K.L.N. COLLEGE OF ENGINEERING

Pottapalayam – 630 612, Sivagangai District

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Estd: 1994

THIRD YEAR CURRICULUM AND SYLLABUS

REGULATIONS 2020

For Under Graduate Program

B.E. – MECHANICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

(For the students admitted from the academic year 2020-2021 onwards)

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)

VISION OF THE INSTITUTION

To become a Centre of Excellence in Technical Education and Research in producing Competent and Ethical professionals to the society.

MISSION OF THE INSTITUTION

To impart Value and Need based curriculum to the students with enriched skill development in the field of Engineering, Technology, Management and Entrepreneurship and to nurture their character with social concern and to pursue their career in the areas of Research and Industry**.**

VISION OF THE DEPARTMENT

To become a Centre of excellence for Education and Research in Mechanical Engineering.

MISSION OF THE DEPARTMENT

- Attaining academic excellence through effective teaching learning process and state of the art infrastructure.
- Providing research culture through academic and applied research.
- Inculcating social consciousness and ethical values through co-curricular and extra-curricular activities.

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1 Graduates will have successful career in Mechanical Engineering and service industries.

PEO 2 Graduates will contribute towards technological development through academic research and industrial practices.

PEO 3 Graduates will practice their profession with good communication, leadership, ethics and social responsibility.

PEO 4 Graduates will adapt to evolving technologies through lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1 Derive technical knowledge and skills in the design, develop, analyze and manufacture of mechanical systems with sustainable energy, by the use of modern tools and techniques and applying research based knowledge.

PSO 2 Acquire technical competency to face continuous technological changes in the field of mechanical engineering and provide creative, innovative and sustainable solutions to complex engineering problems.

PSO 3 Attain academic and professional skills for successful career and to serve the society needs in local and global environment.

PO1: Engineering knowledge

Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis

Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions

Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems

Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society

Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability

Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work

Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance

Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM
(An Autonomous Institution, Affiliated to Anna University, Chennai)

REGULATIONS 2020

For Under Graduate Program

B.E. – MECHAINCAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

CATEGORY OF COURSES

i. **Humanities and Social Sciences (HS) Courses** include Technical English, Environmental Science and Engineering, Engineering Ethics and human values, Communication Skills and Management courses.

ii. **Basic Sciences (BS**) **Courses** include Mathematics, Physics, and Chemistry.

iii. **Engineering Sciences (ES) Courses** include Engineering practices, Engineering Graphics, Basics of Electrical / Electronics / Mechanical / Computer Engineering / Instrumentation etc.

iv. **Professional Core (PC) Courses** include the core courses relevant to the chosen programme of study.

v. **Professional Elective (PE) Courses** include the elective courses relevant to the chosen programme of study.

vi. **Open Elective (OE) Courses** include courses from other branches which a student can choose from the list specified in the curriculum of the students B.E. / B.Tech. Programmes.

vii. **Employability Enhancement Courses (EEC)** include Project Work and/or Internship, Seminar, Professional Practices, Case Study and Industrial / Practical Training.

viii. **Mandatory Courses (MC)** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc

K.L.N. COLLEGE OF ENGINEERING, POTTAPALAYAM – 630 612

(An Autonomous Institution, Affiliated to Anna University, Chennai)

B.E. MECHANICAL ENGINEERING

REGULATIONS – 2020

CHOICE BASED CREDIT SYSTEM

SEMESTER V

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	20ME501	Design of Machine Elements	PC	3	3	1	0	4
2	20ME502	Dynamics of Machines	PC	3	3	0	0	3
3	20ME503	CAD / CAM	PC	3	3	0	0	3
4	20ME504	Heat and Mass Transfer	PC	3	3	0	0	3
5	----------	Open Elective - I **	OE	3	3	0	0	3
6	20ME505	Machine Drawing	PC	5	1	0	4	3
7	20MC501	Constitution of India	MC	1	1	0	0	0
PRACTICAL								
8	20ME5L1	Dynamics Laboratory	PC	3	0	0	3	1.5
9	20ME5L2	CAD / CAM Laboratory	PC	4	0	0	4	2
10	20ME5L3	Heat and Mass Transfer Laboratory	PC	3	0	0	3	1.5
TOTAL				**31**	**17**	**1**	**14**	**24**

SEMESTER VI

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	20ME601	Design of Transmission Systems	PC	3	3	0	0	3
2	20ME602	Finite Element Analysis	PC	3	3	0	0	3
3	20ME603	Lean Manufacturing	PC	3	3	0	0	3
4	20ME604	Compressible flow and Turbo machinery	PC	3	3	0	0	3
5	20HS601	Operations Research	HS	3	3	0	0	3
6	20MC601	Essence of Indian Traditional Knowledge	MC	1	1	0	0	0
7	----------	Professional Elective - I	PE	3	3	0	0	3
PRACTICAL								
8	20ME6L1	Computer Aided Simulation and Analysis Laboratory	PC	3	0	0	3	1.5
9	20ME6L2	Design and Fabrication Project	EEC	3	0	0	3	1.5
TOTAL				**24**	**18**	**0**	**6**	**21**

PROFESSIONAL ELECTIVES (PE)

SEMESTER VI ELECTIVE I

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20ME6A1	Piping Design Engineering	PE	3	3	0	0	3
2	20ME6A2	Product Design and Development	PE	3	3	0	0	3
3	20ME6A3	Digital Manufacturing	PE	3	3	0	0	3
4	20ME6A4	Fundamentals of HVAC Systems	PE	3	3	0	0	3
5	20ME6A5	Renewable energy sources	PE	3	3	0	0	3
6	20ME6A6	Applied Hydraulics and Pneumatics	PE	3	3	0	0	3
7	20ME6A7	Statistical Quality Control	PE	3	3	0	0	3

OPEN ELECTIVE I (OE)

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	20OE201	Fundamentals of Renewable Energy system	OE	3	3	0	0	3
2	20OE302	Microprocessor and Embedded systems	OE	3	3	0	0	3
3	20OE401	Fundamentals of Artificial Intelligence	OE	3	3	0	0	3
4	20OE402	Introduction to Database Management Systems	OE	3	3	0	0	3
5	20OE501	Principles of Software Testing	OE	3	3	0	0	3
6	20OE502	Fundamentals of Web Technology	OE	3	3	0	0	3
7	20OE503	Internet of Things and Applications	OE	3	3	0	0	3
8	20OE601	Fundamentals of Electric Vehicles	OE	3	3	0	0	3
9	20OE701	Biomedical instrumentation and Measurements	OE	3	3	0	0	3
10	20OE704	Instrumentation in steel industry	OE	3	3	0	0	3

OPEN ELECTIVE – I (V SEMESTER) offered to other Department

Sl. No.	COURSE CODE	COURSE TITLE	Category	Contact Periods	L	T	P	C
THEORY								
1	20OE101	Mechatronics and Applications	OE	3	3	0	0	3
2	20OE102	Solid free form Manufacturing	OE	3	3	0	0	3
3	20OE103	Refrigeration and Air Conditioning	OE	3	3	0	0	3
4	20OE104	Production and Operations Management	OE	3	3	0	0	3

20ME501 DESIGN OF MACHINE ELEMENTS

L	T	P	C
3	1	0	4

(Use of PSG Design data book is permitted)

OBJECTIVES

- To understand the procedure for choosing standard data.
- To understand the selection of suitable material properties for the requirement.
- To know about the theories of failure.
- To know about the design procedure for shaft, couplings, joints and springs.
- To understand the theory of lubrication and the design procedure for bearings.

PREREQUISITE:

Course Code: 20BS202, 20GE202, 20ME301

Course Name: Applied Physics, Engineering Mechanics, Strength of materials

UNIT - I INTRODUCTION 15

Basic requirements of machine elements, Use of standards in design, Aesthetic and ergonomic considerations in Design, Selection of Materials, Determination of Loads, Deflection in simple machine parts, Theories of Failure, Factor of safety, Design against Static Load, , Design against Fluctuating loads, Fatigue failure theories.

UNIT – II DESIGN OF SHAFTS AND COUPLINGS 11

Shaft materials, Design of solid and hollow shafts on strength and torsional rigidity basis, Types of keys, Design of square, flat and Kennedy keys, Design of splines, Design of Couplings - Rigid and flexible couplings.

UNIT – III DESIGN OF SPRINGS AND POWER SCREWS 11

Springs: Types of springs, Terminology of helical spring, Styles at end, series and parallel connection,-exponential relationship Spring material, Design of helical, concentric, multi leaf Springs against variable loading, Surge in springs.

Power screws: Forms of threads, Terminology, Torque requirement, self-locking, Design of power screw.

UNIT – IV DESIGN OF JOINTS 11

Threaded joints, Screw threads –Terminology, ISO metric, Bolted joint – Simple analysis and eccentrically loaded.

Welded joints - Butt, parallel fillet and transverse fillet welds - Welded joints subjected to axial and eccentric load, bending and torsional moment.

Types of rivet heads, rivet materials, Types of failure, Longitudinal butt joint, circumferential lap joint, eccentrically loaded riveted joint for boiler shells.

Joint failure and evaluation, Fail - safe design

UNIT - V DESIGN OF BEARINGS 12

Rolling contact bearings – types, selection, static and dynamic load carrying capacity, Design for cyclic loads and speeds, Reliability of bearings, bearing failure – causes and remedies.

Sliding contact bearing – basic modes of lubrication, Petroff's equation, Mckee's investigation, Bearing design – selection of parameters, bearing construction, bearing materials, Lubricating oils, selection of lubricants, bearing failure – causes and remedies.

Comparison of rolling and sliding contact bearings.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Bhandari V B, "Design of Machine Elements", Tata McGraw-Hill Book Co, 5th Edition, 2020.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 11th Edition, Tata McGraw-Hill, 2020.
3. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", Global Edition, Wiley, 2018.

REFERENCES:

1. Sundararajamoorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2018.
2. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-HillBookCo.(Schaum’s Outline), 2010
3. Bernard Hamrock, Steven Schmid,Bo Jacobson, “Fundamentals of Machine Elements”, Tata McGraw-Hill Book Co., 3rd Edition, 2013.
4. AnselUgural, “Mechanical Design – An Integral Approach", Tata McGraw-Hill Book Co, 1stEdition, 2003.
5. Ganesh Babu, Sridhar, “Machine Design” Tata McGraw-Hill Education, 2nd Edition 2010.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DESIGN OF MACHINE ELEMENTS													**Course Code : 20ME501**		
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**				**PSOs**
C301.1	Design the given machine component for static and fluctuating loads.								I	K3	1,2,3,4,10,12				1,2,3
C301.2	Design a shaft/ coupling for a given application.								II	K3	1,2,3,4,10,12				1,2,3
C301.3	Design a suitable spring under various loading conditions.								III	K3	1,2,3,4,10,12				1,2,3
C301.4	Design a suitable joint for the given application.								IV	K3	1,2,3,4,10,12				1,2,3
C301.5	Design suitable sliding contact bearing for the given application.								V	K3	1,2,3,4,10,12				1,2,3
C301.6	Select suitable rolling contact bearings from data book.								V	K3	1,2,3,4,10,12				1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**		**PSO2**	**PSO3**
C301.1	3	3	3	1	0	0	0	0	0	2	0	1	3		2	1
C301.2	3	3	3	1	0	0	0	0	0	2	0	1	3		2	1
C301.3	3	3	3	1	0	0	0	0	0	2	0	1	3		2	1
C301.4	3	3	3	1	0	0	0	0	0	2	0	1	3		2	1
C301.5	3	3	3	1	0	0	0	0	0	2	0	1	3		2	1
C301.6	3	3	3	1	0	0	0	0	0	2	0	1	3		2	1

20ME502	DYNAMICS OF MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge about dynamic force analysis in reciprocating engines.
- To provide knowledge about analytical and graphical methods for calculating balancing of rotary and reciprocating masses.
- To understand about natural frequency, resonance and critical speeds.
- To study about forced vibrations, transmissibility of forces and isolation of systems.
- To study about governors and effect of gyroscope.

PREREQUISITE:

Course Code: 20ME401

Course Name: Kinematics of Machines

UNIT - I DYNAMIC FORCE ANALYSIS 9

Inertia force and D' Alembert's principle; Dynamic force analysis of mechanisms; Turning moment diagram: Fluctuation of energy and speed, mass of flywheel required for IC engines and mechanical presses.

UNIT – II BALANCING 9

Balancing of rotating masses: Masses in single plane and several planes; Balancing of reciprocating masses: Primary and secondary forces and couples, balancing of multi-cylinder inline engines, V and radial engines.

