MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS								
Code	Category	Periods			Sessional Marks	End Exam	Total Marks	Credits
		L	T	P				
MEC 312(A)	HS	3	0	0	40	60	100	3

Prerequisite: NIL

Course Objectives: To make the students to learn the fundamentals of managerial economics and explain the concepts of costs and break – even analysis. To acquaint the students with the different market situations and forms of business organization. To impart the knowledge of financial accounting.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Differentiate** micro vs. macroeconomics and apply the concepts of demand analysis & demand forecasting
CO-2	**Explain** the cost concepts and types of costs and further **evaluate** Break-even point.
CO-3	**Identify** classes of market structures, business organizations and phases of business cycles
CO-4	**Differentiate** fixed and working capital and **explain** the methods and sources of finance and **apply** this concept in banking and small scale industries.
CO-5	**Prepare** balance sheet of a business organization with a sole proprietor.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1							1	2	1	1
CO-2	2	1							1	2	1	1
CO-3	1	1							1	2	1	1
CO-4	1	1							1	2	1	1
CO-5	1	1							1	2	1	1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT - I	**Periods: 10L+0T=10**
Introduction to Managerial Economics	
Definition, micro and macro economics, demand analysis - demand determinants, law of demand and its exceptions, elasticity of demand; demand forecasting - survey methods, statistical methods.	
UNIT - II	**Periods: 8L+0T=8**
Cost Analysis	
Cost concepts - opportunity cost, fixed vs. variable costs, explicit vs. implicit costs, out of pocket vs. imputed costs; Break Even Analysis -determination of break-even point (simple problems)**.**	
UNIT - III	**Periods: 8L+0T=8**
Market Structures & Types of Business Organization and Business Cycles	
Market Structures: Types of competition; features of perfect competition; imperfect competition monopoly, monopolistic competition. **Types of Business Organization and Business Cycles:** Sole trader; partnership; joint stock company; pubic enterprises; business cycles - definition and characteristics, phases	
UNIT - IV	**Periods: 8L+0T=8**
Capital –Types and Sources	
Fixed and working capital; methods and sources of finance.	
UNIT - V	**Periods: 8L+0T=8**
Introduction to Financial Accounting	
Final accounts of a sole proprietor - preparation of trading account, profit and loss account, balance sheet.	
TEXT BOOKS:	
1.	Managerial Economics and Financial Analysis by A. R. Aryasri; McGraw-Hill Education (India) Private Limited, New Delhi (2015).
2.	Engineering Economics, Volume I by Tara Chand; Published By Nem Chand & Bros, Roorke (2007).
REFERENCE BOOKS:	
1.	Managerial Economics by Varshney & Maheswari; Published by Sultan Chand, 2007.
2.	Financial Accounting by Shim &Siegel; Published by Schaum's Outlines, TMH 2007.
WEB RESOURCES:	
1.	http://www.nptel.ac.in

2.	http://www.freevideolectures.com

INDUSTRIAL ENGINEERING AND MANAGEMENT								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 312(B)	HS	3	0	0	40	60	100	3

Prerequisite: Basic Mathematics

Course Objectives: The course is indented to impart knowledge on the basics of management functions and principles, fundamentals of production planning and control, work study, selection of material handling equipment, various dispute acts and quality assessment techniques.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Apply** functions and principles of management to private/public sectors.
CO-2	**Employ** the techniques of production planning and control to manage production operations.
CO-3	**Apply** work measurement techniques and method study procedures for productivity improvement.
CO-4	**Analyze** the selection of material handling equipment & purchasing techniques and explain factories act-1948 & Industrial dispute act-1947.
CO-5	**Evaluate** quality of product using statistical process control charts and acceptance sampling plans.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1					1		1	1	2		1
CO-2	1					1	1	1	1	2	1	1
CO-3	1					1		1	1	2	1	1
CO-4	1	1				1		1	1	2	1	1
CO-5	2	1		1		1	1	1	1	2		1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 12L+0T=12**
Concepts of Industrial Management & Introduction to Personnel Management	
Concepts of Industrial Management: Principles of management- Growth of management thought, Functions of management, Principles of organization, Types of organization and committees. **Introduction to Personnel Management**: Functions, Motivation, Theories of motivation, Hawthrone studies, Discipline in industry, Promotion, Transfer, lay off and discharge, Labour turnover.	
UNIT - II	**Periods: 10L+0T=10**
Production Planning and Control & Plant Layout	
Production Planning and Control: Types of productions, Production cycle, Product design and development - Process planning, Forecasting, Loading, Scheduling, Dispatching, Routing- Simple problems. Materials Planning – ABC analysis – Incoming materials control – Kanban system – Just in time. MRP systems- Master Production Schedule – Bill of Materials –MRP II. **Plant Layout** Plant location - Factors - Plant layout - Types - Layout design process.	
UNIT - III	**Periods: 10L+0T=10**
Work study	
Introduction to work study – Method study – Recording Techniques – charts & Diagrams Time study – stopwatch time study – Standard data - Method Time Measurement (M-T-M) – simple problems – Ergonomics.	
UNIT - IV	**Periods: 12L+0T=12**
Materials Handling and Management & Industrial relations	
Materials Handling and Management: Principles, Concept of unit load, Containerization, Pelletization, Selection of material handling equipment, Applications of belt conveyors, Cranes, Forklift trucks in industry. Purchasing, Objectives of purchasing department, Buying techniques, Purchase procedure, Stores and material control, Receipt and issue of materials, Store records **Industrial relations**: Trade unions, Industrial disputes, Strikes, Lock-out, Picketing, Gherao, Settlement of industrial disputes, Collective bargaining, Industrial dispute act 1947 and factories act 1948.	

UNIT - V	**Periods: 6L+0T=6**

Statistical Quality Control	
Control charts of variables and attributes (p-chart, x-bar & R-chart, U-chart, KU-chart, C-chart) (Use of formulae only). single and double sampling plans.	
TEXT BOOKS:	
1.	Dr.O.P.Khanna, Industrial Engineering Management, 4th edition, Dhanpat Rai publications.
2.	Martand Teslang Industrial Engineering and Production Management 2nd Edition, S. Chand & Co.
REFERENCE BOOKS:	
1.	Koontz & Donnel, Principles of Management, 3rd edition, Mc-Graw Hill Publishers.
2.	Everette Adam & Ronald Ebert, Production and Operations Management, Prentice Hall, 1992.
WEB RESOURCES:	
1.	www.iems.ucf.edu/
2.	www.iise.org/
3.	www.iiie-india.com/

ENTREPRENEURSHIP DEVELOPMENT								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 312(C)	HS	2	1	0	40	60	100	3

Prerequisite: Nil

Course Objectives:

1. To develop a knowledge on basic concepts of entrepreneurship.
2. To develop a knowledge on affecting parameters of entrepreneurship and it policies.
3. To create a knowledge on preparation of entrepreneurship methodology.
4. To get a knowledge on applications of entrepreneurship.
5. To know about effective management of entrepreneurship in small scale Industries.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Apply** the knowledge of entrepreneurship qualities and skills to startup a business.
CO-2	**Apply** the knowledge of entrepreneurship policies to startup a business.
CO-3	**Prepare** a feasibility report and evalution criteria for an entrepreneurship.
CO-4	**Analyze** marketing strategies of entrepreneurship.
CO-5	**Apply** preventive measures to be followed for effective management of entrepreneurship.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1				1	1	1	1	2	2	1
CO-2	1	1				1	1	1	1	2	1	1
CO-3	1	2	1			1	1		1	2	1	1
CO-4	1	2				1	1		1	2	2	1
CO-5	1	1				1	1	1	1	2	2	1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT - I	**Periods: 6L+3T=9**
ENTREPRENEURAL COMPETENCE	
Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.	
UNIT - II	**Periods: 6L+3T=9**
ENTREPRENEURAL ENVIRONMENT	
Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services - Central and State Government Industrial Policies and Regulations - International Business.	
UNIT - III	**Periods: 6L+3T=9**
BUSINESS PLAN PREPARATION	
Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.	
UNIT - IV	**Periods: 6L+3T=9**
LAUNCHING OF SMALL BUSINESS	
Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.	
UNIT - V	**Periods: 6L+3T=9**
MANAGEMENT OF SMALL BUSINESS	
Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.	
TEXT BOOKS:	
1.	"Management and Entrepreneurship"- NVR Naidu& T. Krishna Rao, I K Publishing
2.	"Dynamics of Entrepreneurial Development & Management"- Vasant Desai, Himalaya Publishing House.
3.	"Entrepreneurship Development",-Poornima M. Charantimath, Small Business
4.	"Entrepreneurship Development",- S. S. Khanka S. Chand & Co.
REFERENCE BOOKS:	
1.	Entrepreneurship: New Venture Creation - David H. Holt
2.	The Culture of Entrepreneurship - Brigitte Berger
3.	Project Management - K. Nagarajan
4.	Entrepreneurship Development - Dr. P.C.Shejwalkar
WEB RESOURCES:	
1.	http://nptel.ac.in/courses.php

SUPPLY CHAIN MANAGEMANT								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 312(D)	HS	3	0	0	40	60	100	3

Prerequisite: Nil

Course Objectives:

