2017, Mechanical Design of Electrical motors, CRC Press.

ME1603 **HEAT AND MASS TRANSFER**

(Usage of approved HMT data book is permitted)

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the mechanisms of conductive heat transfer and the concepts of heat transfer through extended surfaces.
- To identify the concept of convective heat transfer and its calculations.
- To learn about the thermal analysis and sizing of heat exchangers
- To understand the principle of Radiative heat transfer.
- To understand the basic concepts of mass transfer.

UNIT I CONDUCTION 9

General Differential equation - Cartesian and Cylindrical Coordinates - One Dimensional Steady State Heat Conduction - plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts

UNIT II CONVECTION 9

Conservation Equations, Boundary Layer Concept – Forced Convection: External Flow – Flow over Plates, Cylinders Spheres and Bank of tubes. Internal Flow – Entrance effects. Free Convection – Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling, correlations in boiling and condensation (descriptive only). Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods. Introduction to TEMA Standards.

UNIT IV RADIATION 9

Radiation laws, Black Body and Gray body Radiation. Shape Factor. Electrical Analogy (descriptive only). Radiation Shields.

UNIT V MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion. Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply the principle mechanism of conductive heat transfer under steady state and transient conditions.

CO2: Apply the fundamental concepts and principles in convective heat transfer.

CO3: Solve problems in phase change heat transfer and heat exchangers.

CO4: Apply the fundamental concepts and principles in radiation heat transfer.

CO5: Apply the basic principles in mass transfer.

TEXT BOOKS

1. Yunus A. Cengel., 2018, *Heat Transfer A Practical Approach,* Tata McGraw Hill Education Private Limited, 5th Edition.
2. R.C. Sachdeva., 2018, *Fundamentals of Engineering Heat and Mass transfer*, New Age International Publishers

REFERENCE BOOKS

1. Frank P. Incropera and David P. Dewitt., 2014, *Fundamentals of Heat and Mass Transfer*, John Wiley & Sons, 7th Edition.
2. Holman, J.P., 2010, *Heat and Mass Transfer*, Tata McGraw Hill Education Private Limited.
3. Kothandaraman, C.P., 2012, *Fundamentals of Heat and Mass Transfer*, New Age International Publishers
4. Ozisik, M.N., 1994, *Heat Transfer*, Tata McGraw Hill Education Private Limited.
5. S.P. Venkateshan., 2014, *Heat Transfer*, Ane Books Private Limited, New Delhi.

ME1611 SIMULATION AND ANALYSIS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

LIST OF EXPERIMENTS

A. SIMULATION

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable

and two variables

2. Use of Mat lab to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software

B. ANALYSIS

a. Structural Analysis

1. Force and Stress analysis using link elements in Trusses, cables etc.
2. Stress and deflection analysis in beams with different support conditions.
3. Stress analysis of flat plates and simple shells.
4. Stress analysis of axi – symmetric components.

b. Thermal Analysis

5. Thermal stress and heat transfer analysis of plates.
6. Thermal stress analysis of cylindrical shells.

c. Vibrational Analysis

7. Vibration analysis of spring-mass systems.
8. Model analysis of Beams.
9. Harmonic, transient and spectrum analysis of simple systems.

TOTAL: 60 PERIODS

OUTCOMES

Students will be able to

CO1 : Calcualte the stress analysis of one-dimensional structural problems using analysis software and compare it to an analytical solution.

CO2 : Analyze the stress and deformation of two-dimensional structural problems using analysis software.

CO3 : Resolve the heat transfer analysis for a given problem using analysis software.

CO4 : Determine the dynamic analysis for a given structural problem using analysis software.

CO5 : Simulate a mechanism using Multibody Dynamic Software.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Computer System	15
2	Color Desk Jet Printer	01
3	Multibody Dynamic Software Suitable for Mechanism simulation and analysis	15 licenses
4	C / MATLAB	5 licenses

ME1612 THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To study the valve and port timing diagram and performance of IC Engines.
- To study the characteristics of fuels/Lubricants used in IC Engines.
- To study the Performance of steam generator/ turbine.
- To study the different modes of heat transfer phenomena to find out their relevant heat transfer coefficient.
- To study the performance of refrigeration and air conditioning systems.

LIST OF EXPERIMENTS

a) I.C. ENGINE LAB

1. Valve Timing, Port Timing diagrams
2. Performance Test on 4 – stroke Diesel Engine.
3. Heat Balance Test on 4 – stroke Diesel Engine.
4. Morse Test on Multi-Cylinder Petrol Engine.
5. Retardation Test on a Diesel Engine.
6. Determination of Flash Point and Fire Point of various fuels / lubricants.

b) STEAM LAB

1. Study on Steam Generators and Turbines.
2. Performance and Energy Balance Test on a Steam Generator.
3. Performance and Energy Balance Test on Steam Turbine.

c) HEAT TRANSFER LAB:

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Determination of Thermal conductivity of composite wall.
6. Determination of Thermal conductivity of insulating powder.
7. Heat transfer from pin-fin apparatus (natural & forced convection modes)
8. Determination of Stefan – Boltzmann constant.
9. Determination of emissivity of a grey surface.
10. Effectiveness of Parallel / counter flow heat exchanger.
11. Design of Heat Exchanger with given parameter

d) REFRIGERATION AND AIR CONDITIONING LAB

1. Experiments on Psychrometric processes
2. Performance test on a reciprocating air compressor
3. Performance test in a HC Refrigeration System

Total: 60 PERIODS

OUTCOMES:

CO 1 : Conduct tests to draw valve and port timing diagram and evaluate flash and fire point of given fuel

CO 2 : Conduct tests to find out the performance of IC engines and steam generator.

CO 3 : Conduct tests on convective and radioactive heat transfer apparatus to trace out their heat transfer coefficient.

CO 4 : Conduct tests to evaluate the performance of parallel/counter flow heat exchanger and reciprocating air compressor.

CO 5 : Conduct tests to evaluate the performance of refrigeration and air conditioning systems.