UNIT – III FREE VIBRATION 9

Basic features of vibratory systems: Elements, single degree of freedom system; Undamped free vibration: Equation of motion, natural frequency; Damped free vibration: Damping ratio, logarithmic decrement; Transverse vibration: Dunkerley"s method; Critical speed of shaft.

UNIT – IV FORCED VIBRATION 9

Torsional vibration: Two and three rotor systems, geared systems; Response to periodic force: Forcing by unbalance, support motion, force and amplitude transmissibility, vibration isolation; Vibration measurement and analysis: General considerations, vibration measurement, vibration pickups, signature analysis.

UNIT - V MECHANISM FOR CONTROL: GOVERNORS AND GYROSCOPE 9

Governors - Types - Centrifugal governors - Watt, Porter and Proell - Spring loaded governors - Hartnell and Hartung governors - Characteristics - Effect of friction - Controlling force curves.

Gyroscopes - Gyroscopic forces and torques - Gyroscopic stabilization – Gyroscopic effects in automobiles, ships and airplanes

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Rattan SS, "Theory of Machines", 4th Edition, Tata Mc Graw Hill, New Delhi, 2017.

2. Thomas Bevan, "Theory of Machines", 3rd Edition, Pearson India, 2009.

3. F. B. Sayyad, "Dynamics of Machinery", McMillan Publishers India Ltd., Tech-Max Educational resources, 2019.

REFERENCES:

1. Uicker JJ, Pennock GR and Shigley JE “Theory of Machines and Mechanisms”, 5thEdition, Oxford University Press, New Delhi, 2017.
2. Khurmi, R.S.,”Theory of Machines”, S Chand Publications, 14th Edition, 2020.
3. Ballaney P L, “Theory of Machines and Mechanisms”, Khanna Publishers, 25th edition NewDelhi, 2015.
4. Ambedkar AG,” Mechanism and Machine Theory”, PHI Learning, New Delhi, 2007.
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DYNAMICS OF MACHINERY															**Course Code : 20ME502**	
CO	**Course Outcomes**														**Unit**	**K-CO**	**POs**	**PSOs**
C302.1	Determine the dynamic forces in the reciprocating engine and calculate the maximum fluctuation of energy of the flywheel using turning moment diagram.														I	K3	1,2,3,4,10,12	1,2,3
C302.2	Calculate the required mass and the relative angular position for balancing of several masses rotating in same plane / different planes.														II	K3	1,2,3,4,10,12	1,2,3
C302.3	Determine the natural frequency of longitudinal and transverse vibration.														III	K3	1,2,3,4,5,10,12	1,2,3
C302.4	Calculate the critical damping, damping factor, logarithmic decrement and ratio of two consecutive amplitude for the mechanical vibrating systems.														IV	K3	1,2,3,4,5,10,12	1,2,3
C302.5	Determine the amplitude of the forced vibration and it’s resonance.														IV	K3	1,2,3,4,5,10,12	1,2,3
C302.6	Calculate the range of speed of the mechanical governors, and analyze the effect of gyroscopic couple on automobiles, ships and aero plane.														V	K3	1,2,3,4,10,12	1,2,3
CO-PO Mapping																		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**			
C302.1	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1			
C302.2	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1			
C302.3	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1			
C302.4	3	3	1	1	1	-	-	-	-	1	-	1	3	2	1			
C302.5	3	3	1	1	1	-	-	-	-	1	-	1	3	2	1			
C302.6	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1			

20ME503	CAD / CAM	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the applications of computers in design and manufacturing of mechanical components.
- To understand surface and solid modeling techniques.
- To know about the CAD standards.
- To understand part programming for manufacturing components in lathe and milling machines.
- To know about IoT enabled manufacturing system.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 8

Product life cycle, Design process- Shigley model, Computer aided design, methodology, Reasons for implementing CAD, Benefits, Applications, CAD System architecture, co-ordinate systems- 2D and 3D transformations, Projective transformation, homogeneous coordinates. Computer Aided Manufacturing – Hierarchy, Elements – CAM data base, Production management, manufacturing control.

UNIT – II GEOMETRIC MODELING 11

Wireframe modeling and its limitations; Parametric representation of analytic curves, parametric representation of synthetic curves - Cubic spline, Bezier, B-spline, NURBS, curve manipulation; Surface models: Types of surfaces, parametric representation of surfaces, design examples. Fundamentals of solid modeling: Boundary representation, Constructive Solid Geometry, solid manipulations, solid modeling based applications.

UNIT – III CAD STANDARDS AND MASS PROPERTY CALCULATIONS 8

Standards - Graphical Kernel System, standards for exchange images - Open Graphics Library, Data exchange standards. CG and interference, Geometric Tolerance, automation

Mass Property Calculations: Introduction, geometrical property formulation, mass property formulation; Design and engineering applications.

UNIT – IV CNC MACHINING AND PART PROGRAMING 9

Classification of CNC machines, Tooling for CNC machines, Automatic tool changer, work handling devices, Drive systems – stepper and servo motors, Recirculating ball screw and nut assembly.

Detailed Manual part programming on Lathe & Milling machines using G codes and M codes - Cutting Cycles, Loops, Sub program and Macros - Introduction of CAM package.

UNIT - V IOT IN CAM 9

Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007
2. Mikell.P.Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson, 4th Edition 2016.
3. Dr. Sadhu Singh, “Computer Aided Design & Manufacturing, Khanna Publishers 5th Edition 2018.

REFERENCES:

1. Chris McMahon and Jimmie Browne “CAD/CAM Principles", "Practice and Manufacturing management “ 2nd Edition, Pearson Education, 2001
2. M.S.Sehrawat and J.S.Narang “CNC Machines Computer Numerical Control” Dhanpat rai & Co Publishers, 2nd Revised Edition 2002.
3. S.Kant Vajpayee “Principles of Computer Integrated Manufacturing” Prentice hall of India, New Delhi 2003
4. Dr. K.C. Jain and Vikas Gohil “ CAD/CAM/CIM” Khanna Publishers 2014
5. K.Lalit Narayanan, K.Mallikarjuna Rao, M.M.M.Sarcar, “Computer Aided Design and Manufacturing” Prentice hall of India, New Delhi 2008

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : CAD / CAM												**Course Code : 20ME503**			
CO	**Course Outcomes**							**Unit**	**K-CO**	**POs**				**PSOs**	
C303.1	Describe the design process and elements of CAM.							1	K2	1,2,3				1,3	
C303.2	Explain the fundamentals of parametric curves, surfaces and Solids							2	K2	1,2,3				1,3	
C303.3	Explain the different types of Standard systems used in CAD							3	K2	1,2,3				1,3	
C303.4	Explain the principles of tooling and drive systems in CNC.							4	K2	1,2,3,5				1,3	
C303.5	Apply CNC programming concepts to develop part programme for Lathe & Milling Machines							4	K3	1,2,3,5				1,2,3	
C303.6	Explain applications of IOT in computer aided manufacturing							5	K2	1,2,3,5				1,3	
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C303.1	2	1	-	-	-	-	-	1	1	1	-	-	1	-	1
C303.2	2	1	-	-	-	-	-	1	1	1	-	-	1	-	1
C303.3	2	1	-	-	-	-	-	1	1	1	-	-	1	-	1
C303.4	2	1	-	-	2	-	-	1	1	1	-	-	1	-	1
C303.5	3	2	1	-	2	-	-	1	2	1	-	-	1	1	1
C303.6	2	1	-	-	2	-	-	1	1	1	-	-	1	-	1

20ME504	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	0	3

(Use of standard HMT data book is permitted)

OBJECTIVES

- To understand the mechanisms of conductive heat transfer under steady and transient conditions.
- To understand the concepts of convective heat transfer.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of phase change transfer.
- To understand the mechanism of radiative heat transfer
- To understand the mechanism of mass transfer

PREREQUISITE:

Course Code: 20ME302, 20ME304, 20ME403

Course Name: Fluid Mechanics and Machinery, Engineering Thermodynamics, Thermal Engineering

UNIT - I CONDUCTION 9

Conduction – general 3D equation – One Dimensional Steady State Heat Conduction –– plane walls and cylinders, Composite walls – Critical thickness of insulation - Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT – II CONVECTION 9

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

UNIT - III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method.

UNIT – IV RADIATION 9

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases.

UNIT - V MASS TRANSFER 9

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

TOTAL : 45 PERIODS

TEXT BOOKS:

1.Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 10th Edition 2010
2.Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition 2015
3.Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi,3rd edition 2011

REFERENCES:

1.Bergman T.L., Lavine A.S., Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 7th ed., John Wiley, 2011.
2.Rajput R.K., A Text Book of Heat and Mass Transfer, S. Chand Publishers, 2018
3.R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009
4. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2006.
5.Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : HEAT AND MASS TRANSFER												**Course Code : 20ME504**			
CO	**Course Outcomes**							**Unit**	**K-CO**	**POs**			**PSOs**		
C304.1	Determine heat transfer rate in simple geometries under steady state and transient conditions by applying heat conduction equations.							I	K3	1, 2, 3, 4			1, 2		
C304.2	Determine heat transfer in internal and external flows by applying free and forced convective heat transfer correlations.							II	K3	1, 2, 3, 4			1, 2		
C304.3	Calculate heat transfer rate during boiling and condensation.							III	K3	1, 2, 3, 4			1, 2		
C304.4	Determine the performance of different types of heat exchangers by applying LMTD and NTU methods of thermal analysis.							III	K3	1, 2, 3, 4			1, 2		
C304.5	Calculate radiative heat transfer between different types of surfaces.							IV	K3	1, 2, 3, 4			1, 2		
C304.6	Calculate mass transfer rate by applying diffusive and convective mass transfer equations and correlations.							V	K3	1, 2, 3, 4			1, 2		
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C304.1	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C304.2	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C304.3	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C304.4	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C304.5	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C304.6	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1

20MC501	CONSTITUTION OF INDIA	L	T	P	C
		1	0	0	0

OBJECTIVES

- To enable the student to understand the importance of the constitution.
- To understand the structure of executive, legislature, and judiciary.
- To understand the philosophy of fundamental rights, duties and Emergency Provisions.
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court.
- To understand the central and state relation financial and administrative.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 3

History of Making of the Indian Constitution - Drafting Committee - (Composition & Working) - Philosophy of the Indian Constitution – Preamble - Salient Features

UNIT – II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 3

Fundamental Rights - Right to Equality - Right to Freedom - Right against Exploitation Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies Directive Principles of State Policy - Fundamental Duties

UNIT - III ORGANS OF GOVERNANCE 3

Parliament – Composition - Qualifications and Disqualifications - Powers and Functions - Executive President – Governor - Council of Ministers - Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions

UNIT – IV EMERGENCY PROVISIONS 3

Emergency Provisions - National Emergency, President Rule, Financial Emergency

UNIT - V LOCAL ADMINISTRATION 3

District's Administration head- Role and Importance - Municipalities – Introduction - Mayor and role of Elected Representative - CEO of Municipal Corporation - Pachayat raj – Introduction – PRI - Zila Pachayat Elected officials and their roles - CEO Zila Pachayat - Position and role-Block level - Organizational Hierarchy (Different departments) - Village level - Role of Elected and Appointed officials - Importance of grass root democracy

TOTAL : 15 PERIODS

TEXT BOOKS:

1. Rajesh Kumar, 'Universal's Guide to the Constitution of India', Universal Law Publications, 2016.
2. D.C. Gupta, 'Indian Government and Politics', Vikas Pub, 2018.

REFERENCES:

1. H.M.Sreevai, 'Constitutional Law of India', 4th Edition in 3 volumes, Universal Law Publication.
2. J.C. Johari, 'Indian Government and Politics', Shoban Lal & Co, 2012.
3. Noorani A.G.,(South Asia Human Rights Documentation Centre), 'Challenges to Civil Rights Guarantees in India', Oxford University Press, 2012.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : CONSTITUTION OF INDIA													**Course Code : 20MC501**		
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
C306.1	Explain history and philosophy of Indian Constitution.										I	K2	6,8,9,10		-
C306.2	Explain the premises informing the twin themes of liberty and freedom from a civil rights perspective.										II	K2	6,8,9,10		-
C306.3	Explain the powers and functions of Indian government										III	K2	6,8,9,10		-
C306.4	Explain the emergency rules of Indian Constitution.										IV	K2	6,8,9,10		-
C306.5	Explain the structure and functions of local administration.										V	K2	6,8,9,10		-
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C306.1	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C306.2	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C306.3	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C306.4	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C306.5	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-
C306.1	-	-	-	-	-	3	-	2	2	2	-	-	-	-	-

THEORY CUM PRACTICAL

		L	T	P	C
20ME505	**MACHINE DRAWING**	1	0	4	3

OBJECTIVES

- To understand Indian standards for machine drawing.
- To gain knowledge about limits, fits and tolerances.
- To understand graphical representation of surface finish.
- To read the blue print and understand the given information.
- To draw assembly drawing from the part drawings of the industrial components.