1. To provide an overview of role and importance of supply chain management in today's dynamic world.
2. To explore important aspects of supply chain management.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Explain** the concepts related to Supply Chain Management and also **identify** the supply chain network to bring the product in to the market
CO-2	**Describe** the various demand forecasting techniques and **apply** them in forecasting the demand of a particular product.
CO-3	**Develop** supply chain planning to get the optimum results.
CO-4	**Explain** location alternatives and **apply** this method to **find** the optimum solution.
CO-5	**Develop** supply chain in logistics.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1	1			1	1		1	2	2	1
CO-2	1	1	2			1	1		1	2	2	1
CO-3	1	1	2			1	1		1	2	2	1
CO-4	1	1	2			1	1		1	2	2	1
CO-5	1		2			1	1		1	2	2	1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT - I	**Periods: 8L+0T=8**
Introduction to Supply Chain Management & Supply ChainNetwork	
Supply Chain, Importance of Supply Chain management (SCM), Overview, Objectives, Nature & Scope of SCM, Managing the supply Chain, Models of SCM, Evolution of SCM. Supply chain networks, integrated supply chain planning, importance of design, role of facility decisions, Distribution channels, design of distribution channel, channel design, locational determinants.	
UNIT - II	**Periods: 8L+0T=8**
Demand Management	
Demand management process, the role of forecasting and production, basic approach to forecasting, overview of qualitative and quantitative methods of forecasting, Nature of forecasting, relationship between customer service and demand management.	
UNIT - III	**Periods: 8L+0T=8**
Supply Chain Planning	
Aggregate planning in a supply chain, aggregate planning strategies, planning supply and demand in a supply chain, planning and managing inventories in a supply chain, planning for optimal level of product availability.	
UNIT - IV	**Periods: 8L+0T=8**
Location Alternatives	
The need for long range planning, major locational determinants, historical perspectives on location problems, single facility versus multi facility location, methods of evaluating location alternatives.	
UNIT - V	**Periods: 8L+0T=8**
Organization & Control in Supply Chain	
Need for supply chain organizational structure, importance of supply chain organization, organizational development, organizational structure in integrated logistics, organizational choice and organizational scope, alliances and partnerships	
TEXT BOOKS:	
1.	Supply Chain & Logistics Mgmt. – Bowersox, Closs & Cooper (TMGH) 2nd Ed.
2.	Supply Chain Management Strategy Planning & Operations – Chopra, Meindl (Pearson) 1st Ed.
REFERENCE BOOKS:	
1.	Logistics & Supply Chain Management: Martin Christopher.
2.	Supply Chain Management Process, System & Practice –N.Chadrasekaran (Oxford)1st Ed
3.	Purchasing & Supply Chain Management: Dobler and Burt.
4.	Designing & Managing the Supply Chain – Concepts, Strategies &Case studies – Levi, Kaminsky et al (TMGH) 3rd Ed.
WEB RESOURCES:	
1.	http://www.cscmp.org
2.	http://scm.ncsu.edu/

DESIGN THINKING								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 313	ES	2	0	2	40	60	100	3

Prerequisite: NIL

Course Objectives: To familiarize students with design thinking concepts and principles

To ensure students can practice the methods, processes and tools of design thinking.

To ensure students can apply the design thinking approach and have ability to model real

world situations. To enable students to analyse primary and secondary research in the introduction to design thinking

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Explain** the design thinking principles & **Identify** an opportunity and scope of the project and **prepare** the problem statement
CO-2	**Apply** the empathy tools to study the user and **summarize** finding related to problem for define phase.
CO-3	**Describe** and **define** the problem specific to the user group and **apply** Ideation tools to **generate** Ideas to **solve** the problem
CO-4	**Develop** prototypes for test phase.
CO-5	**Test** the ideas and **demonstrate** Storytelling ability to present the Ideas.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1	1						1	2		1
CO-2	1	1	1			1	1		1	2		1

CO-3	1	1	2			1	1		1	2		1
CO-4	1	1	2			1	1		1	2		1
CO-5	1	1	2			1	1		1	2		1

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	1	
CO-3	1	
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 3L+3P=6**

Introduction To Design Thinking

Design Thinking, Need of design thinking, 7 characteristics that define design thinking, comparison of design thinking to other ways of thinking, tools and resources, 5 actions phases of Design thinking, 5 characteristics of action plan. Problem statement. Design principles.

Activities:

a. Case studies of General, engineering and service applications

b. Identify an opportunity and scope of the project and prepare the problem statement.

UNIT - II	**Periods: 5L+5P=10**

Empathize Phases: Design Thinking Tools

Interview for empathy, Explorative interview, Ask 5x why, 5W+H questions, Stakeholder map, Emotional response cards, Empathy map, Persona/User profile, Customer journey map, AEIOU, Analysis questions builder,

Activities:

a. Study the user using empathy tools and summarize finding related to your problem for define phase.

b. Iterate the process at any stage if required

UNIT - III	**Periods: 5L+5P=10**

Define point of view & Ideate Phase: Design Thinking Tools

Define point of view :"How might we…" question, Storytelling, Context mapping, Define success, Vision cone, Critical items diagram

Ideate: Brainstorming, 2x2 Matrix, Dot voting, 6-3-5 Method, Special brainstorming, Analogies & benchmarking as inspiration

Activities:

a. Apply the define tools to your problem: Finalize the problem statement

b. Apply the ideate tools to your problem: Generate lots of Ideas

c. Iterate the process at any stage if required

UNIT - IV	**Periods: 6L+6P=12**

Prototyping Phase: Methods and Tools

Frequently used kinds of prototypes, Focused experiments – Critical Experience Prototype (CEP) & Critical Function Prototype (CFP), Crazy experiments – Dark horse prototype, Combined experiments – Funky prototype, Imagining the future – Vision prototype, Prototype with a first function - functional (system) prototype, Solutions in detail - "X is finished", (Hopefully) at the finish – Final prototype, Exploration map, Prototype to test

Activities:

a. Create prototype for best idea to your problem using any prototype method.

b. Iterate the process at any stage if required

UNIT - V	**Periods: 5L+5P=10**

Test Phase: Methods and Tools & Implementation

Test Phase: Methods and Tools Testing sheet, Feedback capture grid, Powerful questions in experience testing, Solution interview, Structured usability testing, A/B Testing

Implementation: Road map for implementation, Problem to growth & scale innovation funnel

Activities:

a. Test the developed prototype by test phase tools and finalize the solution to the problem.

b. Iterate the process at any stage if required

c. Prepare the complete project report.

TEXT BOOKS:

1.	Daniel Ling "*Complete Design Thinking Guide for Successful Professionals*", Emerge Creatives Group LLP, Print ISBN: 978-981-09-5564-9.
2.	Tim Brown, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, HarperCollins e-books, 2009.
3.	Jeanne Liedtka, Andrew King, And Kevin Bennett, "*Solving Problems with Design Thinking"* , Columbia University Press Publishers, E-ISBN 978-0-231-53605-9
4.	Michael Lewrick, Patrick Link, Larry Leifer, *The Design Thinking Toolbox,* John Wiley & Sons, 2020.

REFERENCE BOOKS:

1.	Michael G. Luchs, Scott Swan, Abbie Griffin , *"Design Thinking: New Product Development Essentials from the PDMA"*, ISBN-13 : 978-1118971802
2.	Beverly Rudkin Ingle, *"Design Thinking for Entrepreneurs and Small Businesses"*, Apress, ISBN: 9781430261827
3.	Jose Betancur *"The Art of Design Thinking: Make More of Your Design Thinking Workshops",* ISBN: 9781522095378

4.	Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook, John Wiley & Sons, 2018
WEB RESOURCES:	
1.	https://dschool.stanford.edu/resources/design-thinking-bootleg
2.	https://www.ideo.com/post/design-thinking-for-educators
3.	https://static1.squarespace.com/static/57c6b79629687fde090a0fdd/t/58890239db29d6cc6c3338f7/1485374014340/METHODCARDS-v3-slim.pdf.
4.	https://www.intel.com/content/dam/www/program/education/us/en/documents/K12/design-and-discovery/student-guide-full-curriculum-session1-18.pdf

Dynamics of machinery								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 314	PC	2	1	0	40	60	100	3

Prerequisite: Mathematics, Engineering Mechanics, Kinematics of machinery

Course Objectives: To make the students understand the gyroscopic effect on vehicles, ships and aircrafts and design governors for specific application. The objective is also to enable students to perform dynamic and vibration analysis and solve balancing problems in practical applications.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Calculate** gyroscopic couple and **analyze** its effect in aeroplane, ship, two and four wheelers and **design** Governors for a specific application.
CO-2	Perform static and dynamic force analysis on slider crank mechanism to **determine** the inertia torque on the crank and **design** flywheel for an IC engine.
CO-3	**Calculate** the magnitude and direction of the balancing mass in rotating and reciprocating systems (shafts & locomotives).
CO-4	**Determine** the frequency & amplitude of free, forced and damped vibrations in longitudinal vibration systems.
CO-5	**Calculate** the natural frequency of free vibrations in transverse and torsional vibration systems.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1	1									
CO-2	2	1	1									
CO-3	2	1										
CO-4	2	1										
CO-5	2	1										

Course Outcomes	PSO1	PSO2
CO-1	2	
CO-2	2	
CO-3	2	
CO-4	2	
CO-5	2	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+3T=9**

Gyroscope & Governors

Gyroscope: Gyroscopic torque, Gyroscopic effect on Aeroplanes, Ships. Stability of four wheeled and two wheeled vehicles.

Governors: Types of governors, Watt, Porter and Proell governors, spring loaded governors – Hartnell. Sensitiveness of a governor, Hunting, Isochronism and Stability. Effort and Power of Governor, Controlling force (Porter and Hartnell governors).

UNIT-II	**Periods: 6L+3T=9**

Engine Force analysis & Turning moment diagram

Static and dynamic force analysis: D'Alembert's principle, Equivalent offset inertia force, Static and Dynamic analysis of slider crank mechanism (Analytical/Graphical method), Engine force analysis, Dynamically equivalent system, inertia of connecting rod.

Turning moment diagrams: Turning moment diagrams for I-C engines, fluctuation of energy, flywheels, and dimensions of flywheel rims.

UNIT - III	**Periods: 6L+3T=9**

Balancing of rotating and reciprocating masses

Balancing of rotating masses: Static and Dynamic Balancing of rotating masses, Balancing of several masses in different planes.

Balancing of reciprocating masses: Primary and secondary unbalanced forces of reciprocating masses, Effects of partial balancing in locomotives- hammer blow, swaying couple, variation of tractive force.

UNIT - IV	**Periods: 6L+3T=9**

Longitudinal Vibrations

Vibrations: Definitions- Types of vibrations- Degrees of freedom.

Longitudinal vibrations: Free longitudinal vibrations of systems having single degree of freedom- Equilibrium method- Energy method and Rayleigh's method, Inertia effect of spring. Damped vibrations, Logarithmic decrement, Forced vibrations with damping- Magnification factor, Vibration isolation and Transmissibility.

UNIT - V	**Periods: 6L+3T=9**

Transverse and Torsional vibrations

Free transverse vibrations of shafts due to single concentrated load, uniformly distributed load and carrying several concentrated loads- Dunkerley's method and Energy method. Whirling of shafts. Free torsional vibrations (single, two rotor and three rotor system), Torsionally equivalent shaft.