LIST OF EQUIPMENTS:

S.No.	NAME OF THE EQUIPMENT	Qty.
1	I.C Engine – 2 stroke and 4 stroke model	1 set
2	Apparatus for Flash and Fire Point	1 No.
3	4-stroke Diesel Engine with mechanical loading.	1 No
4	4-stroke Diesel Engine with hydraulic loading.	1 No.
5	4-stroke Diesel Engine with electrical loading.	1 No.
6	Multi-cylinder Petrol Engine	1 No.
7	Single cylinder Petrol Engine	1 No.
8	Data Acquisition system with any one of the above engines	1 No.
9	Steam Boiler with turbine setup	1 No.
10	Guarded plate apparatus	1 No.
11	Lagged pipe apparatus	1 No.
12	Natural convection-vertical cylinder apparatus	1 No.
13	Forced convection inside tube apparatus	1 No.
14	Composite wall apparatus	1 No.
15	Thermal conductivity of insulating powder apparatus	1 No.
16	Pin-fin apparatus	1 No.
17	Stefan-Boltzmann apparatus	1 No.
18	Emissivity measurement apparatus	1 No.
19	Parallel/counter flow heat exchanger apparatus	1 No.
20	Single/two stage reciprocating air compressor	1 No.
21	Refrigeration test rig	1 No.
22	Air-conditioning test rig	1 No.

ME1621 DESIGN AND FABRICATION PROJECT

L	T	P	C
0	0	4	2

OBJECTIVE:

- The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department.

At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

CO1: Identify, select the need based potential problem related to engineering.

CO2: Develop the solution by applying the design principles

CO3: Create the design model and find solution

CO4: Develop the detailed design in manufacturing aspect by preparing the bill ofmaterials and cost estimation

CO5: Fabrication of the model and implementation / Testing

ME1631 **BASICS OF FINITE ELEMENT ANALYSIS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce to fundamentals of finite element techniques.
- To appreciate the use of FEM to a range of Engineering Problems
- To analyze one dimensional phenomenon using finite element techniques.
- To impart knowledge in the area of finite element methods and its application in mechanical engineering.

UNIT I INTRODUCTION **9**

Historical Background – Mathematical Modeling of field problems in Engineering – Need for weighted integral forms – Boundary, Initial and Eigen Value problems– Weak Formulation of Boundary Value Problems – Weighted Residual Methods – Variational methods of approximation – Ritz Technique – Basic concepts of the Finite Element

Method.

UNIT II **ONE-DIMENSIONAL FEA – SOLID MECHANICS** **9**

One Dimensional Second Order Equations – Basic steps of FEA - Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solid mechanics Problems – Thermal Stress Problems – Euler Bernoulli Beam Element – Plane Truss and Frame Element – Case studies with several combinational finite elements.

UNIT III **ONE-DIMENSIONAL FEA – STRUCTURAL DYNAMICS** **9**

Dynamics of a Spring-Mass System - Direct Derivation of the Bar Element Equations - Numerical Integration in Time - Natural Frequencies of a One-Dimensional Bar - Time-Dependent One-Dimensional Bar Analysis - Beam Element Mass Matrices and Natural Frequencies – Mode shapes & Modal Analysis -Eigen value Problems on Mode Shapes

UNIT IV **ONE-DIMENSIONAL FEA – HEAT TRANSFER & FLUID FLOW** **9**

Derivation of the Basic Differential Equation of Heat Transfer- Heat Transfer with Convection - One-Dimensional Finite Element Formulation of Heat Transfer Element- Derivation of the Basic Differential Equations of Fluid Flow- One-Dimensional Finite Element Formulation of Fluid Flow and case studies.

UNIT V **TWO DIMENTIONAL FINITE ELEMENT ANAYSIS** **9**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors – Application to Field Problems - Axisymmetric Elements -Derivation of the Stiffness Matrix - Application to Axisymmetric Problems – Formulation of the Thermal Stress Problem - Quadrilateral elements

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply different mathematical modelling for FEM methods.

CO2: Discretize and solve one-dimensional solid mechanics problems in FEA.

CO3: Apply FEA concepts and procedure for solving 1D structural dynamics problems.

CO4: Apply FEA concepts and numerical methods in solving one dimensional heat transfer and fluid flow problems.

CO5: Implement 2D FEA in solving 2D solid mechanics problems.

TEXT BOOKS

1. Chandrupatla & Belagundu., 1990, *Introduction to Finite Elements in Engineering*, 3rd Edition, Prentice Hall College Div, New Jersy.
2. Logan, D.L., 2002, *A first course in Finite Element Method*, Thomson Asia Pvt. Ltd., Singapore

REFERENCE BOOKS

1. Reddy. J.N., 2005, *An Introduction to the Finite Element Method* , 3rd Edition, Tata McGraw-Hill Inc, New Jersy.
2. Bhatti Asghar M., 2013, *Fundamental Finite Element Analysis and Applications*, John Wiley & Sons., New Jersey
3. Bathe K.J., 1990, *Finite Element procedures in Engineering Analysis*, Prentice Hall, New Jersy.
4. Rao, S.S., 2005, *Finite Element method in engineering*, Elsevier Science & Technology., Miami.
5. Seshu P., 2004, *Textbook of Finite Element Analysis*, PHI Learning Pvt. Ltd.

ME1632	MECHANICAL VIBRATIONS AND NOISE CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Apply the fundamental concepts of vibration.
- Apply the fundamentals of noise.
- Describe the various sources of noise for automotive applications.
- Determine the natural frequencies and mode shapes of the two degree freedom systems.
- Describe the different types of noise and its control measures.

UNIT I BASICS OF VIBRATION 9

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree systems, torsional vibration - determination

of natural frequencies and critical speed of shafts.

UNIT II BASICS OF NOISE **9**

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, Measurement and analysis of noise, Measurement environment, Equipment, Frequency analysis, Tracking analysis, Sound quality analysis.

UNIT III AUTOMOTIVE NOISE SOURCES **9**

Noise - Characteristics of engines, Engine overall noise levels, Assessment of combustion noise, Assessment of mechanical noise, Engine radiated noise, Intake and exhaust noise, Engine necessary contributed noise, Transmission noise, Aerodynamic noise, Tyre noise, Brake noise.