PREREQUISITE:

Course Code: 20ME201

Course Name: Engineering Graphics

INTRODUCTION **6 + 6**

Introduction to machine drawing, sectional views of machining components; Code of practice for machine drawing; Conventional representation of features: Drilled and tapped holes, countersunk and counter bored holes, internal and external threads, undercuts, grooves, chamfers, fillet radii and keyways; Conventional representation of standard parts: Bolts, nuts, washers, screws, cotters, pins, circlips, bearings, gears, springs and flanges, Weld symbols.

LIMITS, FITS AND TOLERANCE **6 + 6**

Limits, fits and tolerances; Need, types, representation of tolerances on drawing, calculation of minimum and maximum clearances and allowances; Geometric tolerance: uses, types of form and position tolerances, symbols, method of indicating geometric tolerances on part drawings; Surface finish symbols - methods of indicating the surface roughness.

Blue print reading – Interpretation of information from the given production drawing.

ASSEMBLY OF MACHINE COMPONENTS **6 + 6**

Assembly requirements, bill of materials; Methods of assembly-bolts, nuts, studs, screws and pins; Methods of axial and radial retention of parts of an assembly; Assembly of parts with emphasis on assembly sequence and appropriate fits.

ASSEMBLY DRAWING **9+30**

Preparation of assembly drawing from the given part drawings of industrial components.

TOTAL : 75 PERIODS

PROCEDURE FOR AWARDING MARKS FOR INTERNAL ASSESSMENT:

The first test (100 marks) will be from conventional representation, GT and SF symbols.

The second and third test portions (maximum mark 100) will be for blue print reading and assembly drawing from the given part drawings of industrial components. The first test mark shall be arrived to 40 marks and the sum of marks of second and third tests shall be arrived to 60 marks. The sum of these 100 marks may then be arrived at for 30 rounded to the nearest integer.

END SEMESTER EXAMINATION QUESTION PATTERN:

Part-A

5 x 6 =30 Marks (Either/ OR Pattern, Question no. 1 to 5 from Introduction, Limits, Fits and Tolerance, Assembly of Machine Components)

Part-B

1 x 70=70 Marks (Either/ OR Pattern, Question no. 6a or 6b from Assembly Drawing)

TEXT BOOKS:

1. K.R.Gopalakrishna, "Machine Drawing", 23rd Edition, Subhas Publications, Bangalore, 2017.
2. K.L.Narayana, P.Kannaiah and K.Venkata Reddy, "Production Drawing", 3rd Edition, New Age International Publishers, New Delhi, 2014.
3. N.D.Bhatt, "Machine Drawing", 15th Edition, Charotar Publishing House Pvt. Limited, 2016.

REFERENCES:

1. K.L.Narayana, P.Kannaiah and K.Venkata Reddy, "Machine Drawing", 3rd Edition, New Age International Publishers, New Delhi, 2019.
2. Thamos P.Olivo and Dr.C.Thamos Olivo, "Basic Blueprint Reading and Sketching", 9th Edition Revised, Industrial Press Inc, New York, 2010.
3. Walter W Sturtevant, "Practical Problems in Mechanical Drawing and Blue- Print Reading", Wentworth Press, 2016.
4. PS. Gill, " A Text Book of Machine Drawing", S.K. Kataria & sons, 9th edition, 2013.
5. RK Dhawan, "A Text book of Machine Drawing", 1st Edition, Sultan Chand and Sons, New Delhi, 2015.
6. BIS recommendation for school practices: SP46:2003.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : MACHINE DRAWING													**Course Code : 20ME505**		
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**		**PSOs**		
C307.1	Explain the Indian standards for the preparation of machine drawing.								-	2	1,2		1,2,3		
C307.2	Draw the symbols for the standard machine parts.								-	2	1,2		1,2,3		
C307.3	Calculate and Identify the type of limits and fits for the given tolerance grade.								-	3	1,2,3		1,2,3		
C307.4	Interpret the information from the given production drawing.								-	2	1,2		1,2,3		
C307.5	Explain the assembly requirements and the sequence of assembly.								-	2	1,2		1,2,3		
C307.6	Draw the assembled view of the mechanical products from the given part drawing.								-	3	1,2,3		1,2,3		
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C307.1	2	1	-	-	-	-	-	1	1	1	-	-	2	1	1
C307.2	2	1	-	-	-	-	-	1	1	2	-	-	2	1	1
C307.3	3	2	1	-	-	-	-	1	2	2	-	-	2	1	1
C307.4	2	1	-	-	-	-	-	1	1	1	-	-	2	1	1
C307.5	2	1	-	-	-	-	-	1	1	1	-	-	2	1	1
C307.6	3	2	1	-	-	-	-	1	2	2	-	-	2	1	1

20ME5L1 DYNAMICS LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To understand simple mechanisms like gears, cam, four bar and slider crank mechanism.
- To understand dynamic testing of machines.
- To understand the concept of torsional vibration of rotors.
- To know about the mass moment of inertia of axi symmetric bodies.
- To understand machine dynamics with various equipments like governors, gyroscopes and balancing machines.

PREREQUISITE:

Course Code: 20GE202, 20ME301, 20ME401

Course Name: Engineering Mechanics, Strength of materials, Kinematics of machines

LIST OF EXPERIMENTS

1. Study of Kinematics of four bar, slider crank, crank rocker, double crank, double rocker, oscillating cylinder mechanisms, single and double universal joints.
2. Study of gyroscopic effect and couple.
3. Determine the velocity ratio of simple and compound gear train.
4. Determine the mass moment of inertia of fly wheel and axle system.
5. Determine the mass moment of Inertia of axisymmetric bodies using Turn Table apparatus.
6. Determine the mass moment of Inertia using bifilar suspension and compound pendulum.
7. Draw the controlling force diagram for Watts, Porter, Proell, and Hartnell Governors.
8. Draw the Cam profile and study about jump phenomenon.
9. Determine the natural frequency, damping coefficient for single and multi-degree spring mass system.
10. Determine the natural frequency of single rotor system.
11. Determine the natural frequency of double rotor system.
12. Determine the critical speeds of shafts with concentrated loads.
13. Determine the deflection in Cantilever beam under different loading conditions.
14. Determine the unbalanced mass and relative angular setting for balancing the rotating body.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. No.	Name of The Equipment	Quantity
1	Cam follower setup.	1
2	Motorized gyroscope.	1
3	Governor apparatus -Watt, Porter, Proell and Hartnell governors	1
4	Whirling of shaft apparatus	1
5	Dynamic balancing machine	1
6	Spring mass vibration system	1
7	Torsional Vibration of single rotor system setup	1
8	Gear Models	1
9	Kinematic Models	5
10	Turn table apparatus	1
11	Transverse vibration setup of a cantilever	1

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DYNAMICS LABORATORY															**Course Code : 20ME5L1**
CO	**Course Outcomes**												**EXP**	**K-CO**	**POs**	**PSOs**
C308.1	Calculate the deflection of the cantilever beam and Determine the critical speed of the shaft.												1,2	K3	1,2,3,4,9	1,2,3
C308.2	Determine the unbalanced mass and relative angular setting for balancing the rotating body and cam analysis												3,4	K3	1,2,3,4,9	1,2,3
C308.3	Calculate the natural frequency of the longitudinal, transverse and torsional vibratory systems.												5,6	K3	1,2,3,4,9	1,2,3
C308.4	Calculate the Effect of Actual Spindle Speed on Sleeve Displacement, Effect of Radius of Rotation on Centrifugal Force and draw the characteristics curve for different types of governors.												7	K3	1,2,3,4,9	1,2,3
C308.5	Determination of Mass moment of inertia of Fly wheel and Axle system and calculate the speed ratio and train value of simple and compound gear train												8,9	K3	1,2,3,4,9	1,2,3
C308.6	Determine the Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus, compound pendulum and bifilar suspension												10,11, 12	K3	1,2,3,4,9	1,2,3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	
C308.1	3	2	1	1	-	-	-	-	2	-	-	-	2	1	1	
C308.2	3	2	1	1	-	-	-	-	2	-	-	-	2	1	1	
C308.3	3	2	1	1	-	-	-	-	2	-	-	-	2	1	1	
C308.4	3	2	1	1	-	-	-	-	2	-	-	-	2	1	1	
C308.5	3	2	1	1	-	-	-	-	2	-	-	-	2	1	1	
C308.6	3	2	1	1	-	-	-	-	2	-	-	-	2	1	1	

20ME5L2	CAD / CAM LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To gain practical experience in handling 2D drafting and 3D modelling software systems.
- To study the features of CNC Machine Tool.
- To gain knowledge in modern control systems.
- To know the application of various CNC machines.
- To know the application of CAM packages.

PREREQUISITE:

Course code: 20GE201, 20ME402

Course Name: Engineering graphics, Manufacturing Technology

LIST OF EXPERIMENTS

3D GEOMETRIC MODELLING

1. Introduction of 3D Modelling software
2. Creation of 3D assembly model of following machine elements using 3D Modelling software
    - Flange Coupling
    - Plummer Block
    - Screw Jack
    - Universal Joint
    - Geneva mechanism
    - CAM and follower mechanism
    - Quick return mechanism of shaping machine

3. Manual Part Programming.

(i) Part Programming - CNC Turning Centre

- Straight, Taper and Radius Turning.
- Thread Cutting.
- Rough and Finish Turning Cycle.
- Drilling and Tapping Cycle.

(ii) Part Programming - CNC Machining Centre

- Linear Cutting.
- Circular cutting.
- Cutter Radius Compensation.
- Canned Cycle Operations.
- Pocketing

4. Design and fabrication of a component using extrusion based additive manufacturing.
5. Perform machining operation in the given work piece using Wire cut EDM

TOTAL:60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

HARDWARE		
1.	Computer Server	1
2.	Computer systems networked to the server	30
3.	Laser Printer	1
4.	CNC Lathe	1
5.	CNC milling machine	1
6.	3D Printer	1
7.	Wire cut EDM	1
SOFTWARE		
8.	High end integrated modeling and manufacturing CAD / CAM software	15 licenses

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : CAD / CAM LABORATORY			**Course Code : 20ME5L2**		
CO	**Course Outcomes**	**EXP**	**K-CO**	**POs**	**PSOs**
C309.1	Practice the basic commands in 3D modeling software.	1,2	K3	1,2,3,5,8,9,12	1,2,3
C309.2	Draw 3D part drawings and assemble them using 3D modeling software.	3,4	K3	1,2,3,5,8,9,12	1,2,3
C309.3	Prepare manual part programming and perform machining process in CNC Lathe for the given component.	5,6,7,8	K3	1,2,3,5,8,9,12	1,2,3
C309.4	Prepare manual part programming and perform machining process in CNC milling for the given component.	9,10,11,12	K3	1,2,3,5,8,9,12	1,2,3
C309.5	Develop a component using 3D printer.	13	K3	1,2,3,5,8,9,12	1,2,3
C309.6	Prepare a component using wirecut EDM.	14	K3	1,2,3,5,8,9,12	1,2,3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C309.1	3	2	1	-	3	-	-	3	3	-	-	-	2	1	1
C309.2	3	2	1	-	3	-	-	3	3	-	-	-	2	1	1
C309.3	3	2	1	-	3	-	-	3	3	-	-	-	2	1	1
C309.4	3	2	1	-	3	-	-	3	3	-	-	-	2	1	1
C309.5	3	2	1	-	3	-	-	3	3	-	-	-	2	1	1
C309.6	3	2	1	-	3	-	-	3	3	-	-	-	2	1	1

20ME5L3	HEAT AND MASS TRANSFER LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To learn to measure thermal conductivity of materials
- To study the free and forced convective heat transfer
- To study condensation heat transfer
- To study the performance of Heat exchangers
- To study the applicability of Stefan – Boltzmann law

PREREQUISITE:

Course Code: 20ME302, 20ME304, 20ME403

Course Name: Fluid Mechanics and Machinery, Engineering Thermodynamics, Thermal Engineering

LIST OF EXPERIMENTS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of Thermal conductivity of insulating powder, liquid and composite wall
3. Heat transfer from pin-fin apparatus (natural & forced convection modes)
4. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
5. Determination of heat transfer coefficient under forced convection from a tube.
6. Determination of heat transfer coefficient in film wise and drop wise condensation
7. Effectiveness of double pipe heat exchangers.
8. Effectiveness of cross flow heat exchanger.
9. Determination of Stefan – Boltzmann constant.
10. Determination of emissivity of a grey surface.