TEXT BOOKS:

1. S. S. Rattan, Theory of Machines, 5th edition, McGraw-Hill Publications, New Delhi, 2019
2. R.S.Khurmi & J.K.Gupta, Theory of Machines, 14th edition, S Chand & CO Ltd Publisher,

REFERENCE BOOKS:	
1.	Thomas Bevan, Theory of Machines 3rd edition, CBS publishers & distributors, 2005.
2.	P.L.Ballaney, Theory of Machines and mechanisms, 25th edition, Khanna publishers, New Delhi, 2016.
WEB RESOURCES:	
1.	https://nptel.ac.in/courses/112/101/112101096/
2.	http://nptel.ac.in/courses/112104114/

APPLIED THERMAL ENGINEERING - II								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 315	PC	2	1	0	40	60	100	3

Prerequisite: Engineering Mathematics, Engineering Mechanics, Basic Thermodynamics

Course Objectives: To impart knowledge on the basics of IC engines, gas turbines and compressors-their construction, working features and performance and further generate interest on combustion phenomena in IC engines.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Distinguish** between different classes of IC Engines and further **evaluate** their performance.
CO-2	**Compare & analyze** the air standard, fuel-air and actual cycles.
CO-3	**Describe** the combustion phenomenon in S.I & C.I engines and further **analyse** the effect of engine parameters on it.
CO-4	**Distinguish** various classes of compressors, **evaluate** their performance and **interpret** their characteristics.
CO-5	**Categorize** the gas turbine plants and **analyse** different methods for improving their performance.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2							1	1		1
CO-2	2	2				1	1		1	1		1
CO-3	1	2				1	1		1	1		1
CO-4	2	2							1	1		1
CO-5	2	2							1	1		1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT – I	**Periods: 8L+4T=12**
I.C. engines	
Heat engines, engine components & nomenclature, working principle of engines- four stroke & two stroke engines, S.I & C.I engines, classification, carburetion-simple carburetor, Fuel injection systems-classification, fuel injection pump, Testing & performance-frictional power-Willan's line method, Morse test, retardation test, indicated power, brake power-rope brake and hydraulic dynamometer, indicated & brake mean effective pressures, engine efficiencies, engine performance characteristics, heat balance sheet.	
UNIT – II	**Periods: 6L+3T=9**
Cycles and analysis	
Air standard cycles- Otto, Diesel & Dual cycles-Thermal efficiency, work output and mean effective pressure, comparison of cycles-fuel-air cycles and their significance-composition of cylinder gases-variable specific heats-dissociation, comparison of air standard and fuel-air cycles, actual cycles and their analysis, time loss factor, heat loss factor, exhaust blow down, losses due to gas exchange process.	
UNIT – III	**Periods: 7L+0T=7**
Combustion in IC engines	
Combustion in SI Engines: S.I. engines- Normal combustion and abnormal combustion-Importance of flame speed and effect of engine variables-types of abnormal combustion-pre-ignition and knock, knock limited parameters, effect of engine variables on knock, Combustion chamber requirements and Types of combustion chambers. **Combustion in CI Engines:** Stages of combustion- Delay period and its importance- effect of engine variables, diesel knock-suction, compression and combustion induced turbulence, Direct & Indirect injection combustion chambers. Fuel requirements, fuel rating and anti-knock additives.	
UNIT – IV	**Periods: 8L+3T=11**
Air compressors	
Reciprocating Compressors: Classifications, indicated diagram, equation for work, isothermal efficiency-effect of clearance in compressors, free air delivered, volumetric efficiency, actual p-v diagram, single stage and multi stage compressors, effect of inter cooling in multi stage compressors. **Rotary Compressors:** classification, steady flow compressors, static and stagnation quantities, centrifugal compressor-construction, working principle, velocity diagrams, Euler's work, Isentropic efficiency, slip factor & pressure co-efficient, compressor characteristics, Axial flow compressors–velocity diagrams – degree of reaction, polytropic efficiency, Surging & chocking.	

UNIT – V	**Periods: 7L+2T=9**
Gas Turbines & Jet propulsion	
Gas Turbines: Simple gas turbine plant-closed and open cycle gas turbines, Brayton cycle, Efficiency, work ratio and optimum pressure ratio for simple gas turbine cycle, actual cycle, methods for performance improvement- regeneration, Inter-cooling and reheating. **Jet propulsion:** Turbo-jet engines, thrust, thrust power, efficiencies, Turbo-prop engines, Ramjet and pulse jet engines, Rocket engines.	

TEXT BOOKS:	
1.	V. Ganesan, *Internal Combustion Engines* 4th edition, Tata McGraw Hill Education (P) Ltd, 2012.
2.	R. K. Rajput, *Thermal Engineering* 10th edition, Laxmi publication (P) Ltd, 2018.

REFERENCE BOOKS:	
1.	R. Yadav, *Applied Thermodynamics* 6th revised edition, Central Publishing House, Allahabad, 2011.
2.	M.L. Mathur and R.P. Sharma, *Internal Combustion Engines* Danpat Rai Publications, 2016.
3.	V. Ganesan, *Gas Turbines* 3rd edition, Tata McGraw Hill Education (P) Ltd, 2010.

WEB RESOURCES:	
1.	https://nptel.ac.in/course.html
2.	https://www.slideshare.net/fellowbuddy/internal-combustion-engine-gas-turbines
3.	https://nptel.ac.in/courses/112/103/112103262/

DESIGN OF MACHINE ELEMENTS – I								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 316	PC	2	1	0	40	60	100	3

Prerequisite: Engineering Mathematics, Engineering Mechanics & Strength of materials

Course Objectives: This course introduces the design philosophy at basic level, engineering materials, types of loading and different failure criteria. Further the student will get acquainted with the design of threaded and welded joints and basic machine elements like shafts, keys, couplings, springs etc.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Formulate** a design problem based on design & manufacturing considerations and **identify** appropriate material of construction.
CO-2	**Analyze** the various criteria of failure and design a component based on these criteria against static and fluctuating loads.
CO-3	**Design** threaded and welded joints, subjected to Eccentric & fluctuating loads.
CO-4	**Design** shafts, keys and couplings subjected to static and dynamic loads.
CO-5	**Design** springs subjected to static and dynamic loads.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1	3						1	2		1
CO-2	2	2	3						1	2		1
CO-3	2	2	3						1	2		1
CO-4	2	2	3						1	2		1
CO-5	2	2	3						1	2		1

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	2	
CO-3	2	
CO-4	2	
CO-5	2	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 5L+1T=6**
Introduction to Mechanical engineering design	
Traditional design methods, design process, Problem formulation, Design considerations, manufacturing considerations, engineering materials, Mechanical properties, BIS designation of steels.	
UNIT-II	**Periods: 8L+4T=12**
Design against static loads & Design against fluctuating load:	
Design against static loads : Modes of failure, Factory of safety, Axial, bending and torsional Stresses, Cotter joint, Knuckle joint, Static failure theories. **Design against fluctuating load:** Stress concentration, Methods of reducing stress concentration, Fatigue, Endurance limit, S-N Curve for steels, Soderberg, Goodman and modified Goodman diagrams, Gerber's Theory, cumulative damage in fatigue, Fatigue design under combined stresses.	
UNIT - III	**Periods: 6L+4T=10**
Threaded joints&Welded joints:	
Threaded joints : Forms of threads, ISO metric screw threads, eccentrically loaded bolted joints, Torque requirement for bolt tightening, Fluctuating loads on bolted joints, bolt of uniform strength. Power screws, Force analysis on screw jack, Collar friction **Welded joints:** Types of weld joints, strength of butt and fillet joints, axially loaded unsymmetrical welded joints, eccentrically loaded welded joints, and welded joints subjected to bending moment, welding inspection.	
UNIT - IV	**Periods: 6L+4T=10**
Shafts & keys & Couplings:	
Shafts & keys: Types of shafts, selection of material, shafts design on strength basis & torsional rigidity basis, Design of hollow shafts, ASME codes for shaft design. Types of keys, Design of square and flat key, Kennedy key, Splines **Couplings:** Types of couplings, selection of material, Rigid flange couplings, Flexible couplings, universal coupling.	

UNIT - V	**Periods: 7L+3T=10**
Spring Design:	
Classification of springs, spring materials, style of spring end, Design of helical Compression springs, helical extension springs, torsion springs. Leaf springs, Equalized stress in spring leaves. Surge in springs, nipping and shot peening.	
TEXT BOOKS:	
1.	V.B.Bhandari, Design of Machine Elements3rd edition, , Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2016.
2.	Design data book, PSG College of technology, Coimbatore, 2011
REFERENCE BOOKS:	
1.	R.K. Jain, *Machine Design,* 9th edition, Khanna Publications.
2.	Pandya and Shah, Machine Design, 20th edition,Charotar publishing house Pvt. Ltd. 2015.
3.	R.L.Norton, Machine design, an integrated approach, 2nd edition, Pearson Education 2014.
4.	Joseph Edward Shigley, Mechanical Engineering design, 9th edition, McGraw Hill Company, 2011.
WEB RESOURCES:	
1.	http://www.nptelvideos.in/2012/12/design-of-machine-elements.html
2.	https://www.machinedesignonline.com/
3.	http://nptel.iitg.ernet.in/

THERMAL ENGINEERING LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 318	PC	0	0	3	50	50	100	1.5

Prerequisite: Knowledge of Engineering Chemistry and Applied Thermal Engineering-I & II.