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS **9**

Vibration isolation, tuned absorbers, un-tuned viscous dampers, damping treatments, dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.

UNIT V SOURCES OF NOISE AND ITS CONTROL **9**

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers

TOTAL: 45 PERIODS

OUTCOMES

CO1: Calculate the natural frequency of different types of vibrations.

CO2: Illustrate the fundamentals of noise and noise analysis technique.

CO3: Summarize the various sources of noise for automotive applications

CO4: Determine the natural frequencies and mode shapes of the two degree freedom systems.

CO5: Describe the different types of noise and its control measures.

TEXT BOOKS

1. Singiresu S. Rao., 2017, *Mechanical Vibrations*, Pearson Education Incorporated.

REFERENCE BOOKS

1. Ambekar. A. G., 2006, *Mechanical Vibrations and Noise Engineering*, Prentice Hall of India Pvt. Ltd.
2. Singiresu S. Rao., 2017, *Mechanical Vibrations*, Pearson Education Incorporated.
3. Benson H. Tongue., 2017, *Principles of Vibrations* Oxford University.
4. David A. Bies and Colin H. Hansen., 2009, *Engineering Noise Control – Theory and Practice*, Spon Press.
5. Grover. G.K., edited by Nigam. S. P., 2014, *Mechanical Vibrations*, Nem Chand and Bros.

ME1633 **COMPUTER AIDED DESIGN**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide an overview of how computers are being used in mechanical component design.
- To understand the basic mathematical concepts for formulating points, lines, curves, solids for the application of CAD.
- To interpret the assembly of parts using various CAD techniques.
- To understand the various data exchange and product exchange CAD standards for working in modern CAD platforms.
- To understand the possible applications of the CAD/CAM systems in motion analysis, structure analysis, optimization & rapid prototyping.

UNIT I **INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS** **9**

Product cycle - CAD system architecture - CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices; Graphics - Coordinate systems - Line and Curve generation algorithm: DDA, Bresenham's algorithms – Clipping and its Algorithm.

UNIT II GEOMETRIC TRANSFORMATIONS 9

Translation, Scaling, Reflection, Rotation - Homogeneous representation - Composite transformations - 3D transformations - Orthographic and perspective projections. Window to View-port transformation.

UNIT III CURVES AND SURFACES 9

Introduction to curves - Analytical curves – Synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – Curve manipulations - NURBS - Introduction to surfaces - Analytical surfaces – Types of Surfaces – Synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface- Surface manipulations

UNIT IV SOLID MODELLING TECHNIQUES 9

Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Solid modeling techniques: B-rep, CSG, Sweep representation - user interface for solid modeling.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

Assembly modeling - interferences of positions and orientation – mass property calculations - interference checking - mechanism simulation. Graphics and Computing Standards – Application of GKS, IGES, STEP, DXF, CALS, STL etc in CAD applications – Communication standards – Collaborative Design – Introduction to Cloud based CAD.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply mathematical concepts in generating lines and clipping algorithms for CAD.

CO2: Solve various 2D & 3D geometric transformations which could be applied in CAD.

CO3: Apply the mathematical modelling for the generation of curves and surfaces for CAD.

CO4: Analyze and compare the various solid modelling techniques by its properties.

CO5: Implement various assembly modelling, tolerance and CAD standards for working in various CAD platforms.

TEXT BOOKS

1. Ibrahim Zeid., 2007, *Mastering CAD CAM,* Tata McGraw-Hill Publishing Co., New Delhi.

REFERENCE BOOKS

1. Chris McMahon and Jimmie Browne., 1999, *CAD/CAM Principles, Practice and Manufacturing management,* Second Edition, Pearson Education.
2. William M Neumann and Robert F.Sproul., 1989, *Principles of Computer Graphics*, McGraw Hill Book Co. Singapore.
3. Donald Hearn and M. Pauline Baker., 1992, *Computer Graphics,* Prentice Hall, Inc.
4. Foley, Wan Dam, Feiner and Hughes., 2003, *Computer graphics principles & practice,* Pearson Education.

ME1634 **DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the functions and design principles of Jigs, fixtures and press tools
- To gain proficiency in the development of required views of the final design

UNIT I PRINCIPLES OF JIGS, FIXTURES AND PRESS WORKING 9

Objectives and importance of tool design—work holding devices- Basic elements of jigs and fixtures- location – clamping-indexing-operational chart-Fits and Tolerances Tools for press working Press Working Terminologies –cutting and non-cutting operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure– knockouts – direct and indirect – pressure pads – Ejectors- Die Block – Punch holder, Die set, 103 guide plates – Stops – Strippers – Pilots – Selection of Standard parts –Recent trends in tooling recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies-Poka Yoke.

UNIT II JIGS **9**

Design and development of jigs for given component - Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs

UNIT III FIXTURES **9**

Design and development of fixtures for given component- General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures

UNIT IV DESIGN OF CUTTING DIES **9**

Complete design and preparation of standard views of simple blanking, piercing, compound and progressive dies -fine Blanking dies

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **9**

Difference between bending forming and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back– Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply the principles of locating and clamping in Jigs and fixtures and various components related to Press tools.

CO2: Design and draw the various types of Jigs for given applications.

CO3: Design various types of Fixtures for given components and draw multiple views of the same.

CO4: Design various parts of cutting dies and draw the standard dimensioned views.

CO5: Design various parts of forming dies and draw the standard dimensioned views.

TEXT BOOKS

1. Joshi, P.H., 2010,*Jigs and Fixtures*, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi.

2. Joshi P.H., 2001, *Press tools - Design and Construction*, S. Chand & Co Ltd.

REFERENCE BOOKS

1. ASTME 1984, – *Fundamentals of tool design*, Prentice Hall of India.
2. Donaldson, Lecain and Goold., 2000, *Tool Design*, Tata McGraw Hill.
3. K. Venkataraman., 2015, *Design of Jigs Fixtures & Press Tools*, Anne Publications.