TOTAL: 45 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Guarded plate apparatus	1
2	Lagged pipe apparatus	1
3	Composite wall apparatus	1
4	Thermal conductivity of insulating powder apparatus	1
5	Pin-fin apparatus	1
6	Natural convection-vertical cylinder apparatus	1
7	Forced convection inside tube apparatus	1
8	Parallel flow heat exchanger apparatus	1
9	Counter flow heat exchanger apparatus	1
10	Cross flow heat exchanger apparatus	1
11	Stefan-Boltzmann apparatus	1
12	Emissivity measurement apparatus	1

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : HEAT AND MASS TRANSFER LABORATORY		**Course Code : 20ME5L3**			
CO	**Course Outcomes**	**EXP**	**K-CO**	**POs**	**PSOs**
C310.1	Determine thermal conductivity of materials by conducting tests on heat conduction apparatus	1,2	K3	1,2,3,4	1,2,3
C310.2	Determine heat transfer rate and fin efficiency of a pin fin under natural/forced convective mode	3	K3	1,2,3,4	1,2,3
C310.3	Calculate natural/forced convective heat transfer coefficient by conducting tests on convective heat transfer apparatus.	4,5,6	K3	1,2,3,4	1,2,3
C310.4	Determine the performance of parallel/counter/cross flow heat exchangers	7,8	K3	1,2,3,4	1,2,3
C310.5	Calculate the Stefan-Boltzmann constant by conducting tests on radiative heat transfer apparatus.	9	K3	1,2,3,4	1,2,3
C310.6	Calculate the emissivity of a gray surface.	10	K3	1,2,3,4	1,2,3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C310.1	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C310.2	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C310.3	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C310.4	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C310.5	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1
C310.6	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1

20ME601 DESIGN OF TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

(Use of PSG Design data book is permitted)

OBJECTIVES

- To gain knowledge on the working principle of power transmission components.
- To understand the step by step procedure for the design of mechanical drives
- To understand the force and thermal considerations for design of components.
- To learn to draw ray diagram of gear box
- To understand the design of clutches and brakes.

PREREQUISITE:

Course Code: 20ME501

Course Name: Design of Machine Elements

UNIT - I DESIGN OF BELT AND CHAIN DRIVES 9

Belt drive – Belt construction, belt length- geometric relationships, Analysis of belt tensions, conditions for maximum power, Characteristics of belt drives, Basic procedure for selection of V belt.

Chain drive – Construction of roller chain, chain length – geometrical relationship, polygonal effect, Sprocket wheels, design of chain drive. Wire ropes

UNIT – II SPUR GEARS AND HELICAL GEARS 9

Gear drives – classification, selection, Spur gear – terminology, gear trains, interference and undercutting, backlash, force analysis - beam strength, wear strength, gear tooth failure, selection of material, Design of spur gear, Spiral gears, Helical Gears – terminology, virtual number of teeth, tooth proportions, force analysis – beam strength, effective load, wear strength, design of helical gear.

UNIT - III BEVEL GEARS, WORM AND WORM GEARS 9

Bevel gears – terminology, force analysis – beam and wear strength, effective load, design of bevel gears.

Worm gears – terminology, proportion, force analysis, friction, selection of material, strength and wear rating, thermal considerations. Design of worm gears.

UNIT – IV GEAR BOXES 9

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

UNIT - V CLUTCHES AND BRAKES 9

Clutches – torque transmitting capacity, friction materials, design of multidisk, cone, centrifugal clutches.

Brakes – energy equations, block brake with short and long shoe, pivoted block brake with long shoe, internal expanding brake, band and disk brakes.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Bhandari V B, “Design of Machine Elements”, Tata McGraw-Hill Book Co, 5th Edition, 2020.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 11th Edition, Tata McGraw-Hill, 2020.
3. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, Global Edition, Wiley, 2018.

REFERENCES:

1. Sundararaja moorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2018.
2. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co. (Schaum’s Outline), 2010
3. Bernard Hamrock, Steven Schmid,Bo Jacobson, “Fundamentals of Machine Elements”, Tata McGraw-Hill Book Co., 3rd Edition, 2013.
4. Ansel Ugural, “Mechanical Design – An Integral Approach", Tata McGraw-Hill Book Co, 1stEdition, 2003.
5. Ganesh Babu, Sridhar, “Machine Design” Tata McGraw-Hill Education, 2nd Edition 2010.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DESIGN OF TRANSMISSION SYSTEMS													**Course Code : 20ME601**		
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
C311.1	Design a suitable belt drive for a given application.											I	K3	1,2,3,4,10,12	1,2,3
C311.2	Design chain sprockets for the given power transmission conditions.											I	K3	1,2,3,4,10,12	1,2,3
C311.3	Design spur and helical gears based on strength and wear consideration.											II	K3	1,2,3,4,10,12	1,2,3
C311.4	Design bevel gear and worm gear pair based on strength and wear consideration.											III	K3	1,2,3,4,10,12	1,2,3
C311.5	Design various gear boxes (sliding mesh, constant mesh, multispeed) through geometric progression, standard step ratio, ray diagram and kinematics layout.											IV	K3	1,2,3,4,10,12	1,2,3
C311.6	Design various clutches, internal and external shoe brakes.											V	K3	1,2,3,4,10,12	1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C311.1	3	3	3	1	-	-	-	-	-	2	-	1	3	2	1
C311.2	3	3	3	1	-	-	-	-	-	2	-	1	3	2	1
C311.3	3	3	3	1	-	-	-	-	-	2	-	1	3	2	1
C311.4	3	3	3	1	-	-	-	-	-	2	-	1	3	2	1
C311.5	3	3	3	1	-	-	-	-	-	2	-	1	3	2	1
C311.6	3	3	3	1	-	-	-	-	-	2	-	1	3	2	1

20ME602 FINITE ELEMENT ANALYSIS

L	T	P	C
3	0	0	3

OBJECTIVES

- To apply knowledge of mathematics, science and engineering to the analysis of simple structures using the finite element method.
- To identify, formulate, and solve engineering problems using the finite element method.
- To perform steady-state heat transfer analysis including the effects of conduction and convection.
- To perform structural analysis of a part to determine its displacements, stress, strain and reactions.
- To study about the fatigue and nonlinear analysis.

PREREQUISITE:

Course Code: 20ME301, 20ME504

Course Name: Strength of materials, Heat and mass transfer

UNIT - I INTRODUCTION 9

Methods to solve engineering problems, past present and future of FEA, Theoretical FEA, Variational (Ritz) method, Weighted residual method, General procedure of FEA, Types of FEA analysis.

UNIT – II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations, Discretization, Derivation of Shape functions, Stiffness matrices, force vectors and assembly of matrices, Solution of structural problems - Bar and Beam.
Longitudinal vibration frequencies of bars and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams

UNIT - III TWO-DIMENSIONAL PROBLEMS 9

Second Order 2D Equations - Scalar and Vector Variable Functions, Variational formulation, Finite Element formulation, 3 noded triangular elements-Shape functions and element matrices and vectors.
Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress and strain calculations.

UNIT – IV HEAT FLOW PROBLEMS AND ISOPARAMETRIC FORMULATION 9

Steady state heat transfer analysis: 1D analysis of composite walls and fins – 2D analysis of thin plate
Natural co-ordinate systems, Isoparametric elements –Shape functions- stress-strain and strain-displacement relations – Numerical integration

UNIT - V FATIGUE AND NON LINEAR ANALYSIS 9

Introduction to fatigue, various approaches in fatigue analysis – SN curve, factors affecting fatigue analysis. General FEA procedure for fatigue analysis.
Introduction to non-linear analysis, Types of nonlinearity, Stress–strain measures for nonlinear analysis, General FEA procedure for nonlinear static analysis.
Simulation life cycle management - Introduction

TOTAL : 45 PERIODS

TEXT BOOKS:

1. David V Hutton “Fundamentals of Finite Element Analysis”, McGraw-Hill International Editions, 2018.
2. J.N.Reddy, “An Introduction to the Finite Element Method”, McGraw-Hill International Editions (Engineering Mechanics Series), 2018.
3. P.Seshu, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd. New Delhi, 2007.

REFERENCES:

1. Cook,Robert.D., Plesha,Michael.E&Witt,Robert.J. “Concepts and Applications of Finite Element Analysis”,Wiley Student Edition, 2004.
2. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice-Hall of India, Eastern Economy Editions.
3. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons,2005 (Indian Reprint 2013)
4. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002
5. Gokhale Nitin S “Practical Finite Element Analysis” Finite To Infinite edition, 2020.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : FINITE ELEMENT ANALYSIS													**Course Code : 20ME602**		
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
C312.1	Determine the mathematical modeling constant for the given governing equation by variational and weighted residual methods.											I	K3	1,2,3,4,12	1,2,3
C312.2	Determine the nodal stresses of the structural components using one dimensional analysis.											II	K3	1,2,3,4,5,12	1,2,3
C312.3	Demonstrate suitable two-dimensional triangular element equation to solve structural problems under plane stress, plane strain and axisymmetric conditions.											III	K3	1,2,3,4,5,12	1,2,3
C312.4	Determine the steady state nodal temperature for heat flow problems.											IV	K3	1,2,3,4,5,12	1,2,3
C312.5	Determine the stress-strain and strain-displacement relations of the 2-dimensional structural problems by using isoparametric elements											IV	K3	1,2,3,4,12	1,2,3
C312.6	Explain the FEA procedure for fatigue analysis and non linear analysis and various approaches in fatigue analysis.											V	K2	1,2,3,4,12	1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C312.1	3	3	2	1	-	-	-	-	-	-	-	1	3	2	1
C312.2	3	3	2	1	1	-	-	-	-	-	-	1	3	2	1
C312.3	3	3	2	1	1	-	-	-	-	-	-	1	3	2	1
C312.4	3	3	2	1	1	-	-	-	-	-	-	1	3	2	1
C312.5	3	3	2	1	-	-	-	-	-	-	-	1	3	2	1
C312.6	3	2	1	1	-	-	-	-	-	-	-	1	3	2	1

20ME603	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the principles and elements of lean manufacturing.
- To understand the value chain and to map the current state of material and information flow through the value chain.
- To develop road map of lean implementation by understanding the activities.
- To apply the lean tools to implement lean manufacturing system in an organization.
- To understand about six sigma concept methodologies.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO LEAN MANUFACTURING 9

Conventional Manufacturing versus Lean Manufacturing – Necessity - Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.

UNIT – II LEAN TRANSFORMATION 9

Five step approach to transforming conventional manufacturing into Lean manufacturing plants – Value Stream Mapping – Process Cycle Efficiency – Bottlenecks and Lean Projects.

UNIT - III FLOW ENABLERS 9

Set up time reduction – Definition, philosophies, and reduction approaches. Kanban & Supermarkets, FIFO lane and Andon.

UNIT – IV LEAN TOOLS FOR CONTINUOUS IMPROVEMENT 9

TPM – Principles and implementation. 5S Principles and implementation. Poka-Yoke Principle and Implementation. Kaizen – Gemba level improvement, Problem Solving with A3 reports.

UNIT - V SIX SIGMA FUNDAMENTALS 9

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments, Six Sigma implementation. Design for Six Sigma (DFSS), Design for Six Sigma Method - Failure Mode Effect Analysis (FMEA)

Various case studies of implementation of lean manufacturing at industries.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Pascal Dennis, Lean production simplified, CRC press, New York, 3rd edition , 2016
2. Steve Blank, Bob Dorf, K&S Ranch (2012) the startup Owner's Manual: The Step-By-Step Guide for Building a great company, Wiley, Kindle Edition, 2020.
3. James Womack. P, Lean thinking: Banish waste and create wealth in your corporation, Simon & Schuster, 2nd edition, 2003.