Course Objectives: The laboratory serves the purpose of imparting training on the basics of internal combustion engines, Air compressor, Refrigerator & Air conditioner, their construction, operation and performance assessment.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Experiment with I.C Engines to **evaluate** their performance
CO-2	Experiment with two stage Air compressor and **determine** its efficiencies.
CO-3	**Estimate** actual & theoretical COP's of VCR System and Air conditioning System by experimentation.
CO-4	**Estimate** the Dryness Fraction of wet steam by using Separating and Throttling Calorimeter.
CO-5	**Determine** the properties of Fuels like Flash, Fire points & Calorific value.
CO-6	**Calibrate** a Pressure Gauge and Assess the Variation of Viscosity of a Lubricating oil with temperature by Experimentation.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1		1				1		2		1
CO-2	2	1		1				1		2		1
CO-3	2	1		1				1		2		1
CO-4	2	1		1				1		2		1
CO-5	2	1		1				1		2		1
CO-6	1	1		1				1		2		1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		
CO-6		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

LIST OF EXPERIMENTS (any ten) **Periods: 3practicals/week**

1. Load test on a single cylinder Diesel Engine to evaluate its **Performance**
2. Morse test on Multi-cylinder petrol engine to determine **Frictional power.**
3. Prepare a **Heat balance sheet** of a Diesel Engine by experimentation.
4. Retardation test on a slow speed Diesel engine to obtain **Frictional power**
5. Determination of **Various Efficiencies** of a given 2-stage air compressor.
6. Determination of theoretical, actual and relative **COP's** of a vapour compression refrigeration system.
7. Measurement of **Dryness fraction** of steam using separating and throttling calorimeter.
8. Determination of **Calorific value** of Gaseous fuel by using Junker's Gas Calorimeter.
9. Observation and marking of **Valve timings** of a four stroke Engine and **Port timings** of a two stroke Engine and further draw **VTD & PTD** respectively.
10. Determination of Absolute **& Kinematic viscosities** of a given lubricating oil sample using Redwood Viscometer and study their variation with temperature.
11. Determination of **Flash & Fire points** of Fuel oils.
12. **Calibration** of a Pressure Gauge by using Pressure gauge tester
13. Determination of theoretical, actual and relative **COP's** of an Air conditioning system.
14. Demonstration Experiment on a Computerized Variable compression ratio Diesel Engine to obtain **Crank angle Vs Pressure diagram.**

REFERENCE BOOKS:

1.	R.K.Rajput, Thermal Engineering 10th edition, Laxmi publications (P) Ltd.
2.	V.Ganesan, Internal Combustion Engines, Tata McGraw-Hill Publishing Company Limited.

APPLIED MECHANICS LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 319	PC	0	0	3	50	50	100	1.5

Course Objectives
The laboratory serves the purpose of training students to understand the kinematic and dynamic characteristics of machines and their components.

Course Outcomes	
CO-1	**Plot** displacement, velocity and acceleration of a slider crank mechanism and **determine** the coriolis component of acceleration.
CO-2	**Analyze** the cam follower behaviour for various cam positions.
CO-3	**Evaluate** performance characteristics of various centrifugal governors
CO-4	Observe the gyroscopic effect and **calculate** the gyroscopic couple
CO-5	**Find** the angular position of the balancing mass to balance the given rotating mass system.
CO-6	**Determine** the natural frequency of longitudinal & transverse vibrations and also **calculate** the whirling speed of a rotating shaft

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1		1				1		2		1
CO-2	2	1		1				1		2		1
CO-3	2	1		1				1		2		1
CO-4	2	1		1				1		2		1
CO-5	2	1		1				1		2		1
CO-6	2	1		1				1		2		1

Course Outcomes	PSO1	PSO2
CO-1	2	1
CO-2	2	1
CO-3	2	1
CO-4	2	1
CO-5	2	1

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

Sl. No	NAME OF THE EXPERIMENT	COURSE OUTCOME
1	To plot slider displacement, velocity and acceleration for a slider crank mechanism	CO 1
2	To study the coriolis component of acceleration at various speeds	CO 1
3	To study the cam follower behaviour at different cam positions	CO 2
4	To draw performance characteristic curves and find the stability and sensitivity of Porter and Proell Governor	CO 3
5	To draw performance characteristic curves and find the stability and sensitivity of Hartnell Governor	CO 3
6	To study the Gyroscopic effect and determine the gyroscopic couple on a motorized Gyroscope	CO 4
7	To perform static balancing experiment on the static balancing machine	CO 5
8	To perform Dynamic balancing experiment on the Dynamic balancing machine	CO 5
9	To determine the moment of Inertia of a connecting rod by the compound pendulum method and to study the dynamic equivalent system	CO 5
10	To find the natural frequency of longitudinal and transverse vibrations	CO 6
11	To determine the critical or whirling speed of the rotating shaft	CO 6

Experiments for demonstration

1	To measure Epicyclic gear ratio between input shaft and output shaft.
2	To observe the pressure profile of lubricating oil at different loads in journal bearing.

Reference books	
1.	S. S. Rattan, Theory of Machines, 5th edition, McGraw-Hill Publications, New Delhi, 2019

PRODUCTION PLANNING & CONTROL								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 322(A)	PE	3	0	0	40	60	100	3

Prerequisite: Manufacturing Processes; Metal Cutting, Machine Tools & Metrology.

Course Objectives: To make the students acquaint with the planning and control of production operations.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Apply** the functions of production planning and control in production organizations.
CO-2	**Solve** forecasting problems using the forecasting techniques to manage production operations.
CO-3	Apply inventory models to **plan** and **control** the utilization of various resources.
CO-4	**Determine** the plans for smooth and efficient running of production operations.
CO-5	**Apply** the functions of dispatching and progressing in production operations.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1	1				1				2	
CO-2	2	1	1				1				2	
CO-3	2	1	1				1				2	
CO-4	2	1	1				1				2	
CO-5	2	1	1				1				2	

Course Outcomes	PSO1	PSO2
CO-1	-	-
CO-2	-	-
CO-3	-	-
CO-4	-	-
CO-5	-	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT – I	**Periods: 6L+0T=6**
Introduction to production planning and control (PPC)	
Definition, objectives and functions of PPC; Types of production; Organization of PPC.	
UNIT – II	**Periods: 9L+0T =9**
Forecasting	
Importance of forecasting; Types of forecasting; Forecasting techniques – qualitative and quantitative methods – least square method, moving average method, exponential smoothing method.	
UNIT – III	**Periods: 12L+0T =12**
Inventory management	
Functions of inventory; Inventory costs; ABC analysis; VED analysis; EOQ & EPQ deterministic model without shortages; Inventory control systems – P-system and Q-system; Material Requirement Planning, MRP-II; Aggregate planning strategies; Capacity requirement planning; Enterprise resource planning.	
UNIT – IV	**Periods: 12L+0T =12**
Routing & Scheduling	
Routing: Definition; Routing procedure; Route sheets; Factors affecting routing procedure; Loading. **Scheduling:** Definition; Forward and backward scheduling; Gantt charts; Flow shop scheduling – n jobs and 2 machines, n jobs and 3 machines; Job shop Scheduling – 2 jobs and n machines; Line balancing.	
UNIT - V	**Periods: 6L+0T =6**
Dispatching & Progressing	
Dispatching: Definition; Functions of dispatching; Duties of dispatcher. **Progressing:** Definition; Types of progressing.	
TEXT BOOKS:	
1.	R. Panneerselvam, *Production and Operations Management*, 3rd edition, PHI, 2012.
2.	Martand Telsang, *Industrial Engineering and Production Management*, 3rd edition, S. Chand & Co. Ltd, 2018.
REFERENCE BOOKS:	
1.	S.K. Mukhopadhyay, *Production Planning and Control- Text & Cases*, 3rd edition, PHI, 2015.
WEB RESOURCES:	
1.	https://nptel.ac.in/courses/112/107/112107238
2.	https://nptel.ac.in/courses/110/106/110106045

GAS TURBINES AND JET PROPULSION								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 322(B)	PE	2	1	0	40	60	100	3

Prerequisite: Engineering Thermodynamics – I, III & Fluid Mechanics

Course Objectives: To provide an insight on the principles of compressible fluid flow, gas turbine power cycles and further to create an understanding of the working principles of axial flow compressors, axial flow gas turbines, combustion chambers and jet propulsion systems.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Analyze** compressible fluid flow and its characteristics.
CO-2	**Explain** the working principles of gas turbine power cycles and **evaluate** their performance characteristics.
CO-3	**Describe** the working characteristics of Axial flow compressors, **evaluate** the effect of blade design on the performance and further **analyze** operational disturbances.
CO-4	**Explain** the combustion phenomena in a gas turbine & **identify** the factors affecting combustion chamber design and performance & further **explain** the working principles of Axial flow gas turbines.
CO-5	**Distinguish** the different types of jet propulsion systems, their relative merits, demerits and applications and further **analyze** parameters affecting flight performance.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1										
CO-2	2	1										
CO-3	2	2										
CO-4	1	1					1					
CO-5	1	1										

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		

CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT – I	**Periods: 5L+3T=8**

Introduction to compressible flow

Introduction- Conservation of Mass - Continuity Equation- Conservation of Energy (First Law of Thermodynamics)- Momentum Equation- Sonic Velocity, Mach Number and Mach Waves- Stagnation Temperature, Pressure and Enthalpy- Isentropic Flow Through a Passage of varying cross sectional Area- choking and isentropic flow, operation of nozzle under varying pressure ratio- converging, converging-diverging nozzle.

UNIT-II	**Periods: 5L+3T=8**

Gas Turbine Power Cycles

Introduction- Brayton Cycle- Brayton Cycle with Regeneration- Complex Cycle- Closed Cycle, Performance of actual gas turbine cycle: Efficiency of the compressor and Turbine- Pressure or Flow Losses- Heat Exchanger Effectiveness- Effect of varying mass Flow-Loss due to incomplete combustion- Mechanical Losses- Effect of Variable Specific Heats - Calculation of Fuel consumption and cycle Efficiency- Polytropic Efficiency- Performance of Actual Cycles.

UNIT – III	**Periods: 8L+3T=11**

Axial Flow Compressors

Introduction- Description- Principle of Operation- Performance Analysis- Momentum, Stage Velocity Diagrams, Symmetric Stage, Non-Symmetric Axial -in flow, Non-Symmetric Axial outflow- Actual Energy Transfer- Airofoil Analysis, One Dimensional Ideal Incompressible Flow, Two Dimensional flow With Friction- Blading Efficiency, Losses in terms of Air Angles and Drag Co efficient- Coefficient of Performance, Flow Coefficient (Φ), Pressure Coefficient(ψ**p**),Work Coefficient(Ω)- Blade Loading- Cascade Characteristics-Blade angles- Reynolds and Mach Number Effects- Three Dimensional flow Analysis, Radial Equilibrium Theory, Free Vortex Blades, Constant Reaction Blades, Forced Vortex of Solid Rotation Blades, The General Design -Three Dimensional Blades, Losses- Compressor Stall, Surge and choke- Overall Performance- Compressor Characteristics.

UNIT – IV	**Periods: 7L+4T=11**

Combustion Systems & Axial Flow Gas Turbines

Combustion Systems**:** Introduction- Combustion theory applied to gas turbine combustion, factors affecting combustion chamber design and performance – Pressure loss, Combustion intensity and Efficiency; Requirements of the Combustion chamber- Process of Combustion- Combustion geometry, mixing and dilution, Combustion chamber arrangements.
Axial Flow Gas Turbines: Introduction- Description- Turbine and Nozzle efficiencies- Degree of Reaction, Ideal Impulse Turbine, Impulse Turbine with Loss, Blades Speed Ratio, Velocity Ratio and Torque, Velocity Compound Turbine (Curtis Stage)- The Reaction Turbine- Three Dimensional Flow Analysis, The Free Vortex Blades.