ME1635 **ADDITIVE MANUFACTURING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know the principle, methods, possibilities and limitations as well as environmental effects of Additive Manufacturing technologies
- To familiar with the characteristics of the different materials those are used in Additive Manufacturing technologies

UNIT I **INTRODUCTION** **9**

Overview – Need - Development of Additive Manufacturing Technology -Principle – AM Process Chain- Classification –Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Applications- Benefits –Case studies.

UNIT II **CAD&REVERSE ENGINEERING** **9**

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS. MAGICS

UNIT III **PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES** **9**

Photo polymerization: SLA – Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description – powder fusion mechanism – Process Parameters – Application. Electron Beam Melting.

UNIT IV **EXTRUSION BASED AND SHEET LAMINATION PROCESSES** **9**

Extrusion Based System: FDM-Introduction – Basic Principle – Materials – Applications and Limitations – Bioextrusion. Sheet Lamination Process: LOM- Gluing or Adhesive bonding.

UNIT V **PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES** **9**

Droplet formation technologies – Continuous mode – Drop on Demand mode – Three Dimensional Printing – Advantages - Beam Deposition Process: LENS- Process description – Material delivery – Process parameters – Materials – Benefits – Applications. Customized Implants -Design and Production.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the Principles of Additive Manufacturing technology

CO2: Apply the concept of reverse engineering for CAD models

CO3: Apply the concept of powder bed fusion for manufacturing

CO4: Describe the various extrusion based and sheet lamination processes.

CO5: Apply the concept of beam deposition process and LENS for industrial applications.

TEXT BOOKS

1. Chua C.K., Leong K.F., and Lim C.S., 2005, *Rapid prototyping: Principles and applications: a training guide*, Wiley, 2nd edition World Scientific Publishers NewJersey.
2. Gebhardt A., 2003, *Rapid prototyping*, Hanser Gardener Publications.
3. Ian Gibson, David W.Rosen, Brent Stucker., 2010, *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing,* Springer.

REFERENCE BOOKS

1. Andreas Gebhardt., 2011, *Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing,* Hanser Gardner Publication.
2. Kamrani A.K. and Nasr E.A., 2006, *Rapid Prototyping: Theory and practice*, Springer.
3. Liou L.W. and Liou F.W., 2007, *Rapid Prototyping and Engineering applications: A tool box for prototype development*, CRC Press.

ME1636 **OPERATION RESEARCH**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.
- Formulate a real-world problem as a mathematical programming model.
- To provide idea for optimizing and approximating industrial problems to the Managers and decision makers.
- To devise appropriate measures for modeling and solving engineering problems of different fields.
- Apply scientific techniques to monitor the organizations ongoing activities such as production mix, transportation and assignment problem.

UNIT I **LINEAR PROGRAMMING** **9**

Introduction – Basic concepts – Linear programming Formulation – Graphical method – Simplex algorithm – Sensitivity analysis.

UNIT II **DUALITY, TRANSPORTATION AND ASSIGNMENT MODELS** **9**

Definition of dual problem – Primal – Dual relationships – Dual simplex methods – Post optimality analysis – Transportation problem – Assignment Models – Hungarian method, Traveling Salesman problem.

UNIT III INVENTORY MODELS 9

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV QUEUEING MODELS 9

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT V NETWORK MODELS 9

Networks models – Shortest route – Minimal spanning tree – Maximum flow models – Project network – CPM and PERT networks – Critical path scheduling – Sequencing models - Introduction to decision models.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Make a model for finding optimal solution during the given set of resources.

CO2: Develop an optimum solution for simple transportation/assignment problems.

CO3: Apply the different inventory models for solving simple problems.

CO4: Apply the concept of different queuing models for solving simple problems.

CO5: Determine the shortest route in the production model using PERT & CPM

TEXT BOOKS

1. Sharma J.K., 1997, *Operations Research – Theory and Applications*, Macmillan India Ltd.
2. Paneer Selvam, 2002, *Operations Research*, Prentice Hall of Indi.

REFERENCE BOOKS

1. Taha H.A., 2003, *Operations Research*, Sixth Edition, Prentice Hall of India.

2. Anand Sarma, 2003, *Operation Research*, Himalaya Publishing House.
3. Hira, Gupta, 2010, *Problems in Operations Research*, S.Chand and Co, 3rd Edition.
4. Hiller Frederick S., GeraldJ.Lieberman, 2005, *Introduction to Operations Research*, TMH (SIE) 8th Edition.
5. Kanti Swarup, Gupta P.K., Man Mohan, 2015, *Operations Research*, 18th edition, S. Chand & Sons.

ME1637 NON DESTRUCTIVE TESTING AND EVALUATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study and understand the various Non-Destructive Evaluation and Testing methods,
- To make the students to understand the importance of NDT in quality assurance
- To imbibe the students the basic principles of various NDT techniques, it's application, limitations, codes and standards.
- To equip the students with proper competencies to locate a flaw in various materials, products

UNIT I INTRODUCTION & VISUAL INSPECTION METHODS 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT.

Visual Inspection -Unaided, Aided- Borescopes -Videoscopes, Special features in Borescopes, Selection of borescopes, Optical sensors, Microscopes & replication Microscopy Technique and applications, Holography, Case study

UNIT II LIQUID PENETRANT TESTING& MAGNETIC PARTICLE TESTING 9

LPT - Principle, types, Procedures, Penetrants and their characteristics, Emulsifiers, Solvent Cleaners / Removers, Developers- properties and their forms, Equipment, Advantages and limitations, Inspection and Interpretation, Applications and case study.

MPT-Principle, Theory of Magnetism, Magnetising current, Magnetisation methods, Magnetic particles, Procedure, Interpretation, Relevant and Non-relevant indications-Residual magnetism, Demagnetisation – need, methods, Advantages and Limitations, Applications, Magnetic Rubber Inspection, Magnetic Printing, Magnetic Painting, Case study.

UNIT III THERMOGRAPHY & EDDY CURRENT TESTING 9

Thermography – Introduction, Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods and applications, Case study.