REFERENCES:

1. Design and Analysis of Lean Production Systems, Ronald G. Askin and Jeffrey B. Goldberg, Wiley, 2001.
2. Mikell P. Groover, Automation, Production Systems and CIM, Pearson Education, 4th Edition, 2016
3. Rother M. and Shook J, Learning to See: Value Stream Mapping to Add Value and Eliminate Muda , Lean Enterprise Institute, Version 1.3 , 2003
4. Jeffrey K. Liker, the Toyota Way,: 14 Management Principles from the World's Greatest Manufacturer, Tata Mc Grew Hill, 2nd Edition,2021
5. Prof. Kate & Prof. Phadke: Toyota Production System - Elementary Concepts, Everest publishing house, 1st edition, 2016

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : LEAN MANUFACTURING													Course Code : 20ME603		
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**			**PSOs**	
C313.1	Explain the fundamental concepts of lean manufacturing								1	K2	1,2,3,8			2	
C313.2	Develop a roadmap for successful implementation of lean principles								2	K3	1,2,3,8,10			1	
C313.3	Solve the industrial problems by applying the concepts of lean manufacturing								3	K3	1,2,3,8,9,10			1	
C313.4	Explain the importance and the role of TPM								4	K2	1,2,3,8			1	
C313.5	Demonstrate the concepts of FMEA towards solving productivity related problems								5	K3	1,2,3,8			1	
C313.6	Determine the role of Six Sigma in lean manufacturing								5	K3	1,2,3			1	
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C313.1	3	2	1	-	-	-	-	1	-	-	-	-	-	1	-
C313.2	3	2	1	-	-	-	-	1	-	1	-	-	1	-	-
C313.3	3	2	1	-	-	-	-	2	2	1	-	-	1	-	-
C313.4	3	2	1	-	-	-	-	1	-	-	-	-	1	-	-
C313.5	3	2	1	-	3	-	-	1	-	-	-	-	1	-	-
C313.6	3	2	1	-	-	-	-	2	2	1	-	-	1	-	-

20ME604	COMPRESSIBLE FLOW AND TURBOMACHINERY	L	T	P	C
		3	0	0	3

(Use of approved gas tables, standard Steam Tables, Mollier diagram and Psychrometric chart permitted)

OBJECTIVES

- To understand the basic difference between incompressible and compressible flow.
- To understand the Flows through constant area ducts with and without Heat transfer.
- To understand the phenomenon of shock waves and its effect of flow on variable area of ducts.
- To understand the basic concepts of steam turbine and different types of gas turbines.
- To understanding the basic concepts and operating principles of Rotary compressors.

PREREQUISITE:

Course Code: 20ME302, 20ME304

Course Name: Fluid Mechanics and Machinery, Engineering Thermodynamics

UNIT - I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

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

UNIT – II COMPRESSIBLE FLOW THROUGH DUCTS 9

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

UNIT - III NORMAL AND OBLIQUE SHOCKS 9

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations.

UNIT – IV STEAM TURBINES AND GAS TURBINES 9

Impulse and reaction principles, Velocity diagrams for simple impulse turbine, Work done and efficiency – optimal operating conditions. Compounding and governing.

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations.

UNIT - V ROTARY COMPRESSOR 9

Classifications, Root blower, Vane type compressor, Centrifugal and Axial flow compressor Construction and working, velocity triangle, degree of reaction, polytropic efficiency, coefficients, losses and Characteristic curve of axial flow compressor.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Yahya S M, 'Fundamentals of Compressible Flow with Aircraft and Rocket Propulsions, New Age International Publishers, 5th Edition (2016).

2. Kothandaraman.C.P., Domkundwar. S, Domkundwar. A.V., "A course in thermal Engineering", 5th Edition, Dhanpat Rai & sons, 2016.

3. Oosthuizen, P.H. and Carscallen, W.E., Compressible Fluid Flow, McGraw-Hill, 1997.

REFERENCES:

1. Anderson, J.D., "Modern Compressible flow", 4th Edition, McGraw Hill, 2021.
2. Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 2010.
3. Yahya, S.M., 'Turbines, Compressor and Fans', McGraw Hill Education Publishing Company, 4th edition, 2017.
4. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", Pergamon Press, 2014.
5. Gopalakrishnan .G and Prithvi Raj .D, "A Treatise on Turbo machines", Scitech Publications (India) Pvt. Ltd., 2010.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : COMPRESSIBLE FLOW AND TURBOMACHINERY												**Course Code : 20ME604**			
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
C314.1	Apply the concepts of compressible flow behaviour in isentropic flow in variable area ducts.										I	K3	1,2,3,4		1,2
C314.2	Apply the concepts of compressible flow behaviour in constant area ducts with and without heat transfer.										II	K3	1,2,3,4		1,2
C314.3	Calculate the changes in physical properties when a normal shock occurs in One-dimensional constant area or variable area ducts.										III	K3	1,2,3,4		1,2
C314.4	Determine the performance of steam turbine.										IV	K3	1,2,3,4		1,2
C314.5	Determine the performance of gas turbine										IV	K3	1,2,3,4		1,2
C314.6	Explain the working and performance of Rotary compressor.										V	K2	1,2,3,4		1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C314.1	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
C314.2	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
C314.3	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
C314.4	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
C314.5	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3
C314.6	3	3	2	1	-	-	-	-	-	-	-	-	3	2	3

20HS601	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide knowledge about optimization techniques and approaches.
- To formulate a real time problem as a mathematical programming model.
- To gain mathematical, computational and communication skills for solving problems.
- To gain knowledge to solve networking and inventory problems.
- To gain knowledge on solving different waiting line models

PREREQUISITE: NIL

UNIT - I LINEAR PROGRAMMING 9

Introduction to Operations Research, Linear programming (LP) – assumptions, properties of LP solutions, Formulations of linear programming problem – Graphical method. Solutions to LPP – simplex, Big M method.

UNIT – II TRANSPORTATION AND ASSIGNMENT MODELS 9

Transportation Problem - Mathematical Model, Types – Balanced and Unbalanced, Solution to Transportation Problem - Finding the initial basic solution, Optimizing the basic feasible solution applying U–V Method (Modi method)

Assignment problem –Hungarian method, Travelling salesman problem - Branch and Bound technique.

UNIT - III NETWORK MODELS 9

Network problem: shortest path – Systematic method, Dijkstra's algorithm, Floyd's algorithm, Minimal spanning tree – PRIM and Kruskal's algorithm, Maximum flow models – linear programming models, maximal flow problem algorithm

Project network representation, Critical Path Method computations, construction of time schedule, linear programming formulation of CPM, PERT networks.

UNIT – IV INVENTORY MODELS 9

Inventory models, Quantity Discount, Purchase Inventory Model - Q System, P System, Multiple-item Model - Shortage Limitation, Inventory Carrying Cost Constraint, EOQ Model - Multi-item Joint Replenishment with and without Shortages, Space Constraint.

UNIT - V QUEUEING MODELS 9

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

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Hamdy A.Taha "Operations Research – An Introduction", MacMillan India Ltd., 10th Edition,2017.
2. Panneerselvam R, "Operations Research", Prentice Hall India, 2016.
3. Hira.D Gupta.P.K, "Operations Research",S.Chand Publications, 1st Edition, Reprint 2016

REFERENCES:

1. G.Srinivasan, "Operations Research: Principles and Applications", PHI Ltd., 2016.
2. Kanti swarup Gupta.P.K, Man Muhan" „Operations Research: Sultan Chand & Sons India Ltd., 12th Edition,New Delhi 2016.
3. Philips, Ravindran and Solberg, "Operations Research principle and practise", John Wiley, 2016.
4. Hiller and Liberman, Introduction to Operations Research, McGraw Hill, 2015.
5. Ramamurthy P, "Operations Research", New age International Publishers, 2nd edition, 2007.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : OPERATIONS RESEARCH													**Course Code : 20HS601**		
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**		**PSOs**		
C315.1	Solve Linear Programming Problems by appropriate technique.								I	K3	1,2,3,8,10		1,2,3		
C315.2	Determine the performance characteristics such as time and cost in solving shortest route, transportation problems with an appropriate model.								II	K3	1,2,3,9,10		1,2,3		
C315.3	Solve the given assignment problem with an appropriate method.								II	K3	1,2,3,8,10		1,2,3		
C315.4	Determine the optimal solution for a project scheduling problem.								III	K3	1,2,3		1,2,3		
C315.5	Determine the order quantity of goods under different constraints.								IV	K3	1,2,3,8		1,2,3		
C315.6	Determine the solutions to single and multi channel queuing problems.								V	K3	1,2,3,8,9,10		1,2,3		
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO 3**
C315.1	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1
C315.2	3	2	1	-	-	-	-	-	2	2	-	2	3	2	1
C315.3	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1
C315.4	3	2	1	-	-	-	-	-	-	-	-	2	3	2	1
C315.5	3	2	1	-	-	-	-	2	-	-	-	2	3	2	1
C315.6	3	2	1	-	-	-	-	1	2	2	-	2	3	2	1

20MC601	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
		1	0	0	0

OBJECTIVES:

- Get a knowledge about Indian Culture
- Know Indian Languages, Literature, religion and philosophy and fine arts in India
- Explore the Science and Scientists of Ancient, Medieval and Modern India
- Understand education systems in India

PRE-REQUISITE: NIL

UNIT-I INTRODUCTION TO CULTURE 3

Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India.

UNIT-II INDIAN LANGUAGES AND LITERATURE 3

Indian Languages and Literature – I: Languages and Literature of South India, – Indian Languages and Literature – II: Northern Indian Languages & Literature

UNIT-III RELIGION AND PHILOSOPHY 3

Major religions practiced in India and Understanding their Philosophy – religious movements in Modern India (Selected movements only)

UNIT - IV FINE ARTS IN INDIA (ART, TECHNOLOGY& ENGINEERING) 3

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India

UNIT - V EDUCATION SYSTEM IN INDIA 3

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

TOTAL: 15 PERIODS

REFERENCES:

1. Kapil Kapoor, “Text and Interpretation: The India Tradition”, 2005
2. “Science in Samskrit”, Samskrita Bharti Publisher, 2007
3. NCERT, “Position paper on Arts, Music, Dance and Theatre”,
4. Narain, “Examinations in ancient India”, Arya Book Depot, 1993
5. Satya Prakash, “Founders of Sciences in Ancient India”, Vijay Kumar Publisher, 1989
6. M. Hiriyanna, “Essentials of Indian Philosophy”, Motilal Banarsidass Publishers, 2014

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE		Course Code : 20MC601			
CO	**Course Outcomes**	**Unit**	**K –CO**	**POs**	**PSOs**
C320.1	Explain philosophy of Indian culture.	1	K2	-	-
C320.2	Distinguish the Indian languages and literature.	2	K2	-	-
C320.3	Explain the philosophy of ancient, medieval and modern India.	3	K2	-	-
C320.4	Acquire the information about the fine arts in India.	4	K2	-	-
C320.5	Know the contribution of scientists of different eras.	5	K2	-	-
C320.6	Explain education systems in India	5	K2	-	-

20ME6L1	COMPUTER AIDED SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To understand the applications of various software tools for analysis.
- To understand geometric modeling in analysis software.
- To find the stress and other related parameters of bars, beams loaded with loading conditions.
- To derive the output from the analysis software.
- To solve real time problems using these tools.

PREREQUISITE:

Course Code: 20ME301, 20ME304, 20ME502

Course Name: Strength of Materials, Thermal engineering, Dynamics of Machinery

LIST OF EXPERIMENTS

1. 1D application problems like composite walls/beams
2. 2D application problems like flat plates, simple shells, cylinder
3. Stress analysis of axi – symmetric components.
4. Modal analysis (Beams).
5. 3D modeling of pulley.
6. 3D analysis of rotating shaft.
7. Nonlinear analysis using contact elements.
8. Thermo mechanical analysis of plate.
9. Transient analysis of Fin.

TOTAL: 45PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	Computer Work Station	30
2	Printer	1
3	ANSYS Software	30 License

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : COMPUTER AIDED SIMULATION AND ANALYSIS LABORATORY			**Course Code : 20ME6L1**		
CO	**Course Outcomes**	**EXP**	**K-CO**	**POs**	**PSOs**
C318.1	Determine the stresses induced in plates and brackets	1,2	K3	1,2,3,4,5,9,12	1,2,3
C318.2	Determine the deflection of beam with various types of loading problem	3,4	K3	1,2,3,4,5,9,12	1,2,3
C318.3	Calculate the thermal stress and heat transfer in plates.	5,6	K3	1,2,3,4,5,9,12	1,2,3
C318.4	Determine the Stress analysis of axi – symmetric components.	7	K3	1,2,3,4,5,9,12	1,2,3
C318.5	Calculate the natural frequency and mode shape analysis of 2D components and beams.	8,9	K3	1,2,3,4,5,9,12	1,2,3
C318.6	Determine the response of harmonic and transient analysis.	10,11	K3	1,2,3,4,5,9,12	1,2,3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C318.1	3	2	1	1	2	-	-	-	2	-	-	1	2	1	1
C318.2	3	2	1	1	2	-	-	-	2	-	-	1	2	1	1
C318.3	3	2	1	1	2	-	-	-	2	-	-	1	2	1	1
C318.4	3	2	1	1	2	-	-	-	2	-	-	1	2	1	1
C318.5	3	2	1	1	2	-	-	-	2	-	-	1	2	1	1
C318.6	3	2	1	1	2	-	-	-	2	-	-	1	2	1	1

20ME6L2 DESIGN AND FABRICATION PROJECT

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- To get hands on training in the fabrication of one or more components of a complete working model, designed by the student.
- To gain knowledge about mechanical components and fabrication techniques
- To provide knowledge about the assembling of components and prepare a working model.
- To work as an individual or in a team in development of technical projects.
- To communicate and report effectively project related activities and findings.