UNIT – V	**Periods: 5L+2T=7**

Jet Propulsions

Introduction-The Ramjet Engine-The Pulse-jet Engine- The Turbo-jet Engine-Thrust Equation-Specific Thrust of the Turbo Jet Engine- Efficiencies- Inlet Diffuser or Ram Efficiency- thermal Efficiency of the TurboJet Engine- Propulsive Efficiency - Overall Efficiency of a Propulsive system-parameters affecting flight performance, Effect of Forward Speed- Effect of Altitude - Overall Turbojet Process- Thrust augmentation- The After burn, Injection of Water-Alcohol
Mixtures- Bleed, Burn Cycles.

TEXT BOOKS:

1.	V. Ganesan, Gas Turbines, 3rd edition, McGraw Hill Education, 2017.
2.	P.R. Khajuria and S.P. Dubey, Gas Turbines and Propulsive Systems, Dhanpat Rai Publiations, 2012.

REFERENCE BOOKS:

1.	Dr. R. Yadav ,Steam and Gas turbine and Power plant Engineering,7th edition, Central Publishing House, 2000.
2.	H.I.H. Sarvanamuttoo,G.F.C. Rogers & H. Cohen, Gas Turbines Theory, 7th edition, Pearson Publications, 2017

WEB RESOURCES:

1.	http://www.nptel.ac.in/courses/112106166/

ADDITIVE MANUFACTURING (AM)								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 322(C)	PE	3	0	0	40	60	100	3

Prerequisite: None

Course Objectives: To acquaint students with the basics of additive manufacturing technology and various techniques of it. They can define their advantages, limitations and applications in various fields of engineering.

Course Outcomes: At the end of this course the student will be able to:	
CO-1	**Explain** additive manufacturing, its working principle, process parameters, and can **identify** AM processes for specific application
CO-2	**Describe** Vat photo polymerization process and can **identify** a specific technique of it for a given application.
CO-3	**Classify** various extrusion based and sheet lamination based additive manufacturing processes and **categorize** these processes for a specific application.
CO-4	**Explain** the concept of powder bed fusion and can **select** particular PBF processes for an engineering application.
CO-5	**Describe** direct energy deposition additive manufacturing processes, their basic principles and can **identify** suitable post-processing for the AM product.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1						1	1	1		1
CO-2	1	1						1	1	1		1
CO-3	1	1			2			1	1	1		1
CO-4	1	1						1	1	1		1
CO-5	1	1						1	1	1		1

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	1	
CO-3	1	2
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT – I	**Periods: 9L**
Introduction to Additive Manufacturing	
Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM.	
UNIT – II	**Periods: 9L**
Vat Photopolymerization Processes	
Stereolithography (SL), Materials, Process Modeling, SL resin curing process, SL scan patterns, Micro-stereolithography, Mask Projection Processes, Two-Photon vat photopolymerization, Process Benefits and Drawbacks, Applications of Vat Photopolymerization, Material Jetting and Binder Jetting AM Processes.	
UNIT – III	**Periods: 10L**
Extrusion-Based and Sheet LaminationProcesses	
Extrusion Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Benefits and Drawbacks, Applications of Extrusion-Based Processes. **Sheet Lamination AM Processes**: Bonding Mechanisms,Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.	
UNIT – IV	**Periods: 10L**
Powder Bed Fusion Processes	
Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process, Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.	
UNIT – V	**Periods: 10L**
Directed Energy Deposition Processes and Post- Processing of AM parts	
Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement and Accuracy Improvement.	
TEXT BOOKS:	

1.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing,Ian Gibson, David W Rosen, Brent Stucker, 2ndEdition (2015), Springer.
2.	Additive Manufacturing,AmitBandyopadhayay, Susmita Bose, 1st edition (2015), CRC Press.
3.	Rapid Prototyping: Laser-based and Other Technologies,Patri K. Venuvinod andWeiyin Ma, 2010,Kluwer academic publishers.
4.	Rapid Prototyping: Principles and Applications in Manufacturing,Rafiq Noorani, 2006, John Wiley & Sons.

REFERENCE BOOKS:	
1.	3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai. 4thEdition (2015), World Scientific publications.
2.	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, 1st edition (2001),Springer publication.
WEB RESOURCES:	
1.	https://blogs.sw.siemens.com/additive/free-am-101-introductory-online-3d-printing-
2.	https://additivemanufacturing.com/basics/

NON-DESTRUCTIVE TESTING								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 322(D)	PE	3	0	0	40	60	100	3

Prerequisite: Physics, Material science and Metallurgy

Course Objectives: To give an insight to the students on the basic principles of various NDT methods, fundamentals, discontinuities in different product forms, importance of NDT, applications, limitations of NDT methods and techniques.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Classify** the different visual inspection methods used in NDT and further **demonstrate** Liquid Penetration Test principle to **identify** surface defects on a given component and **interpret** the test results through applicable international codes and standards
CO-2	**Describe** the fundamentals of theory of magnetism, magnetic materials, magenetic fields, and further **illustrate** the different MPT methods and the equipment used thereof and also **evaluate** the test results of MPT based on applicable codes and standards.
CO-3	**Explain** the principles of radiography, characteristics and generation of X rays and **analyze** the working techniques of X-Ray equipment, X-Ray films, quality indicators etc and further **apply** these principles to **determine** internal defects in test pieces produced by different production processes.
CO-4	Recognize the significance of ultrasonic testing to **identify** internal defects in metals, the fundamental principles embedded in this technique and also d**istinguish** and **apply** the different ultrasonic inspection methods their advantages and limitations and lastly **interpret** the test results of ultrasonic test.
CO-5	**Demonstrate** the basics of acoustic emission techniques and their characteristics and utilize this technique to **investigate** the defects in structural components like pressure vessels, piping system etc.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	2		1		2	1		1	2		1
CO-2	1	2		1		2	1		1	2		1
CO-3	1	2		1		2	1		1	2		1
CO-4	1	2		1		2	1		1	2		1
CO-5	1	2		1		2	1		1	2		1

Course Outcomes	PSO1	PSO2
CO-1	2	1
CO-2	2	1
CO-3	2	1
CO-4	2	1
CO-5	2	1

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT – I **Periods: 9L+0T=9**

Introduction to Non Destructive Test (NDT) Techniques

History, Surface NDT methods, Visual Testing – vision, lightning and material attributes, environmental factors, visual perception, direct and indirect methods, light sources and special lightning, inspection objectives, sampling plan, classification of indications for acceptance criteria – codes, standards and specifications with significance to National industries

Liquid Penetrant Test (LPT): Principles – types and properties of liquid penetrants - application of Liquid penetrants to parts – dye penetrant process - different washable systems – removal of excess penetrants – developers – post cleaning - emulsifiers– special lighting for penetrant testing – calibration– interpretation and evaluation of test results – applicable codes and standards of LPT.

UNIT – II **Periods: 9L+0T=9**

Magnetic Particle Test (MPT)

Theory of magnetism – ferromagnetic, paramagnetic materials, characteristics of magnetic fields, magnetic hysteresis - principle of operation of magnetic particle test, Surface strength characteristics – depth of magnetic field penetration factors – circular and longitudinal magnetization technique - Eddy current inspection, application, advantages and limitations.

Magnetic Particle Testing Equipment: method of magnetization, inspection materials, wet and dry particles, portable, mobile and stationary equipment, calibration, dry continuous method, wet residual method, interpretation and evaluation of test indications – principles and methods of demagnetization– residual magnetism – applicable codes and standards used in national industries

UNIT – III **Periods: 9L+0T=9**

Radiography Test (RT)

Principle of Radiography, Radiation isotopes sources – types and characteristics, X-ray source – generation and properties, industrial X-ray tubes – film characteristic exposure charts, contrast study – quality, intensity, operational characteristics of X-ray equipment - X- ray film – structure and types for industrial radiography - Image Quality - sensitivity – Image Quality Indicators – Intensifying screens – intensification factor, control of scattered radiation, filters, diaphragms, masks. **Radiography Interpretation and Safety Precautions:** Principle of radiation detectors – Ionization chamber, operational limits of exposures – Radiation hazards evaluation and control - Interpretation of radiographs for welds, castings and Inspection standards - applicable codes, standards and specifications for national industries.

UNIT – IV	**Periods: 9L+0T=9**
Ultrasonic Test (UT)	
Fundamentals of Ultrasonic Waves - Nature of sound waves, wave propagation in metals– modes of sound wave generation – longitudinal waves, transverse waves, surface waves, lamb waves – Velocity, frequency and wavelength of ultrasonic waves – Ultrasonic pressure, intensity and impedance – Attenuation of ultrasonic waves – Snell's law and critical angles – ultrasonic beam split – wave propagation in other engineering materials. **Ultrasonic Inspection Methods and Equipment and Safety:** Principle of pulse echo method, through transmission method, resonance method – Advantages, limitations - Data presentation A, B and C scan displays - Ultrasonic testing and evaluation of base material - Ultrasonic test indications, safety and precautions.	
UNIT – V	**Periods: 9L+0T=9**
Acoustic Emission Technique (AET)	
Principles of acoustic emission technique - sources such as melting, twinning, and phase transformations in metals - detection and interpretation of AE signals - importance of signal conditioning, detection, processing. **Acoustic Emission Test systems and applications:** Instrumentation, sensor, amplifier, filter, display, and storage equipment – applications - leak test, detection of active corrosion, detecting creep damage in high energy piping (HEP) systems, pressure vessel inspection, advantages and disadvantages.	
TEXT BOOKS:	
1.	J. B. Hull, Vernon John, *Non Destructive Testing*, Macmillan Education, 1988.
REFERENCE BOOKS:	
1.	J Prasad and C. G. Krishnadas Nair, *Non-Destructive Test and Evaluation of Materials*, 2nd Edition, McGraw Hill Education , 2017.
2.	Barkanov, Evgeny N.; Dumitrescu, Andrei; Parinov, Ivan A*, Non-destructive Testing and Repair of Pipelines*, Springer International Publishing AG, 2017.
WEB RESOURCES:	
1.	www.ndt-ed.org/recoursecenter

REFRIGERATION & AIR-CONDITIONING								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 323 (A)	PE	2	1	0	40	60	100	3

Prerequisite: Engineering Thermodynamics

Course Objectives: To acquaint the student with the working of different conventional and non-conventional refrigeration systems, their applications and performance evaluation techniques and enable them to apply the basics of psychrometry in calculating air conditioning loads for various applications

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Identify** the appropriate refrigeration method for the given application and also **evaluate** the performance of different air cycle systems for air craft refrigeration.
CO-2	**Suggest** suitable techniques to improve the performance of Vapour Compression Refrigeration Systems (VCRS) and **explain** multi pressure systems, flash gas removal and defrosting methods.
CO-3	**Identify** the suitable refrigerant for a given application and **explain** the functioning of evaporators and expansion devices popularly used in VCR system.
CO-4	**Describe** the working of different types of Vapour Absorption Refrigeration Systems (VARS), steam-jet and vortex tube refrigeration methods and further **evaluate** the performance of VARS,
CO-5	**Explain** the concept of comfort air-conditioning and **calculate** air conditioning loads.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	1				1						
CO-2	2	1				1						
CO-3	1	1				2	1					
CO-4	1	1				1						
CO-5	2	1				1						

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+4T = 10**

INTRODUCTION:

Basic principles; Methods of Refrigeration; Joule-Thomson coefficient; liquefaction of gases by Linde's process; Unit of Refrigeration; Applications of Refrigeration.