Eddy current Testing – Principle, properties of eddy currents, Eddy current sensing elements, probes, Instrumentation, Types of arrangement, Advantages & Limitations, Interpretation of Results& applications, Case study

UNIT IV ULTRASONIC TESTING & ACOUSTIC EMISSION TESTING 9

Ultrasonic Testing-Principle, Basic Equipment, Transducers, couplants, Ultrasonic wave, Variables in UT, Transmission and Pulse-echo method, Straight beam and angle beam, A-Scan, B-Scan & C-Scan, Phased Array Ultrasound & Time of Flight Diffraction, Advantages & Limitations, Interpretation of Results & Applications, Case study

Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications, Case study.

UNIT V RADIOGRAPHY AND APPLICATIONS OF NDT 9

Principles of radiography – Sources of X-rays and rays – Equipment – general radiographic procedure - Radiographic film, paper and screens – radiographic attenuation and penetration – Acceptance standards – Safety in radiography – Special radiography techniques (Fluoroscopy, Xeroradiography) Applications of NDT in railways, nuclear, chemical, aerospace, automobile and coal mining industries – case

studies.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply the concept of visual inspection method for finding the surface defect in the material.

CO2: Determine the defect by applying the standard procedures of Liquid penetrant test and Magnetic particle testing for leakage in in tank and industrial applications.

CO3: Identify the defect by making use of thermography and eddy current test.

CO4: Apply the concept of Ultrasonic testing and Acoustic emission test for industrial applications.

CO5: Apply the concept of Radiography for finding the defect in a material and applications such as railways, nuclear, chemical, aerospace, automobile and coal mining industries as case study.

TEXT BOOKS

1. Paul E Mix., 2005, *Introduction to Non-destructive testing: a training guide*, Wiley, 2nd edition NewJersey.
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu., 2009, *Practical Non-Destructive Testing*, Narosa Publishing House.
3. ASM Metals Handbook, *Non-Destructive Evaluation and Quality Control*, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

REFERENCE BOOKS

1. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, N*DT Handbook*, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4,Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing.
2. Charles, J. Hellier., 2001, *Handbook of Non-destructive evaluation*, McGraw Hill, New York.
3. G. Gaussorgues., 1994, *Infrared Thermography*, Chapman & Hall,

University Press, Cambridge.

4. Ravi Prakash, 2010, *Non-Destructive Testing Techniques*, New Age International Publishers, 1st revised edition.

ME1638 **PRODUCTION PLANNING AND CONTROL**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the various components and functions of production planning and control such as work study, product planning, production scheduling, Inventory Control.
- To provide an exposure to Production Planning & Control (PPC) and its significance in Manufacturing Industries
- To give exposure to production scheduling and sequencing so as to optimize resources

UNIT I INTRODUCTION **9**

Objectives and benefits of planning and control - Functions of production control - Types of production – job - batch and continuous - Product development and design - Marketing aspect - Functional aspects - Operational aspect - Durability and dependability aspect - aesthetic aspect. Profit consideration - Standardization, Simplification & specialization - Break even analysis - Economics of a new design.

UNIT II WORK STUDY **9**

Method study, basic procedure – Selection - Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards- Human machine interface

UNIT III PRODUCT PLANNING AND FORECASTING 9

Product planning - Extending the original product information - Value analysis - Problems in lack of product planning – forecasting – need – objectives - Long and short term demand forecasting methods - computer based forecasting methods -Time series analysis - Aggregate planning

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems - Loading and scheduling - Master Scheduling - Scheduling rules - Gantt charts - Perpetual loading - Basic scheduling problems - Line of balance Flow production scheduling - Batch production scheduling - Product sequencing Production Control systems - Periodic batch control - Material requirement planning Kanban Dispatching - Progress reporting and expediting - Manufacturing lead time -Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control - Purpose of holding stock - Effect of demand on inventories - Ordering procedures. Two bin system - Ordering cycle system - Determination of Economic order quantity and economic lot size - ABC analysis - Recorder procedure - Introduction to computer integrated production planning systems - Overview of supply chain management.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the functions and significances of production planning and control.

CO2: Explain suitable work study techniques for enhancing productivity.

CO3: Identify the forecasting techniques for predicting the demand of the product and preparation of an aggregate plan.

CO4: Comprehend the feasible production scheduling and sequencing methods to improve productivity.

CO5: Discuss the recent techniques in production planning

TEXT BOOKS

1. James. B. Dilworth., 1992, *Operations management Design, Planning and Control for manufacturing and service,* Mcgraw Hill International

edition.

2. Martand Telsang., 2000, *Industrial Engineering and Production Management*, First edition, S. Chand and Company.
3. MukhpadyayS K., 2007, *Production Planning and Control*, PHI Learning Pvt. Ltd.

REFERENCE BOOKS

1. UpendraKachru.,2007, *Production and operations management - Text and cases*, Excel books, 1st Edition.
2. James B Dilworth., 1992, *Operations management - Design, Planning and Control for manufacturing and services*, McGraw Hill International Edition.
3. Kanishka Bedi., 2007, *Production and Operations management*, Oxford University press 2nd Edition.
4. Norman Gaither and Frazier G., 2007, *Operations management*, Thomson learning, 9th Edition
5. Elwood Buffa S, and Rakesh Sarin K., 2000, *Modern Production / Operations Management*, 8thEdition, John Wiley and Sons.

ME1639	GAS DYNAMICS AND JET PROPULSION (Use of Approved Gas Tables is permitted)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basic concepts of incompressible flow for variable area duct.
- To gain knowledge about heat transfer in constant area duct.
- To understand the phenomenon of shock waves and its effect.
- To acquire basic knowledge about jet propulsion systems.
- To understand the working principles of space propulsion systems.

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOW 9

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers.

UNIT II FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations Rankine-Hugoniot Relation – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines

UNIT V SPACE PROPULSION 9

Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights. Cryogenics.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Apply the mass, momentum and energy conservation principles to Nozzles and Diffusers.

CO2: Solve the flow through constant area duct problems of Fanno flow and Rayleigh flow.