PREREQUISITE:

Course Code: 20ME303, 20ME501

Course Name: Manufacturing Processes, Design of machine elements

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 2 to 4 works on a topic approved by the head of the department and prepare a comprehensive project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A design and fabrication project report is required at the end of the semester. The design and fabrication project work is evaluated based on oral presentation and Viva voce examination is conducted jointly by external and internal examiners appointed by COE

TOTAL: 45 PERIODS

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : DESIGN AND FABRICATION PROJECT					**Course Code : 20ME6L2**	
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**	
C319.1	Identify and apply the real world and societal importance problems in the mechaincal and its allied area	-	K4	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3	
C319.2	Identify, analyze, design, implement and handle prototype projects with a complete and organized solution methodologies	-	K4	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3	
C319.3	Apply modern engineering tools for solution	-	K4	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3	
C319.4	Contribute as an individual or in a team in development of technical projects	-	K4	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3	
C319.5	Develop effective communication skills for presentation of project related activities	-	K4	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3	
C319.6	Prepare reports and examination following professional ethics	-	K4	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3	

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C319.1	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2
C319.2	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2
C319.3	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2
C319.4	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2
C319.5	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2
C319.6	3	3	2	1	1	1	1	1	1	1	1	1	2	2	2

20ME6A1	PIPING DESIGN ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on piping processes
- To understand the piping layout and stresses acting on it.
- To evaluate the geometry and dimensions of piping design
- To identify and correct the design errors and create the safe working environment
- To learn the concept of piping layout and the stresses acting on it.

PREREQUISITE:

Course Code: 20GE201, 20BS202,20ME301, 20ME302

Course Name: Engineering Graphics, Applied Physics, Strength of Materials, Fluid mechanics and Machinery

UNIT - I INTRODUCTION TO PIPING 9

Introduction to Piping, Piping components- Fittings- Flanges, Valves , Gaskets ,Bolting and piping special items, Piping Codes and Standards used in power and process industries, Types of equipment's, Types of instruments, Process diagrams – PFD, UFD, P and IDs and line list etc.,

UNIT – II PIPING MATERIALS 9

Basics of metallurgy, Piping commodity's material grades, Influence of corrosion piping design, preparation of piping material specifications, piping wall thickness calculations, Branch reinforcement calculations, and Valve material specification.

UNIT - III DESIGN OF LAYOUT 9

Preparation of plot plan preparation of equipment layouts, Preparation of piping general arrangement drawings, preparation of cross sectional drawings, piping isometric drawings, Introduction to piping software tools.

UNIT – IV JUNCTION STRESSES, OPENINGS AND REINFORCEMENTS 9

Stresses in piping systems-discontinuity stresses-thermal stresses-methods of determination stresses-stress concentration in plate having circular hole due to bi-axial loading-Theory of reinforced opening and reinforcement elements.

UNIT - V INTRODUCTION TO STRESS ANALYSIS 9

Types of stresses-Significance of forces and moments in piping system-Expansion loop and bellows-pipe supports-types of supports-support selection-Support location-Support Span Calculation.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mohinder L Nayyar, "Piping Handbook", McGraw Hill Handbook, 7th Edition, 2000.
2. George A Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair", CRC Press, 2003.
3. Roy A. Parisher, Rhea, "Pipe Drafting and Design", Gulf Professional Publishing, 2012.

REFERENCES:

1. Samkannapan,Introduction to Pipe stress analysis"Abi Enterprises Inc.,2008
2. Peter Smith, Fundamentals of piping design",Gulf publishing Company,2007
3. "Power and Process Piping Standards" ASME B 31.1 & B 31.3, 2012.
4. Kellogg M W, "Design of Piping Systems", John Wiley & Sons, 2019.
5. Liang-ChuanPeng and Tsen-LoongPeng, "Pipe Stress Engineering", ASME Press, New York, 2009.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PIPING DESIGN ENGINEERING												Course Code : 20ME6A1			
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**				**PSOs**
C316E1.1	Explain the various piping components and process diagrams								1	K2	1,2,3,8,9,10,12				2
C316E1.2	Apply various codes and standards for piping systems								1	K3	1,2,3,8,9,10				1
C316E1.3	Calculate the piping wall thickness and branch reinforcement								2	K3	1,2,3,9				1
C316E1.4	Draw the layout for piping systems and equipment								3	K2	1,2,3,8				1
C316E1.5	Determine the stresses induced in the pipes under various loadings								4	K3	1,2,3,8,9,10				1
C316E1.6	Explain the concept of piping layout and stresses acting on it.								5	K2	1,2,3,8,9,10				1
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E1.1	3	2	1	-	-	-	-	1	**1**	1	-	1	-	1	-
C316E1.2	3	2	1	-	-	-	-	2	2	1	-	-	1	-	-
C316E1.3	3	2	1	-	3	-	-	1	-	-	-	-	1	-	-
C316E1.4	3	2	1	-	-	-	-	1	-	-	-	-	1	-	-
C316E1.5	3	2	1	-	-	-	-	1	1	1	-	-	1	-	-
C316E1.6	3	2	1	-	-	-	-	2	2	1	-	-	1	-	-

20ME6A2	PRODUCT DESIGN AND DEVELOPEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand various global trends and identify the scope of a new product development.
- To translate conceptual idea into detailed design.
- To understand the concept of product development.
- To impart knowledge on various industrial design process.
- To create prototype to demonstrate the product.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Strategic importance of Product development – Modern Product development process – Examples of Product development process - Understanding customer needs – Types of Customer needs - Gathering Customer needs – Benchmarking and Establishing Engineering Specifications – A benchmarking Approach - Examples.

UNIT – II CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT - III PRODUCT ARCHITECTURE 9

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues.

UNIT – IV DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs– Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes

UNIT - V INDUSTRIAL DESIGN 9

Integrated process design – Managing costs – Robust design – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process– conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Tata McGraw Hill Education, 4thEdition, 2009.
2. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint 2004, Pearson Education.
3. George E Dieter, Linda C Schmidt, “Engineering Design”, Mc-Graw Hill International Edition, 5th Edition, 2012

REFERENCES:

1.Kemnneth Crow, Concurrent Engg./Integrated Product Development, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2.Stephen Rosenthal, Effective Product Design and Development, Business One Orwin, Homewood, 1992.
3.Staurt Pugh, Tool Design -Integrated Methods for Successful Product Engineering, Addison Wesley Publishing, New york.
4.Reddy G B, "Intellectual Property Rights and the Law", Gogia Law Agency, 7th Edition Reprint, 2009
5. Chiu-Shui Chan, "Style and creativity in design" Springer, 2015.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PRODUCT DESIGN AND DEVELOPEMENT											**Course Code : 20ME6A2**				
CO	**Course Outcomes**							**Unit**	**K-CO**	**POs**			**PSOs**		
C316E2.1	Explain the basic concepts of product design and development							I	K2	1,2,3,6,9,10			1,2,3		
C316E2.2	Describe the basic concepts of concurrent Engineering							I	K2	1,2,3,6,9,10			1,2,3		
C316E2.3	Generate various concepts for a product design and to select the best concept							II	K3	1,2,3,4,6,9,10			1,2,3		
C316E2.4	Discuss the concepts and importance of product architecture							III	K2	1,2,3,6,9,10			1,2,3		
C316E2.5	Illustrate the importance of industrial design in view of aesthetics factors and ergonomic factors							IV	K2	1,2,3,6,9,10			1,2,3		
C316E2.6	Apply design for manufacture guidelines for reducing manufacturing cost without compromising quality							V	K3	1,2,3,4,6,9,10			1,2,3		
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E2.1	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
C316E2.2	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
C316E2.3	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1
C316E2.4	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
C316E2.5	3	2	1	-	-	1	-	-	1	1	-	-	2	1	1
C316E2.6	3	2	1	1	-	1	-	-	1	1	-	-	2	1	1

20ME6A3 DIGITAL MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the technological advancements in industrial production.
- To learn about the product life cycle management.
- To understand about the digital thread and digital twin.
- To learn about Big data and cloud computing.
- To understand about machine learning and artificial intelligence.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO DIGITAL MANUFACTURING 9

Definition-Components of DM- Introduction to 4th industrial revolution-cyber physical systems-Introduction to Digital thread and Digital twin- Introduction to product life cycle management (PLM),

UNIT – II DIGITAL THREAD 9

Digital thread components-Data Sharing Strategies- Interoperability and Data Formats-semantic data-Technical data packages-Strategic issues in implementing the digital thread-Cyber infrastructure Components of the Digital Thread –Digital Thread and the Manufacturing Enterprise. Case study on smart factory using Digital thread.

UNIT - III DIGITAL TWIN 9

Types of Digital Twin -Product twin – Process Twin – Performance Twin-Virtual commissioning of Digital Twin– Data mapping – Simulation of Digital Twin – Data collection and visualization-Case study on smart factory using Digital twin.

UNIT – IV ADVANCED MANUFACTURING PROCESS ANALYSIS 9

Data analysis-Manufacturing Settings and Data Collection-Traditional Data Sets vs Big Data-Data Storage and Organization-Data preprocessing- computational techniques and platform-Components, Categories and Capabilities-high performance and cloud computing

UNIT - V INTELLIGENT MANUFACTURING 9

Concepts and features of intelligent Manufacturing –Intelligent Multi Information Sensing and Fusion in the Manufacturing Process -Intelligent machining components- sensors and sensing techniques-machine learning and artificial intelligence in sensing techniques.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Zudezhou ,"Fundamentals of Digital Manufacturing Science",Springer,2012
2. Mark J. Barrenechea, Tom Jenkins, "Digital manufacturing", open text corpn,2018
3. KEN English, "Specialization course in Digital Manufacturing Design and Technology", Coursera.

REFERENCES:

1. Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018
2. Tien-Chein Chang, Richard A. Wysk, Hsu-Pin (Ben) Wang, Computer Aided Manufacturing (2016), Pearson Education.
3. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.
4. Elvis Hozdić, "Smart factory for Industry 4.0" International Journal of Modern Manufacturing Technologies ISSN 2067–3604, Vol. VII, No. 1 / 2015
5. Frank Lamb, Industrial Automation: Hands On, McGraw Hill Professional, 2013.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:Course Name : DIGITAL MANUFACTURING												**Course Code : 20ME6A3**			
CO	**Course Outcomes**								**Unit**	**K-CO**		**POs**			**PSOs**
C316E3.1	Describe the basic components of Digital manufacturing								I	K2		1,2			1,2
C316E3.2	Implement digital thread components in Manufacturing enterprise								II	K3		1,2,3,5			1,2
C316E3.3	Perform virtual commissioning of Digital Twin in Smart Factory								III	K3		1,2,3,5			1,2
C316E3.4	Perform advanced manufacturing process analysis in digital manufacturing enterprise								IV	K3		1,2,3,5,7,10			1,2
C316E3.5	Design intelligent manufacturing operations in manufacturing enterprise.								V	K3		1,2,3,5,11,12			1,2
C316E3.6	Formulate business models for advanced manufacturing process								V	K3		1,2,3,12			1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E3.1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-
C316E3.2	3	2	1	-	2	-	-	-	-	-	-	-	2	1	-
C316E3.3	3	2	1	-	3	-	-	-	-	-	-	-	2	1	-
C316E3.4	3	2	1	-	1	-	2	-	-	2	-	-	2	1	-
C316E3.5	3	2	1	-	1	-	-	-	-	-	3	2	2	1	-
C316E3.6	3	2	1	-	-	-	-	-	-	-	-	2	2	1	-

20ME6A4 FUNDAMENTALS OF HVAC SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES

- To learn climate variation and its effects on the building heat load.
- To learn building material characteristics and their influence on building heating / cooling load for all weather conditions.
- To study various conversation techniques related to build environment and codes for the same.
- To study various basic concepts related to Duct Installation, Duct Design, Zone Control Systems
- To study various basic concepts related Chilled Water Systems, Cooling Towers, Commercial Refrigeration Systems

PREREQUISITE:

Course Code: 20ME302, 20ME304

Course Name: Fluid Mechanics and Machinery, Engineering Thermodynamics

UNIT - I REFRIGERATION CYCLE 9

Unit of refrigeration, Refrigerating effect, Carnot COP - Refrigerator & heat pumps, Limitations of Carnot cycle

Refrigerants - Definition, Nomenclature, Classification, Essential and Desirable Properties, ODP, GWP & TEWI – and other Environmental issues

Refrigeration cycle - Simple vapour compression – P-h diagram, T-S diagram, COP, Heat rejection ratio, different processes, Effect of sub cooling and super heating, Effect of suction and discharge pressures on the cycle performance, Actual compression cycle – use of P-h charts and Tables.