AIR REFRIGERATION SYSTEM:

Reversed Carnot cycle; Bell-Colemann cycle; Air cycle systems for air craft refrigeration; Boot strap system; Regenerative cycle; Reduced ambient type; Comparison of different systems.

UNIT - II	**Periods: 6L+4T = 10**

VAPOUR COMPRESSION REFRIGERATION SYSTEM:

Wet versus Dry compression; Effect of evaporator and condenser pressures, Liquid sub-cooling, super-heating; Simple vapour compression Refrigeration cycle and its analysis; Actual VCRS; Methods of improving C.O.P; Basics of multi pressure systems; Flash gas removal and Flash inter cooling; Defrosting; Hot gas defrosting.

UNIT - III	**Periods: 7L+1T = 8**

EVAPORATORS, EXPANSION DEVICES & REFRIGERANTS

Evaporators: Classification; working of Once through, flooded, shell and tube, Baudelot cooler type evaporators.

Expansion Devices: Classification; working of Automatic expansion valve, Capillary expansion device and Thermostatic expansion device.

Refrigerants: Classification; Nomenclature; Properties; Selection of refrigerants.

UNIT - IV	**Periods: 7L+2T = 9**

VAPOUR ABSORPTION REFRIGERATION SYSTEMS & NON-CONVENTIONAL REFRIGERATION SYSTEMS:

Vapour absorption refrigeration systems: Simple VARS; Maximum C.O.P. of absorption refrigeration system; Common refrigerant-absorbent systems; Aqua ammonia absorption system; Li-Br absorption refrigeration system; Electrolux refrigeration; Comparison of vapour compression and vapour absorption system.

Non-conventional refrigeration systems: Steam jet refrigeration system and analysis; vortex tube refrigeration system.

UNIT - V	**Periods: 6L+5T = 11**

AIR-CONDITIONING:

Fundamentals of psychrometry; Basic processes in conditioning of air; Sensible heat factor; By pass factor; Air washer: Water injection, Steam injection; Summer and Winter air-conditioning systems; Different types of air-conditioning loads; RSHF; GSHF; Fresh air quantity; Choice of inside design conditions; Cold storage; Industrial air conditioning; Effective temperature; Comfort chart; Human comfort.

TEXT BOOKS:	
1.	A Course in Refrigeration and Air-Conditioning, S.C. Arora and S. Domkundwar, Dhanpat Rai & Co., 2018.
2.	Refrigeration and Air conditioning, C.P. Arora. 3rd Edition, Tata Mc Graw Hill publishers, 2012.
3.	Refrigeration and Air conditioning, P.L. Bellany. 6th Edition, Khanna publishers,1983.
REFERENCE BOOKS:	
1.	Refrigeration and Air conditioning, Jordan R.C. and Priester G.B. 2nd Edition. Prentice-Hall, 1965.
2.	Principles of Refrigeration, Dossat. 5th Edition ,Pearson Education publisher, 2002.
WEB RESOURCES:	
1.	http://www.nptelvideos.in/2012/12/refrigeration-and-airconditioning.html
2.	http://nptel.ac.in/courses/112105129/
3.	https://gmpua.com/CleanRoom/HVAC/Cooling/Handbook%20of%20Air%20Conditioning%20and%20Refrigeration.pdf
4.	https://nptel.ac.in/courses/112/107/112107208/

STATISTICAL QUALITY CONTROL								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 323(B)	PE	3	0	0	40	60	100	3

Prerequisite: Manufacturing Processes; Metal Cutting, Machine Tools & Metrology.

Course Objectives: To acquaint the students with the basic knowledge of statistical quality control**.**

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Apply** the concepts of statistical quality control such as off-line and on-line quality control, quality management philosophies, quality costs, Taguchi's loss function and six sigma concept for quality engineering and management.
CO-2	**Produce** and **analyze** the control charts for variables to evaluate the process performance.
CO-3	**Analyze** and **make** conclusions about the process capability.
CO-4	**Prepare** and **analyze** the control charts for attributes to conclude about the process control.
CO-5	**Design, apply** and **analyze** the sampling plans to judge the quality of the products.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1	1				1				2	
CO-2	2	2	2				1				2	
CO-3	2	2	2				1				2	
CO-4	2	2	2				1				2	
CO-5	2	2	2				1				2	

Course Outcomes	PSO1	PSO2
CO-1	-	-
CO-2	-	-
CO-3	-	-
CO-4	-	-
CO-5	-	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS	
UNIT - I	**Periods: 9L=9**
Introduction to Statistical Quality Control	
Introduction to quality & its definitions; Off-line and on-line quality control; Quality costs; Deming's, Crosby's & Juran's philosophies; Taguchi's loss function; Introduction to six sigma concept.	
UNIT - II	**Periods: 9L=9**
Control Charts for Variables	
Shewhart's normal bowl; Control charts for variables - $\bar{x}$, R and sigma control charts; Theory of runs - ARL and ATS, Type-I and type-II errors.	
UNIT - III	**Periods: 9L=9**
Process Capability Analysis	
Process capability analysis using frequency distribution and control charts; Process capability ratios - Cp and Cpk; Process capability ratios for nominal the better type, smaller the better type and larger the better type product specifications.	
UNIT - IV	**Periods: 9L=9**
Control Charts for Attributes	
Control charts for attributes - p chart, standardized p chart, np chart, c chart, u chart, demerit control chart.	
UNIT - V	**Periods: 9L=9**
Acceptance Sampling Plans	
Acceptance Sampling plans - single, double, multiple and sequential sampling plans; Rectifying inspection - AOQ, AOQL and ATI; Design of single and sequential sampling plans.	
TEXT BOOKS:	
1.	Amitava Mitra, "*Fundamentals of Quality Control and Improvement",* 3rd edition, John Wiley & Sons, 2008.
2.	M. Mahajan, "*Statistical Quality Control",* Dhanpatrai & Co. Pvt. Ltd., 2016 edition.
REFERENCE BOOKS:	
1.	D. C. Montgomery, "*Introduction to Statistical Quality Control*", 6th edition, John Wiley & sons, 2009.
2.	E.L. Grant, "*Introduction to Statistical Quality Control*", 7th edition, Tata Mc-Graw Hill Co. Ltd., 2000.
WEB RESOURCES:	
1.	https://nptel.ac.in/courses/110/105/110105088
2.	https://nptel.ac.in/courses/110/101/110101150

COMPUTATIONAL FLUID DYNAMICS								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 323(C)	PE	3	0	0	40	60	100	3

Prerequisite: Mathematics, Fluid Mechanics and Heat Transfer

Course Objectives: To impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Formulate Governing Equations of fluid dynamics and analyze their mathematical behavior.
CO-2	Apply the Finite Difference and Finite volume methods for solving simple one, two- and three-dimensional diffusion problems.
CO-3	Apply Finite volume method for solving steady one-dimensional convection-diffusion problems.
CO-4	Apply Finite volume method for flow field analysis.
CO-5	Describe the various turbulence models and mesh generation techniques.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2	2									
CO-2	2	2	2									
CO-3	2	2	2		1							
CO-4	2	3	1		1							
CO-5	2	2			1							

Course Outcomes	PSO1	PSO2
CO-1	-	-
CO-2	-	-
CO-3	-	-
CO-4	-	-
CO-5	-	-

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 9L+0T=9**

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations**.**

UNIT - II	**Periods:9L+0T=9**

FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three - dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods**.**

UNIT - III	**Periods: 9L+0T=9**

FINITE VOLUME METHOD FOR CONVECTION AND DIFFUSION

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT - IV	**Periods: 9L+0T=9**

FINITE VOLUME METHOD FOR CONVECTION AND DIFFUSION

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

UNIT - V	**Periods: 9L+0T=9**

TURBULENCE MODELS AND MESH GENERATION

Turbulence models, mixing length model, Two equation (k-Є) models –High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.

TEXT BOOKS:

1.	Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.
2.	Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd.Second Edition – 2007.

REFERENCE BOOKS:	
1.	Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
2.	Chung, T.J., "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3.	Anderson Jr, J.D., "Computational Fluid Dynamics The basics with applications", McGraw Hill Education, 2017.
4.	Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2011.
WEB RESOURCES:	
1.	http://nptel.ac.in/courses/112105045/

NANOTECHNOLOGY								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 323	Elective	3	0	0	40	60	100	3

Prerequisite: Engineering mathematics ,engineeringphysics,engineering chemistry

Course Objectives: To acquaint the student on the basic scientific concepts of nanoscience, properties of nanomaterials, characterization of materials, synthesis, fabrication and also the applications of nanotechnology in various science, engineering and technology fields.