CO3: Apply the Normal & Oblique Shock concepts to find the variation of flow parameters.

CO4: Explain the working principle and performance of aircraft Engines.

CO5: Explain the working principle and performance of rocket propulsion systems.

TEXT BOOKS

1. Yahya, S.M., 2002, *Fundamentals of Compressible Flow*, New Age International (P) Limited, New Delhi.
2. Anderson, J.D., 2012, *Modern Compressible flow*, Tata McGraw Hill Education Private Limited, 3rd Edition.

REFERENCE BOOKS

1. Cohen. H., G.E.C. Rogers and Saravanamutto., 1980, *Gas Turbine Theory*, Longman Group Ltd.
2. Ganesan. V., 2010, *Gas Turbines*, Tata McGraw Hill Education Private Limited.
3. Shapiro. A.H., 1953, *Dynamics and Thermodynamics of Compressible fluid Flow*, John wiley, New York.
4. Sutton. G.P., 2010, *Rocket Propulsion Elements*, John wiley, New York.
5. Zucrow. N.J., 1970, *Principles of Jet Propulsion and Gas Turbines*,

John Wiley, New York.

ME1640 **REFRIGERATION AND AIR CONDITIONING**

L	T	P	C
3	0	0	3

(Use of Approved Refrigerant table and Psychrometric chart is permitted)

OBJECTIVES:

- To explain the different types of refrigerant, their properties, and selecting appropriate refrigerant for a HVAC system.
- To explain the performance and components of VCRS.
- To identify different types, safety and controls in Refrigeration systems.
- To design the heat load and system size.
- To identify different types, safety and controls in Air-conditioning systems.

UNIT I **INTRODUCTION, REFRIGERANTS AND THEIR ENVIRONMENTAL ISSUES** **9**

Introduction to Refrigeration - Unit of Refrigeration and C.O.P. - Ideal cycles - Refrigerants Desirable properties - Classification - Nomenclature - Ozone Depletion Potential (ODP) and Global Warming (GW) - Alternative to existing refrigerants.

UNIT II **VAPOUR COMPRESSION REFRIGERATION SYSTEM** **9**

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle - subcooling and super heating - effects of condenser and evaporator pressure on COP - multipressure system - low temperature refrigeration - Cascade systems - problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators

UNIT III **OTHER REFRIGERATION SYSTEMS, CONTROLS AND SAFETFY** **9**

Working principles of Vapour absorption systems and adsorption cooling systems - Steam jet refrigeration - Ejector refrigeration systems - Thermoelectric refrigeration - Air

refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems - concept of Direct Digital Control. Installation, commissioning, noise, vibration, electrical connections and safety in RAC systems

UNIT IV AIR-CONDITIONING AND HEATING / COOLING LOAD ESTIMATION 9

Introduction to thermal comfort and parameters of indoor environment quality; Psychrometric properties, Psychrometric chart; Basic process in air-conditioning: Humidification and Dehumidification processes; Introduction to evaporative cooling and cooling towers. Heating and Cooling Load Estimation: Components of cooling/heat load, Room sensible heat factor (RSHF), Grand sensible Heat factor (GSHF), Heating and cooling load estimation of a typical office / domestic building, Concept of diversity.

UNIT V AIR CONDITIONING SYSTEM TYPES AND CONTROLS 9

Major system types in air-conditioning: unitary, package, central chilled water based systems; components of chilled water system, concept of primary - secondary chilled water pumping; concept of variable flow systems, components of non-chilled water based system, types and role for energy efficiency, comparison of variable refrigerant flow and constant flow systems. Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the different types of refrigerant and their properties.

CO2: Illustrate the principles of vapor compression refrigeration systems in calculating their performance.

CO3: Describe the various types of refrigeration systems and its controls.

CO4: Exemplify the concepts of air conditioning systems in calculating heating and cooling loads.

CO5: Describe the various types of air conditioning systems and its controls.

TEXT BOOKS

1. Arora CP., 2017, *Refrigeration and Air Conditioning*, Tata McGraw-Hill Education Private Limited, 3rd Edition.

2. Stoecker W.F and Jones J.W., 2009, *Refrigeration and Air*

Conditioning, Tata McGraw Hill Education Private Limited, 2nd Edition.

REFERENCE BOOKS

1. Dossat Roy J., 2002, *Principles of Refrigeration*, Pearson Education Asia, 4th Edition.
2. Arora RC., 2010, *Refrigeration and Air Conditioning*, Prentice Hall India.
3. *ASHRAE.,* 2014, *Handbook Series: Fundamentals, Refrigeration, Systems and Equipments and HVAC Applications*, ASHRAE Inc, Atlanta, USA.

ME1641 **ENERGY CONSERVATION AND AUDITING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To quantify energy demand and energy supply scenario of nation and energy conservation potential in various industries.
- To Analyse factors behind energy billing and applying the concept of demand side management for lowering energy costs
- To Compute the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries
- To Diagnose the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
- To understand the basics of energy auditing, its uses and its applications along with the energy audit instruments.

UNIT I **ENERGY SCENARIO** **9**

Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy conservation and energy efficiency - Energy conservation potential in various Industries and commercial establishments - Energy intensive industries - an overview.

UNIT II **ELECTRICAL SUPPLY SYSTEMS** **9**

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics .

UNIT III **ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES** **9**

Stoichiometry - Combustion principles. Energy conservation in Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices - Basic Cogeneration principles.

UNIT IV **ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES** **9**

Energy conservation in : Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems- Case Study on Energy conservation in Industries.

UNIT V **ENERGY AUDITING** **9**

Definition, need, and 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; Fuel & energy substitution; Energy audit instruments; Energy Conservation Act; Duties and responsibilities of energy managers and auditors- Introduction to Energy ratings- Energy Economics: evaluation techniques.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Interpret the energy demand and energy supply scenario.

CO2: Explain the factors of energy billing and demand side management.

CO3: Infer the energy losses associated with thermal utilities of industries.

CO4: Describe the performance of various electrical utilities.