Vapour absorption and adsorption systems, steam jet, Thermoelectric etc.- concepts only

UNIT – II MAIN COMPONENTS OF HVAC 9

Compressor : Types, classification, Constructional details, working, Selection, capacity control and performance comparison. Condenser: Types, working , Heat transfer estimation, Selection and application , factors affecting condenser performance. Evaporators : Types , heat transfer estimation, selection and application, factors affecting evaporator performance Expansion Devices: Types, Selection and application, Performance

UNIT - III PSYCHROMETRY & HEAT LOAD 9

Psychrometry: Psychrometric terms, Use of Psychrometric Chart, Various Psychrometric processes –Determination of ADP, Enthalpy Calculations , Plotting of air conditioning processes in chart. Factors affecting human comfort, Comfort parameters, Comfort chart. Heat Load Estimation Air Conditioning,

Data collection for Heat load, Study of Drawings, Procedure for heating and cooling load estimation: Interpretation of heat load estimations, Heat load estimation Refrigeration: Product storage temperatures, Design input data, Procedures for estimation of cooling load.

UNIT – IV AIR CONDITIONING SYSTEMS 9

Selection of systems for different Applications: Residential, Commercial – Hotels, Mall, Hospitals, Industrial etc. Window, Ductless split ACs, Package and Ductable units, VRFs/VRV, large DX systems with AHUs, Air cooled and water cooled condensing units. Chilled water systems: Air and water cooled chillers – compressors, types and capacities range and applications, AHUs, Pumps, Fans, Cooling towers and other allied components..

UNIT - V AIR DISTRIBUTION & CONTROL SYSTEMS 9

Duct design methodologies, Different types of duct design, Selection of air terminals, dampers, filters etc. Pressure drop estimation, Constant volume systems, variable air volume systems, VAV boxes, Single duct cooling and heating, VAV with parallel and series fan powered, induction VAVs , accessories, Types of Room air Distribution Systems.

Fan: Law, Types including ventilation, Selection of fan for various applications, Piping design, Pump and Pumping systems Chilled and cooling water – Types, Selection, Head Requirement, Motor sizing, Electrical Fundamentals, Electrical Control and BMS: Fundaments of Control, Types of controllers, Control systems applicable to Chillers, VRF etc., BMS, Introduction to BAC net.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. James E. Brumbaugh Audel, Fundamentals of HVAC Systems Wiley Publications. 4th Edition,2004
2. Roy J. Dossat, Principles of Refrigeration, Pearson, 5th Edition, 2007
3. Richard C. Jordon and Gayle B.Priester, Refrigeration and Air Conditioning Prentice Hall India, 15th Edition, 2000

REFERENCES:

1. Hand book of heating, ventilation and Air-conditioning, Jan. F. Kreider, CRC press. 2000
2. Mike Stubblefield John Harold Haynes - Automotive Heating & Air Conditioning Systems Manual, Haynes Manuals, 2000
3. John W. Mitchell, James E. Braun, Principles of Heating, Ventilation, and Air Conditioning in Buildings, Wiley Publications, 2013.
4. Roger W. Haines, Control Systems for Heating, Ventilating and Air Conditioning, Springer US, 2000
5. Arthur A. Bell Jr., PE, HVAC Equations, Data and Rules of Thumb-McGraw-Hill Professional, 2000

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : FUNDAMENTALS OF HVAC SYSTEMS											**Course Code : 20ME6A4**				
CO	**Course Outcomes**							**Unit**	**K-CO**	**POs**			**PSOs**		
C316E4.1	Estimate heating loads, space heat gains and space cooling loads using accepted engineering methods.							1	K2	1,2,3,4,5,6,7,8			1,2,3		
C316E4.2	Explain the phenomena of various heating systems, like gas and oil furnace also understand the concept of Troubleshooting of heating systems							2	K2	1,2,3,4,6,7,			1,2,3		
C316E4.3	Explain the Fundamentals of Heat Pumps and its Applications							2	K2	1,2,3,4			1,2,3		
C316E4.4	Determine the coil loads for cooling and heating systems							3	K3	1,2,3,4			1,2,3		
C316E4.5	Select equipment and design systems to provide comfort conditions within the building.							4	K3	1,2,3,4			1,2,3		
C316E4.6	Explain the working principle of chillers used in Commercial Refrigeration Systems							5	K2	1,2,3,4			1,2,3		
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E4.1	3	3	2	2	1	2	1	1	-	-	-	-	3	2	1
C316E4.2	3	2	2	2	-	2	1	-	-	-	-	-	3	2	1
C316E4.3	3	2	2	1	-	-	-	-	-	-	-	-	3	2	1
C316E4.4	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
C316E4.5	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
C316E4.6	3	2	1	1	-	-	-	-	-	-	-	-	3	2	1

20ME6A5	RENEWABLE ENERGY SOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the importance of renewable energy
- To understand the functioning of solar power plant
- To understand the functioning of wind power plant
- To understand the mechanism of conversion of biomass into power
- To understand the principle of producing power from wave, tidal and fuel cells

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamilnadu, Present renewable energy status in India and around the World – Potentials - Achievements / Applications – Economics of renewable energy systems.

UNIT – II SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Solar thermal energy storage -Fundamentals of Solar Photo Voltaic Conversion – Solar Cells -– Solar PV Power Generation – Solar PV Applications

UNIT - III WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental issues - Applications

UNIT – IV BIO - ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration - Carbonization – Pyrolysis -Biomass Applications

UNIT - V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen production and Storage - Transport and utilization - Safety issues. Fuel Cell Systems – Hybrid Systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1.Rai. G.D., "Non Conventional Energy Sources", 6th edition, Khanna Publishers, New Delhi, 2017.

2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", 3rd edition, EFN Spon Ltd., UK, 2015.

3. Qiuye Sun, “Energy Internet and We energy”, Springer Nature Singapore Pvt. Ltd., 2018

REFERENCES:

1. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.
2. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017
3. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
4. S. Rao & Dr. B.B.Parulekar. "Energy Technology Nonconventional, Renewable & Conventional", Khanna Publishers, New Delhi , 2015
5. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : RENEWABLE ENERGY SOURCES													**Course Code : 20ME6A5**		
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
C316E5.1	Explain the importance and Economics of renewable Energy											I	K2	1,2,3,4,6,711	1,2,3
C316E5.2	Explain the method of power generation from Solar Energy											II	K2	1,2,3,4,6,7	1,2,3
C316E5.3	Explain the method of power generation from Wind Energy											III	K2	1,2,3,4,6,7	1,2,3
C316E5.4	Explain the method of power generation from Bio Energy											IV	K2	1,2,3,4,6,7	1,2,3
C316E5.5	Explain the power generation method from the newer renewable energy source											V	K2	1,2,3,4,6,7	1,2,3
C316E5.6	Choose the appropriate power plant by applying the knowledge of characteristics of different power plant and explain its function											II,III ,IV,V	K3	1,2,3,4,6,7, 11,12	1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E5.1	2	1	1	1	-	1	2	-	-	-	1	-	2	1	1
C316E5.2	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
C316E5.3	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
C316E5.4	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
C316E5.5	2	1	1	1	-	1	2	-	-	-	-	-	2	1	1
C316E5.6	3	2	1	1	-	1	2	-	-	-	1	1	2	1	1

20ME6A6	APPLIED HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the basic concepts of fluid power system.
- To know about the utilization of cylinders, accumulators, valves and various electrical and electronic control components.
- To gain knowledge in design, construction and operation of fluid power circuits.
- To develop the skills in trouble shooting the hydraulic and pneumatic circuits.
- To understand the applications of hydraulic and pneumatic circuits in modern manufacturing industries.

PREREQUISITE:

Course Code: 20ME302

Course Name: Fluid mechanics and Machinery

UNIT - I INTRODUCTION TO FLUID POWER AND HYDRAULIC POWER DRIVES 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids – Properties of fluids and selection – Basics of Hydraulics – Pascal's Law.

Hydraulic power drives: Pumping Theory – Pump Classification – Construction, Working, Design, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps and motors.

UNIT – II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications- Fluid Power ANSI Symbols.

UNIT - III HYDRAULIC CIRCUITS AND SYSTEMS 9

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

UNIT – IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Basic principles of Pneumatics, Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators.

Design of Pneumatic circuit – Cascade method for sequencing – Electro Pneumatic System – Elements – Programmable Logic Controllers - Ladder diagram, Timers and Counters.

UNIT - V TROUBLE SHOOTING AND APPLICATIONS 9

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

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Anthony Esposito, "Fluid power with Applications," Pearson Education, 7th Edition, 2009.
2. Majumdar S.R., "Oil Hydrualics Systems- Principles and Maintenance", Tata McGraw- Hill, July 2017.
3. James L. Johnson "Introduction to Fluid Power" Delmar Thomson Learning Publishers 2002.

REFERENCES:

1. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2015.
2. Peter Rohner, Fluid Power Logic Circuit Design, Macmillan Publishers, 1994.
3. Eaton Hydraulics Training Services (Vickers), Industrial Hydraulics Manual 6th Edition. 2015.
4. Frank Yeaple, Fluid Power Design Handbook, 3rd Edition, CRC Press, October 24, 1995.
5. James R. Daines -Fluid Power: Hydraulics and Pneumatics 2nd Edition, Textbook Edition, GW publisher 2009.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : APPLIED HYDRAULICS AND PNEUMATICS											**Course Code : 20ME6A6**				
CO	**Course Outcomes**								**Unit**	**K-CO**	**POs**			**PSOs**	
C316E6.1	Discuss the function of different types of hydraulic pumps and motors.								I	K2	1,2,3,4			1,2,3	
C316E6.2	Describe the features and functions of hydraulic actuators, Direction and Flow control valves.								II	K2	1,2,3,4			1,2,3	
C316E6.3	Develop fluid power multi actuation circuits for various purposes in industry.								III	K3	1,2,3,4,5,6			1,2,3	
C316E6.4	Discuss the working of different pneumatic and electro pneumatic components, circuits and systems.								IV	K2	1,2,3,4,5,6			1,2,3	
C316E6.5	Construct the cascaded electro pneumatic circuits for requiring cylinder sequences.								IV	K3	1,2,3,4,5,6			1,2,3	
C316E6.6	Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.								V	K2	1,2,3,4,6			1,2,3	
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E6.1	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1
C316E6.2	2	2	1	1	-	-	-	-	-	-	-	-	2	2	1
C316E6.3	3	2	1	1	3	1	-	-	-	-	-	-	2	2	1
C316E6.4	2	2	1	1	3	1	-	-	-	-	-	-	2	2	1
C316E6.5	3	2	1	1	3	1	-	-	-	-	-	-	2	2	1
C316E6.6	2	2	1	1	-	1	-	-	-	-	-	-	2	2	1

20ME6A7 STATISTICAL QUALITY CONTROL

L	T	P	C
3	0	0	3

Use of Statistical quality control table is permitted

OBJECTIVES

- To develop the basic concepts of quality control procedures.
- To impart knowledge about designing and implementation of Statistical Process control in any industry.
- To design and implement acceptance sampling inspection methods in industry.
- To study the process and machine capability.
- To develop the applications of various charts.

PREREQUISITE:

Course Code: 20BS401

Course Name: Statistics and Numerical Methods

UNIT - I QUALITY FUNDAMENTALS 9

Quality – Importance, evolution, definitions, dimensions of quality. Quality control, quality assurance, areas of quality, quality planning, quality objectives and policies, quality costs, economics of quality, Quality loss function, quality Vs productivity, Quality Vs reliability.

UNIT – II CONTROL CHARTS FOR VARIABLES 9

Control Charts for Variables: Control Charts for X bar and R (statistical basis, development and use, estimating process capability; interpretation, the effect of non- normality on the chart, the OC function, average run length); Control Charts for X bar and S; Control Chart for Individual Measurements; Applications of Variables Control Charts

UNIT - III CONTROL CHARTS FOR ATTRIBUTES 9

Control Chart for Fraction-Nonconforming (OC curve of the control chart, variable sample size, nonmanufacturing application, the OC function and ARL calculation); Control Charts for Nonconformities or Defects; Choices Between Attribute and Variable Control Charts, Guideline for Implementing Control charts.