Course Outcomes: The student will be able to:	
CO-1	**Designate** the nano materials based on their properties and crystal lattice.
CO-2	**Analyze** and apply different techniques used in the synthesis and fabrication of nano materials in the form of thin films, nano structures etc.,
CO-3	Comprehend and apply various characterization techniques to **evaluate** the structure of nanoparticles.
CO-4	**Characterize** carbon allotropes, **analyze** their morphology and **illustrate** the applications of carbon nano technology.
CO-5	**Demonstrate** the applications of nanotechnology in various steams of engineering, environment and sciences.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	1				1	1		1	2		1
CO-2	1	1				1	1		1	2		1
CO-3	1	1				1	1		1	2		1
CO-4	1	1				1	1		1	2		1
CO-5	1					1	1		1	2		1

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	1	
CO-3	1	
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 9L**
UNIT TITLE: INTRODUCTION	
History of nano science, definition of nanometer, nano materials, nanotechnology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes, Band structure. PROPERTIES OF MATERIALS: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nanomaterials	
UNIT-II	**Periods: 9L**
UNIT TITLE: SYNTHESIS AND FABRICATION	
Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of nano particle - Bottom Up Approach - sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach - Ball milling, micro fabrication, lithography. Requirements for realizing semiconductor nano structures, growth techniques for nanostructures	
UNIT - III	**Periods: 9L**
UNIT TITLE: CHARACTERIZATION TECHNIQUES	
X-Ray diffraction and Scherer method, scanning electron microscopy, transmission electronmicroscopy,scanning probe microscopy,atomicforcemicroscopy, Ramanspectroscopy	
UNIT - IV	**Periods: 9L**
UNIT TITLE: CARBON NANOTECHNOLOGY	
Characterization of carbon allotropes, synthesis of diamond - nucleation of diamond, growth and morphology. Applications of nano crystalline diamond films, graphene, applications of carbon nano tubes	
UNIT - V	**Periods: 9L**
UNIT TITLE: APPLICATIONS OF NANOTECHNOLOGY	
Applications in material science, biology and medicine, surface science, energy and environment. Applications of nanostructured thin fins, applications of quantum dots.	

TEXT BOOKS:

1.	Nanoscience and nanotechnology by M.SRamachandra Rao, ShubraSingh, Wiley publishers,Year: 2013
2.	Introduction to Nanoscience and Nanotechnology by K.K.A.N.Banerjee Chattopadhyay,A.N.Banerjee,Year:Feb23,2007.
3.	Introduction To Nanoelectronics: Science, Nanotechnology, Engineering, And Applications VladimirV.Mitin,ViatcheslavA.Kochelap,MichaelA.Stroscio,Year:2010.

REFERENCE BOOKS:	
1.	Introduction to NanoTechnology by Charles P.Poole, Jr.,Frank J.Owens, Wileypublishers, Apr 16,2004
2.	NanotechnologybyJermyJRamsden,Elsevierpublishers,Sep19,2012
3.	NanoMaterials-A.K.Bandyopadhyay/NewAgeInternationalPublishers,Year:2007.
4.	NanoEssentials-T.Pradeep/TMH,Jan20,2007.
5.	Nanotechnology the Science of Small by M.AShah,K.AShah, WileyPublishers,Year:2013.
6.	PrinciplesofNanotechnologybyPhaniKumar,Scitech,Year:2010.
WEB RESOURCES:	
1.	http://www.nptel.ac.in
2.	http://www.freevideolectures.com

OPERATIONS RESEARCH								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 324	PC	2	1	0	40	60	100	3

Prerequisite: Mathematics

Course Objectives: The course is intended to identify and develop operational research models, understand the mathematical tools to solve optimization problems, and develop a report that describes the model, the solving techniques and analyses the results.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Formulate** a linear programming & an assignment problem and **choose** an appropriate method for obtaining an optimal solution.
CO-2	**Assess** the minimum cost of transportation through transportation models and **obtain** the optimum solution by using various methods.
CO-3	**Apply** the concepts of PERT/CPM for decision making and **compute** the scheduled time of completion of a project.
CO-4	**Apply** various replacement models and sequencing models to **compute** optimum replacement period and optimum Job sequencing respectively.
CO-5	**Classify** the inventory models and **apply** them in inventory management and further use Queuing models to **estimate** the average waiting time.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1		1					
CO2	1	2	2	1			1				2	
CO3	1	2	1				1				1	
CO4	1	1	1				1				2	
CO5	1	1	1				1				2	

Course Outcomes	PSO1	PSO2
CO-1	2	1
CO-2	2	1
CO-3	2	
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+2T=8**

LINEAR PROGRAMMING MODEL

Introduction to Operations Research – Linear Programming - Mathematical Formulation – Graphical method – Simplex method – Two – Phase Simplex method ,Big-M method-Duality Simplex method. Introduction to Advanced optimization techniques

UNIT - II	**Periods: 6L+2T=8**

TRANSPORTATION AND ASSIGNMENT MODELS:

Transportation model – Initial solution by North West corner method – least cost method – VAM. Optimality test – MODI method and stepping stone method, Assignment model – formulation – balanced and unbalanced assignment problems.

UNIT - III	**Periods: 6L+2T=8**

PROJECT MANAGEMENT BY PERT & CPM:

Basic terminologies – Constructing a project network – Scheduling computations – PERT – CPM.

UNIT - IV	**Periods: 6L+2T=8**

REPLACEMENT AND SEQUENCING MODELS:

Replacement policies - Replacement of items that deteriorate with time (value of money not changing with time) – Replacement of items that deteriorate with time (Value of money changing with time) – Replacement of items that fail suddenly (individual and group replacement policies), Sequencing models- n job on 2 machines – n jobs on 3 machines – n jobs on m machines, Traveling salesman problem.

UNIT - V	**Periods: 6L+2T=8**

INVENTORY MANAGEMENT AND QUEUING THEORY

Variables in inventory problems, EOQ, deterministic inventory models, order quantity with price break, techniques in inventory management, Queuing system and its structure – Kendall‟s notation – Common queuing models - M/M/1: FCFS/∞/∞ - M/M/1: FCFS/n/∞ - M/M/C: FCFS/∞/∞ - M/M/1: FCFS/n/m

TEXT BOOKS:

1. S.D.Shrama, Operation Research, Kedar Nath Ram Nath Publishers, 2015.
2. Handy A. Taha, Operations Research An introduction, 10th edition, 2017.

REFERENCE BOOKS:

1. Hira D S and Gupta P K, Operations Research, S.Chand & Sons, 2007.
2. Panneerselvan. R., Operation Research, Prentice Hall of India Pvt Ltd. 2006.
3. Kanti Swarup, Gupta P.K., and Manmohan, Operations Research, S.Chand & sons, 2004.

WEB RESOURCES:	
1.	https://orc.mit.edu/
2.	www.orsi.in/
3.	https://www.journals.elsevier.com/european-journal-of-operational-research/

FLUID MECHANICS & HYDRAULIC MACHINERY								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 325	PC	2	1	0	40	60	100	3

Prerequisite: Engineering Mathematics-I, Engineering Mechanics

Course Objective: To acquaint the student with the fundamental & advanced principles of fluid mechanics and their application to any practical problem involving fluids to find a solution and to evaluate the forces exerted by a jet of fluid on vanes of different shapes and further apply this knowledge in the study of hydraulic machinery like turbines, pumps etc.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Calculate** the fluid properties and pressure measurement in fluid flow problems and also **determine** the hydro static forces acting on submerged surfaces of different geometry.
CO-2	**Identify** the type of fluid flow using the fundamentals of fluid kinematics and also **determine** the discharge and reaction forces in closed conduit flow.
CO-3	**Identify** the parameters causing the loss of energy and **calculate** various losses in fluid flow applications.**Determine** the force and work done by the water jet when it strikes vanes of different shapes.
CO-4	**Analyze** the performance of hydraulic turbines.
CO-5	**Evaluate** the performance of reciprocating and centrifugal pumps.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2										
CO-2	2	2										
CO-3	2	2										
CO-4	2	2				1	1					
CO-5	2	2				1						

Course Outcomes	PSO1	PSO2
CO-1	1	
CO-2	1	
CO-3	1	
CO-4	1	
CO-5	1	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT – I	**Periods: 6L+3T=9**
FLUID STATICS:	
Properties of fluids - Fluid Pressure and its measurement - Manometers, Simple manometers, Differential manometers. Hydrostatic forces on surfaces-Total Pressure and Centre of pressure - Horizontal, Vertical, Inclined and Curved plane surfaces submerged in liquid.	
UNIT – II	**Periods: 6L+3T=9**
FLUID KINEMATICS & DYNAMICS:	
Types of fluid flows - velocity and acceleration - continuity equation - velocity potential and Stream Function - Flow net. Forces acting on fluid in motion - Equation of Motion - Euler's equation - Bernoulli's equation and its applications - Venturimeter, Orifice Meter. Momentum Equation - Impulse-Momentum equation - Forces on pipe bend	
UNIT – III	**Periods: 6L+3T=9**
FLOW THROUGH PIPES & IMPACT OF JETS :	
Reynolds Experiment - Laws of fluid friction - Darcy weisbach equation, Major Losses and Minor losses - Hydraulic gradient line, Total energy line, Pipes in series and Pipes in parallel, Equivalent pipe, Siphon. Impact of jet on stationary surfaces, Impact of jet on moving vanes, Impact of jet on series of vanes-Tangential and Radial flow.	
UNIT – IV	**Periods: 6L+3T=9**
HYDRAULIC TURBINES AND ITS PERFORMANCE:	
General layout of hydro power plant, heads and efficiencies of turbines, classification of turbines. **Impulse turbine**: Pelton turbine-components, work and efficiencies. **Reaction turbine**: Francis turbine-constructional features, work and efficiencies, draft tube theory, Axial flow turbine- Kaplan turbine-constructional features, work and efficiencies. Unit quantities, Specific speed of turbines, performance characteristic curves-constant head, constant speed and constant efficiency curves, model testing of turbines, Cavitation in turbines.	
UNIT – V	**Periods: 6L+3T=9**
PUMPS:	
General: Classification of pumps-positive displacement and non-positive displacement. **Reciprocating Pumps**: Main parts, Classification, work done by pumps, coefficient of discharge, slip, negative slip, Indicator diagram, acceleration head and its effects in suction and delivery pipes, effect of friction, air vessels-construction, working, functions and effect of air vessels on discharge, pressure head, work, indicator diagram, maximum speed and work saved against friction. **Centrifugal Pumps**: Components and working principle, priming of centrifugal pumps, Work done by impeller, head, losses and efficiencies, minimum starting speed, specific speed, multi stage pumps, NPSH, cavitation.	