CO5: Interpret the basics of energy auditing and its tools.

TEXT BOOKS

1. Abbi Y P, Shashank Jain., 2006, *Handbook on Energy Audit and Environment Management*, TERI Press.
2. K. Nagabhushan Raju., 2007, *Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies*), Atlantic Publishers & Dist.

REFERENCE BOOKS

1. Albert Thumann and Paul Mehta D., 2013, *Handbook of Energy Engineering*, The Fairmont Press, 7th Edition.
2. Murphy.W.R. and McKay.G., 1982, E*nergy Management*, Butterworth, London.

3. Paul W.O'Callaghan., 1981, *Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers*, Pergamon Press.
4. Steve Doty, Wayne Turner C., 2009, *Energy Management Handbook,* The Fairmont Press, *7th Edition*.
5. *Guide book for National Certification Examination for Energy Managers and Energy Auditors* (4 Volumes). Available at http://www.em-ea.org/gbook1.asp. This website is administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.

ME1642 **RENEWABLE ENERGY SOURCES**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To describe the current energy scenario and future plan.
- To understand the principles of various solar energy generating devices.
- To describe the principles of various wind energy devices.
- To identify the concepts of various bio energy systems.
- To understand the principle of various ocean and geothermal energy devices.

UNIT I ENERGY SCENARIO 9

Indian energy scenario in various sectors - domestic, industrial, commercial, agriculture, transportation and others - Present conventional energy status - Present renewable energy status - Potential of various renewable energy sources - Global energy status -Per capita energy consumption in various countries - Future energy plans.

UNIT II SOLAR ENERGY 9

Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for wind farms – characteristics Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues – Applications

UNIT IV BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermo chemical conversion –

biochemical conversion-mechanical conversion - Biomass gasifiers - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters – Biodiesel production – Ethanol production - Applications.

UNIT V OTHER TYPES OF ENERGY 9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the current energy scenario and future plan.

CO2: Explain the basic principles of various solar energy devices.

CO3: Identify the working principle and components of wind energy systems.

CO4: Explain the process of Bio-energy generation.

CO5: Describe about various forms of renewable energy resources.

TEXT BOOKS

1. G.D. Rai., 1992, *Non-Conventional Energy Sources*, Standard Publishers Distributors.
2. John Twidell., Tony Weir, and Anthony D. Weir, 2006, *Renewable Energy Resources*, Taylor & Francis.

REFERENCE BOOKS

1. B.H. Khan., 2009, *Non-Conventional Energy Resources*, Tata McGraw Hill.
2. G.N. Tiwari., 2015, *Solar Energy – Fundamentals Design, Modelling and applications*, Alpha Science.
3. N.K. Bansal., 2014, *Non-Conventional Energy Resources*, Vikas Publishing House.
4. S.P. Sukhatme., 2009, *Solar Energy: Principles of Thermal Collection and Storage*, Tata McGraw Hill.

OME151 **THERMAL ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To impart basic knowledge on Mechanical Engineering.
- To provide the exposure of boilers.
- To enable the students to distinguish the components and working principle of power plant units, IC engines, and R & AC system

UNIT I SCOPE OF MECHANICAL ENGINEERING 9

Mechanical Engineering contributions to the welfare of Society –Specialized sub disciplines in Mechanical Engineering - Production, Automobile, Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.

UNIT II BOILERS 9

Introduction – classification of boilers, selection of boiler – comparison between Fire tube and Water tube boilers - Fire tube and Water tube boilers and its types – High pressure boilers.

UNIT III INTERNAL COMBUSTION ENGINES 9

Internal Combustion engine – components - functions and materials, Working principle of four stroke and two stroke cycles of diesel and petrol engines – Comparison of four stroke and two stroke cycle engines.

UNIT IV POWER PLANTS 9

Introduction – construction and working principles of thermal power plant, Gas, Diesel, Hydro-electric and Nuclear Power plants – Introduction of renewable energy - solar energy, Wind energy.

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Describe the role of mechanical engineer in society and to relate the various disciplines of mechanical engineering

CO2: Discuss the importance and working principles of boilers.

CO3: Recognize the various parts of the automobile and their functions and materials.

CO4: Explain the layout, construction and working of the components inside a various power plant.

CO5: Summarize the concept of refrigeration and air conditioning systems.

REFERENCE BOOKS

1. Palanikumar, K., 2010, *Basic Mechanical Engineering,* ARS Publications.
2. ShanthaKumar SRJ., 2000*, Basic Mechanical Engineering,* Hi-tech Publications, Mayiladuthurai
3. Venugopal K. and Prahu Raja V., 2000, *Basic Mechanical Engineering,* Anuradha Publishers, Kumbakonam.
4. Kirpal Singh., 2014, *Automobile Engineering,* Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition.
5. Nag. P.K.*,* 2008*, Power Plant Engineering,* Third Edition, Tata McGraw – Hill Publishing Company Ltd.
6. Kothandaraman, C.P., Domkundwar .S and Domkundwar A.V., 2016, *A course in Thermal Engineering*, Dhanpat Rai & Sons.

OME152	FUNDAMENTALS OF MANUFACTURING PROCESS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge about basic machines used in production
- To expose the student on the principle and applications of the simple manufacturing processes used in industry

UNIT I CASTING AND WELDING PROCESS 9

Principles of metal casting: Pattern materials, types and allowance; Study of moulding, sand, moulding tools, moulding materials. Special casting processes: Green sand moulding, die-casting, centrifugal casting and their uses.

Introduction, classification of welding processes. Gas welding, types of flames and their applications. Electric Arc welding, Soldering & Brazing processes and their uses.

UNIT II MACHINING PROCESS 9

Basic principles of lathe - machine and operations performed on it. Basic description of machines and operations of Drilling, Milling & Grinding.

UNIT III ADVANCED MANUFACTURING PROCESS 9

Abrasive flow machining - abrasive jet machining - water jet machining - Electro Discharge Machining (EDM) - Wire cut EDM - Electro Chemical Machining (ECM) - Ultrasonic Machining /Drilling (USM / USD) - Electron Beam Machining (EBM) - Laser Beam Machining (LBM).

UNIT IV COMPUTER INTEGRATED MANUFACTURING 9

Numerical control (NC) machine tools - CNC: types, constitutional details, special features – FMS: Introduction-FMS components-FMS layout-Types of FMS: Flexible manufacturing cell, Flexible Turning cell, Flexible Transfer line, Flexible Machining system-benefits of FMS.

UNIT V ADDITIVE MANUFACTURING PROCESS 9

Basic principles of additive manufacturing – Laminated Object Manufacturing, Fused Deposition Modeling, 3D Printing, Selected Laser Sintering, Electron Beam Melting, Stereolithography – working principle and its applications.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Explain the types of casting and metal joining processes used in industry for manufacturing

CO2: Comprehend the working principle of simple machines such as lathe, milling, drilling, grinding

CO3: Summarize the advanced manufacturing methods used in Industry (Unconventional Machining Process)

CO4: Explain how computers are integrated in manufacturing (NC, CNC & FMS)

CO5: Describe the various types of additive manufacturing processes used in manufacturing industry

TEXT BOOKS

1. Kalpakjian S. and Schmid S., 2009, *Manufacturing Engineering and Technology*, Prentice Hall of India , 5th Edition.
2. Sharma P.C., 2007, *A Text book of production Technology: manufacturing processes*, S.Chand & Company Limited, 7th Edition.

REFERENCE BOOKS

1. Hajra Chowdary., 1971, *Elements of Manufacturing Technology Vol 1 and vol 2.*
2. Gupta. K.N., and Kaushik J.P., 1998, *Workshop Technology Vol I and II*, New Heights, Daryaganj, New Delhi.
3. Vijay.K. Jain., 2007, *Advanced Machining Processes,* Allied Publishers Pvt. Ltd., New Delhi.
4. Chapman W.A.J., 1992, *Workshop Technology*, Part I, II, III, E.L.B.S. and Edward Amold Publishers Ltd, London.
5. Ian Gibson, David W.Rosen, Brent Stucker., 2010, *"Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital*

Manufacturing" Springer.

OME153 **NON-CONVENTIONAL ENERGY SOURCES**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To get exposure on solar radiation and its environmental impact.
- To know about the various collectors used for storing solar energy.
- To know about the various applications in solar energy.
- To learn about the principle of wind energy and biomass systems.
- To know about the different forms of energy sources.

UNIT I PRINCIPLES OF SOLAR RADIATION 9

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II SOLAR ENERGY COLLECTION 9

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS 9

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion

UNIT IV WIND & BIO MASS ENERGY 9

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria, BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

UNIT V GEOTHERMAL & OCEAN ENERGY 9

Resources, types of wells, methods of harnessing the energy, potential in India. Ocean energy: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. Direct Energy Conversion (DEC): Need for DEC, limitations, principles of DEC.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Understand the physics of solar radiation.

CO2: Describe different types of solar energy collectors.

CO3: Elucidate the methods of solar energy storage and its application**.**

CO4: Describe about wind energy and biomass energy systems.

CO5: Outline the basics of different renewable energy system.

TEXT BOOKS

1. Rai G.D., 2018, *Non-Conventional Energy Sources*, Khanna Publishers.
2. Twidell & Wier., 2018, *Renewable Energy Resources*, CRC Press (Taylor & Francis).

REFERENCE BOOKS

1. Tiwari and Ghosal., 2017, *Renewable energy resources*, Narosa Publishing House.
2. Ramesh R & Kumar K.U., 2014, *Renewable Energy Technologies,* Narosa Publishing House.
3. Mittal K M., 2018, *Non-Conventional Energy Systems*, Wheeler Publishing Co. Ltd, New Delhi.
4. Kothari D.P & Singhal K.C., 2018, *Renewable energy sources and emerging technologies*, P.H.I, New Delhi.

OME154 **WORLD CLASS MANUFACTURING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand of the concept and importance of strategy planning for manufacturing industries.
- To apply principles and techniques in the identifiable formulation and implementation of manufacturing strategy for competitive in global context.

UNIT I INDUSTRIAL SCENARIO 9

Global Competitiveness and Manufacturing Excellence - Japan decade – American decade - Manufacturing Challenges, Problems in Manufacturing Industry.

UNIT II WCM AND CUSTOMER FOCUSED PRINCIPLES 9

WCM – evolution, principles – Infinite loop process – Pillars of WCM - Customer - Focused principles - General principles - Design - Operations - Human resources - Quality and Process improvement - Promotion and Marketing.

UNIT III LABOUR AND HRD PRACTICES IN WCM 9

Human Resource Dimensions in WCM - Morale and Teamwork - High Employee Involvement - Cross Functional Teams - Work Study Methods - Human Integration Management.

UNIT IV STABILITY AND STRATEGIC LINKAGES 9

Employee stability - Team stability and cohesiveness - Project cohesiveness and stability - Product decisions and customer service - Multi-company planning - Smoothing the demand turbulence.

UNIT V IMPEDIMENTS 9

Bad plant layout design in production lines, assembly lines - Whole Plant Associates - Facilitators – Teamsmanship - Motivation and reward in the age of continuous.

TOTAL: 45 PERIODS

OUTCOMES

CO1: Explain the industrial scenario in world wise.

CO2: Describe the concepts to build strength through customer focused principles

CO3: Explain the human resource department practices in WCM

CO4: Outline the concepts of making stability and strategic linkages

CO5: Explain about impediments for continuous improvement

TEXT BOOKS

1. Richard J. Schonberger., 2018, *World Class Manufacturing: The next decade: Buliding power, strength and value*, The Free Press, Newyork.
2. Sahay B. S., Saxena K. B. C., Ashish Kumar., 2018, *World Class Manufacturing*, MacMillan Publishers.

REFERENCE BOOKS

1. V. K. Narayanan, *Managing Technology & Innovation for Competitive Advantage*, Prentice Hall.
2. Richard J Schonberger., *World Class Manufacturing - The Lesson of Simplicity,* Free Press - A Division of Simon and Schuster.