TEXT BOOKS:	
1.	Hydraulics and Fluid Mechanics by P.N. Modi &S.M. Seth, 18th ed. 1998, Standard Book House
2.	Fluid Mechanics and Fluid Power Engineering by Dr. D.S. Kumar, S.K. Kataria&Sons.
3.	Jagadish Lal ,Hydrualic Machines, 6th edition, Metropolitan Book Co., New Delhi
REFERENCE BOOKS:	
1.	Dr.R.K.Bansal ,Fluid Mechanics and Hydraulic machinery 9th edition Laxmi publications 2017.
2.	Fluid Mechanics by V.L. Streeter & E.B. Wylie, 1st SI metric ed. 1981, McGraw Hill
3.	T.R Banga & S.C. Sharma Hydraulic machines, Khanna publishers
4.	Fluid Mechanics by YunusCengel and Cimbala.
WEB RESOURCES:	
1.	http://www.science-animations.com/fluidmechanics.html
2.	https://iitbmechdamp.wordpress.com/me-203-fluid-mechanics/
3.	http://nptel.ac.in/courses/112105171/1
4.	http://nptel.ac.in/courses/112104117/26
5.	http://nptel.ac.in/courses/112104117/33

Design of Machine Elements-II								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 326	PC	2	1	0	40	60	100	3

Prerequisite: Engineering Mathematics, Engineering Mechanics, Mechanics of solids

Course Objectives: The main intent of this course is to enhance creativity in designing of components, analyzing induced stresses in a component based on the type of failure. This is achieved through appropriate material selection and design analysis of components like gears, brakes, clutches, crank shaft, connecting rod etc.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Design** various types of gears based on static and dynamic Loads.
CO-2	**Design various** IC engine components (connecting rod, crankshaft, cylinder & Piston) subjected to combined loads and design frictional clutches based on uniform pressure and uniform wear theories.
CO-3	**Design** various types of brakes, crane hooks & wire ropes.
CO-4	**Design** and **analyze** the life of bearings subjected to static and dynamic loads.
CO-5	**Design** belt and chain drives for power transmission.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2	3									
CO-2	2	2	3									
CO-3	2	2	3									
CO-4	2	2	3									
CO-5	2	2	3									

Course Outcomes	PSO1	PSO2
CO-1	2	
CO-2	2	
CO-3	2	
CO-4	2	
CO-5	2	

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome;Level- 1: Low, 2: Medium, 3: High

SYLLABUS

UNIT - I	**Periods: 6L+3T=9**
Gears	
Classification of gears, terminology of gears, standard tooth systems. Force analysis, beam strength, wear strength and effective load of spur, helical, bevel gears. Force analysis and efficiency of worm gears.	
UNIT-II	**Periods: 6L+3T=9**
IC Engine parts and Friction clutches	
Classification of I.C. engines, design of cylinder, piston, connecting rod and crank shaft. Types of clutches, torque transmission capacity of single, multi, cone and centrifugal clutches.	
UNIT - III	**Periods: 6L+3T=9**
Brakes, Crane hook and wire Ropes	
Types of brakes, energy equations, band and block brakes, internal expanding shoe brakes and disc brakes. Design of crane hooks with trapezoidal cross-section, wire rope construction and classification, stresses in wire ropes, design for service of lifts and winches.	
UNIT - IV	**Periods: 6L+3T=9**
Bearings	
Rolling contact bearings: Types of rolling contact bearings, static and dynamic load carrying capacity, equivalent bearing load, load-life relationship, load factor, selection of bearings from manufacturers catalogue. Sliding contact bearings: Basic modes of lubrication, temperature effect on viscosity, hydro static and hydro dynamic bearing design, bearing characteristic number, McKee equations, Reynolds's equation, Raimond and Boyd method.	
UNIT - V	**Periods: 6L+3T=9**
Belt and chain drives	
Belt drives: - Types of belt drives, geometrical relations, analysis of belt tensions, condition for maximum power, design of flat belt drives. Chain drives: Classification, nomenclature, polygonal effect, power transmission of chain drive, length of chain drive.	

TEXT BOOKS:	
1.	1. V.B.Bhandari, *Design of Machine Elements* 4th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2016.
2.	*Design data book* , PSG College of technology, Coimbatore, 2011. **Note:** Design data book is allowed in examinations.
REFERENCE BOOKS:	
1.	R.K. Jain, *Machine Design,* 9th edition, Khanna Publications.
2.	Joseph Edward Shigley, *Mechanical Engineering design*, 8th Edition, McGraw Hill Company, 2011.
3.	R.L.Norton, *Machine design, an integrated approach,* 2nd edition, Pearson Education, 2014.
WEB RESOURCES:	
1.	https://nptel.ac.in/courses/112/106/112106137/
2.	http://www.mrrtechnical.co.in/#dme2

FLUID MECHANICS & HYDRAULIC MACHINERY LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 328	PC	0	0	3	50	50	100	1.5

Prerequisite: Knowledge of Engineering Mathematics-I &II and Fluid mechanics and Hydraulic Machines.

Course Objectives:

- To provide practical knowledge in verification of principles of fluid flow.
- To impart knowledge in measuring pressure, discharge and velocity of fluid flow.
- To understand Major and Minor Losses.
- To gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	Carry out an experiment to verify Bernoulli's theorem.
CO-2	Demonstrate the calibration of various flow measuring devices.
CO-3	Calculate the Frictional losses in internal flows through experimentation.
CO-4	Determine the co-efficient of impact of jet of water on a fixed flat/curved plate.
CO-5	Carry out an experiment to study performance curves of various hydraulic pumps and turbines at different operating condition.

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2		2				2		2		1
CO-2	2	2		2				2		2		1
CO-3	2	2		2				2		2		1
CO-4	2	2		2				2		2		1
CO-5	2	2		2				2		2		1

Course Outcomes	PSO1	PSO2
CO-1		
CO-2		
CO-3		
CO-4		
CO-5		

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

SYLLABUS

LIST OF EXPERIMENTS(any nine) **Periods: 3practicals/week**

1. Verification of Bernoulli's theorem
2. Determination of coefficient of discharge of
   a. Rectangular notch (or)
   b. Triangular notch
3. Determination of coefficient of discharge of
   a. Orifice (or)
   b. Mouthpiece
4. Calibration of flow meters
   a. Venturimeter and
   b. Orificemeter.
5. To demonstrate and study different flow regimes using Reynold's experimental setup.
6. To determine the head losses for flow through pipes and further obtain friction factor.
7. Impact of jet on a
   a. Flat vane (or)
   b. Curved vane
8. To draw the performance characteristic curves for
   a. Pelton turbine and
   b. Francis turbine
9. To draw the performance characteristic curves for Centrifugal pump.
10. To draw the performance characteristic curves for reciprocating pump.

TEXT BOOKS:

1.	Fluid mechanics& hydraulic Machines by R.K. Bansal, Lakhsmi publication.
2.	Fluid mechanics& hydraulic Machines. (in S.I. units), R.S.Khurmi, S.chand & Co.Ltd.

REFERENCE BOOKS:

1.	Fundamentals of fluid mechanics(in SI units), Dr. D.S. Kumar, ketson pub. house
2.	Ch. Ratnam & K. Arun vikram, *Fluid Mechanics and Machinery,* 2nd revised edition, I K International Publishing House Pvt. Ltd. 2011.

WEB RESOURCES:

1.	https://fm-nitk.vlabs.ac.in/
2.	https://www.iitk.ac.in/me/fluid-mechanics-laboratory

METROLOGY & MECHATRONICS- LAB								
Code	Category	Periods			Sessional Marks	End Exam Marks	Total Marks	Credits
		L	T	P				
MEC 329	PC	0	0	3	50	50	100	1.5

Prerequisite: Kinematics of Machinery

Course Objectives:

To acquaint the students with calibrating measuring instruments and also to measure different parameters like angle, distance, flatness, gear tooth parameters and roundness & concentricity of spigot. Further the objective is also to introduce PLC and familiarize them with ladder programming for applications like traffic light & belt conveyor.

Course Outcomes: At the end of the course the student will be able to:	
CO-1	**Calibrate** measuring instruments (Vernier caliper, Screw gauge , Dial gauge & Vernier height gauge).
CO-2	**Measure** the included angle between two adjacent sides of a given specimen by using a Universal Bevel protractor and also taper angle of a tapered bar by using a Sine bar.
CO-3	**Determine** the included angle of a V-block and Gear tooth parameters of a given spur gear by experimentation.
CO-4	**Check** the concentricity and roundness of the given spigot by using a dial gauge, **check** the flatness of the given surface using Autocollimator and also **determine** the central distance between two holes in a template using Vernier height gauge.
CO-5	**List and Explain** the working of components in a PLC and sensor kit & **develop** a ladder logic programme in PLC for various practical applications (Traffic signal & Belt Conveyer).

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	1	2		3				1		2		1
CO-2	1	2		3				1		2		1
CO-3	2	2		3				1		2		1
CO-4	1	2		3				1		2		1
CO-5	2	2	2		2	2		1		2		1

Course Outcomes	PSO1	PSO2
CO-1	1	3
CO-2	1	3
CO-3	2	3
CO-4	1	3
CO-5	2	2

CO- Course Outcome; PO- Program Outcome; PSO-Program Specific Outcome; Level- 1: Low, 2: Medium, 3: High

LIST OF EXPERIMENTS		
S.NO	**NAME OF THE EXPERIMENT**	COURSE OUTCOME
1	Calibrate the given Vernier caliper and determine the thickness of the given work piece.	CO1
2	Calibrate the given micrometer and determine the thickness of the given work piece.	CO1
3	Calibrate the given Dialguage and determine the thickness of the given work piece.	CO1
4	Calibrate the given Vernier height gauge and determine the thickness of the given work piece.	CO1
5	Measure the included angle between two adjacent sides of a given specimen by using a Universal Bevel protractor.	CO2
6	Determine the taper angle of a tapered bar by using a Sine-bar.	CO2
7	Measure the included angle of a V-block.	CO3
8	Measure the Gear tooth parameters of a spur gear.	CO3
9	Check the flatness of the given surface plate by using an auto-collimator.	CO4
10	Measure the central distance between two holes of a template by using a Vernier height gauge.	CO4
11	Check the roundness and concentricity of a spigot using a Dial gauge.	CO4
12	Training on PLC based Sensor kit.	CO5
13	Training on PLC based control of Traffic lights.	CO5
14	Training on PLC based Material handling system (Belt-Conveyor).	CO5