UNIT – IV STATISTICAL PROCESS CONTROL 9

Process stability- process capability study using control charts, capability indices, capability analysis using histogram and normal probability plot, machine capability study, gauge capability study- setting statistical tolerances for components and assemblies. Natural Tolerance Limits of a Process - Based on the Normal Distribution, Nonparametric Tolerance Limits, Predictive model for SQC

UNIT - V ACCEPTANCE SAMPLING 9

Lot-By-Lot Acceptance Sampling For Attributes - The accepting sampling problem, single sampling plan for attributes, Double, Multiple, and sequential sampling, Dodge-Roming sampling plans (AOQL and LTPD plans).

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Douglus C. Montgomery, “Introduction to Statistical Quality Control”, Wiley-India, 7th Edition, 2015.
2. Krishnaiah K.,” Applied Statistical Quality Control and Improvement”, PHI, 2017.
3. Dale H. Besterfield, Quality Control, Pearson Education Asia, 8th Edition, 2018.

REFERENCES:

1. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Wiley, 3rd Edition, 2018.
2. Eugene L. Grant and Richard S. Leaven Worth, “Statistical Quality Control”, McGraw-Hill Education, 7th Edition, 2018.
3. Monohar Mahajan, “Statistical Quality Control”, Dhanpat Rai & Sons, 2017.
5. Statistical Quality Control, R C Gupta, Khanna Publishers, New Delhi, 2015

OUTCOMES:
AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : STATISTICAL QUALITY CONTROL		**Course Code : 20ME6A7**			
CO	**Course Outcomes**	**Unit**	**K-CO**	**POs**	**PSOs**
C316E7.1	Explain the basic Concepts of Quality and its tools.	I	K3	1,2,3,8,10	1,2,3
C316E7.2	Construct the X bar, R & σ charts from the available data.	II	K3	1,2,3,9,10	1,2,3
C316E7.3	Construct the p, np, c & u charts from the available data	II	K3	1,2,3,8,10	1,2,3
C316E7.4	Control the occurrence of defects in product or service industries.	III	K3	1,2,3	1,2,3
C316E7.5	Select and apply appropriate quality control technique for given application.	IV	K3	1,2,3,8	1,2,3
C316E7.6	Measure the performance of the sampling plans	V	K3	1,2,3,8,9,10	1,2,3

CO-PO Mapping

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C316E7.1	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1
C316E7.2	3	2	1	-	-	-	-	-	2	2	-	2	3	2	1
C316E7.3	3	2	1	-	-	-	-	2	-	2	-	2	3	2	1
C316E7.4	3	2	1	-	-	-	-	-	-	-	-	2	3	2	1
C316E7.5	3	2	1	-	-	-	-	2	-	-	-	2	3	2	1
C316E7.6	3	2	1	-	-	-	-	1	2	2	-	2	3	2	1

20OE101	MECHATRONICS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To enable the students understand the basic concepts of mechatronics and measurement systems.
- To teach students about the various types of sensors and transducers.
- To enable the students understand the functions of various Signal Conditioning devices and Data Acquisition system.
- To develop the skills of students in describing the functions and applications of PLC and SCADA system.
- To enable the students understand the applications of Mechatronics system.

PREREQUISITE: NIL

UNIT - I INTRODUCTION TO MECHATRONICS AND MEASUREMENT SYSTEM 9

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – key elements of mechatronics system - Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Generalized Measurement System – Performance Characteristics: Static and Dynamic Characteristics – Errors in Measurements – Statistical Analysis of errors - Calibration and Standards.

UNIT – II SENSORS AND TRANSDUCERS 9

Static and dynamic Characteristics of Sensor - Potentiometers – LVDT – Capacitance sensors – Strain gauges – Piezoelectric sensor - Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors- optical encoders – proximity sensors -Ultrasonic sensor.

UNIT - III SIGNAL CONDITIONING AND DATA ACQUISITION 9

Amplification, Filtering – Level conversion – Linearization - Buffering – Sample and Hold circuit – Quantization – Multiplexer / Demultiplexer – Analog to Digital converter – Digital to Analog converter I/P and P/I converter - Instrumentation Amplifier-V/F and F/V converter- Data Acquisition - Data Logging – Data conversion –Introduction to virtual instrumentation.

UNIT – IV PROGRAMMABLE LOGIC CONTROLLER AND SCADA SYSTEM 9

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

Introduction to SCADA – Typical SCADA System Architecture – Communication Requirements – Desirable properties of SCADA system – Applications of SCADA

UNIT - V APPLICATIONS OF MECHATRONICS SYSTEM 9

Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier – Washing machine system – Automatic camera.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. W.Bolton, “Mechatronics, Electronic control systems in Mechanical and Electrical Engineering”, Pearson Education, 2015.
3. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES:

1. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International 4th Edition, 2011.
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
3. Smaili.A and Mrad.F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2008.
4. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
5. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 2009.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : MECHATRONICS AND APPLICATIONS													**Course Code : 20OE101**		
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
C305E1.1	Describe the key elements, functions of mechatronics and measurement systems.											I	K3	1,2,3,4,10,12	1,2,3
C305E1.2	Describe the working principles and characteristics of various types of sensors.											II	K3	1,2,3,4,10,12	1,2,3
C305E1.3	Discuss about the functions of Signal Conditioning devices and Data Acquisition system.											III	K3	1,2,3,4,5,10,12	1,2,3
C305E1.4	Develop the ladder logic diagram for various automatic control operations with PLC.											IV	K3	1,2,3,4,5,10,12	1,2,3
C305E1.5	Describe the architecture, desirable properties and applications of SCADA system.											IV	K3	1,2,3,4,5,10,12	1,2,3
C305E1.6	Describe the industrial and domestics applications of various mechatronics system.											V	K3	1,2,3,4,10,12	1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C305E1.1	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1
C305E1.2	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1
C305E1.3	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1
C305E1.4	3	3	1	1	1	-	-	-	-	1	-	1	3	2	1
C305E1.5	3	3	1	1	1	-	-	-	-	1	-	1	3	2	1
C305E1.6	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1

20OE102	SOLID FREE FORM MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the evolution of Solid Freeform Manufacturing proliferation into various fields.
- To gain knowledge on Design for Additive Manufacturing and its importance in quality improvement of fabricated parts.
- To impart knowledge in polymerization and sheet lamination processes and their applications.
- To know about material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.

UNIT – II DESIGN FOR ADDITIVE MANUFACTURING 9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies.

UNIT - III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES 9

Stereo lithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications. Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT – IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

UNIT - V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations. Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
2. W.Bolton, “Mechatronics, Electronic control systems in Mechanical and Electrical Engineering”, Pearson Education, 2015.
3. Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES:

1. Michael B.Histand and Davis G.Alciatore, “Introduction to Mechatronics and Measurement systems”, McGraw Hill International 4th Edition, 2011.
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993.
3. Smaili.A and Mrad.F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2008.
4. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, PWS publishing company, 2007.
5. John Turner and Martyn Hill, “Instrumentation for Engineers and Scientists”, Oxford Science Publications, 2009.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : SOLID FREE FORM MANUFACTURING											**Course Code : 20OE102**				
CO	**Course Outcomes**										**Unit**	**K-CO**	**POs**		**PSOs**
C305E2.1	Recognize the importance in the evolution of SFM, proliferation into the various fields and its effects on supply chain.										I	K3	1,2,3,4,10,12		1,2,3
C305E2.2	Evaluate the design for AM and its importance in the quality of fabricated parts.										II	K3	1,2,3,4,10,12		1,2,3
C305E2.3	Describe the principles and applications of polymerization and sheet lamination processes with case studies.										III	K3	1,2,3,4,5,10,12		1,2,3
C305E2.4	Explain principles of material extrusion and powder bed fusion processes and design guidelines.										IV	K3	1,2,3,4,5,10,12		1,2,3
C305E2.5	Perceive jetting and direct energy deposition processes and their applications.										IV	K3	1,2,3,4,5,10,12		1,2,3
C305E2.6	Recognize the importance in the evolution of SFM, proliferation into the various fields and its effects on supply chain.										V	K3	1,2,3,4,10,12		1,2,3
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C305E2.1	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1
C305E2.2	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1
C305E2.3	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1
C305E2.4	3	3	1	1	1	-	-	-	-	1	-	1	3	2	1
C305E2.5	3	3	1	1	1	-	-	-	-	1	-	1	3	2	1
C305E2.6	3	3	1	1	-	-	-	-	-	1	-	1	3	2	1

20OE103	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the properties .Classification and Nomenclature of different Refrigerant.
- To understand the underlying principles of operations in different Refrigeration & Air Conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration.
- To understand the psychrometric properties and processes.
- To provide knowledge on Air Conditioning Systems with Controls

PREREQUISITE:

20ME304 Engineering Thermodynamics
20ME403 Thermal Engineering

UNIT - I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

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

UNIT – III OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems.

UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air conditioning processes, mixing of air streams.

UNIT - V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", McGraw Hill, 3rd edition, 2020.
2. R. S. Khurmi, J. K. Gupta, “A Text Book of Refrigeration and Air-conditioning”, Eurasia Publishing House, 2019.
3. W F Stoecker, Refrigeration and Air Conditioning, Mcgraw Hill Higher Education, 2019.

REFERENCES:

1. Roy J. Dossat, "Principles of Refrigeration", Pearson Education Asia, 4th edition, 2019.
2. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 2021.
3. ASHRAE Hand book, Fundamentals, 2010
4. Jones W.P., "Air conditioning engineering", Elsevier Butterworth-Heinemann, 5th edition, 2018
5. A. R. Trott, T C Welch , Refrigeration and air-conditioning, Butterworth Heinemann, 2018

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : REFRIGERATION AND AIR CONDITIONING													**Course Code : 20OE103**		
CO	**Course Outcomes**												**Unit**	**K-CO**	**POs**	**PSOs**
C305E3.1	Explain the principle of refrigeration, cycles, properties and its environment effects.												I	K2	1, 2, 3	1, 2, 3
C305E3.2	Calculate COP of vapor compression Cycle for different processes.												II	K3	1, 2, 3	1, 2, 3
C305E3.3	Explain the different types and working principle of refrigeration Equipment’s.												II	K2	1, 2, 3	1, 2, 3
C305E3.4	Describe the working principle of various types of refrigeration systems.												III	K2	1, 2, 3	1, 2, 3
C305E3.5	Discuss psychrometric properties and processes, and air conditioning process												IV	K2	1, 2, 3	1, 2, 3
C305E3.6	Estimate cooling load factor, winter and summer air conditioning load and human comfort condition.												V	K3	1, 2, 3	1, 2, 3
CO-PO Mapping																
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO 3**	
C305E3.1	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
C305E3.2	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	
C305E3.3	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
C305E3.4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
C305E3.5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	1	
C305E3.6	3	2	1	-	-	-	-	-	-	-	-	-	3	2	1	

20OE104	PRODUCTION AND OPERATIONS MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- To gain knowledge about forecasting techniques in both manufacturing and service industry.
- To know about the inputs, strategies and models for aggregate planning.
- To understand the concepts of MRP and ERP.
- To know about the tools for capacity planning.

PREREQUISITE: NIL

UNIT - I INTRODUCTION 9

Objectives of Operations Management, Scope of Operations Management, Relationship of Operations with other Functional areas, Manufacturing Vs Service sector, Operations Decision making, Phases in Product Design and Development, Product Life Cycle, Process Selection.

UNIT – II FORECASTING 9

Need, Determinants of Demand, Demand Patterns, Qualitative Forecasting Methods-Delphi techniques. Market Research, Nominal Group Technique. Quantitative Forecasting methods – Moving Average Methods, Exponential Smoothing Methods, Regression methods, Monitoring and Control of Forecasts, Requirements and Selection of Good forecasting methods.

UNIT - III AGGREGATE PLANNING 9

Role of aggregate Product planning, Managerial inputs to Aggregate planning, Pure and Mixed strategies, Mathematical Models for Aggregate planning – Transportation Method, Linear programming Formulation, Linear Decision Rues, Master Production Schedule(MPS), Procedure for developing MPS.

UNIT – IV MRP AND ERP 9

MRP -Lot sizing methods – Implementation issues, MRP – II.

ERP – evolution, comparison of ERP with traditional systems, benefits, need for ERP, overview of modules in ERP. ERP implementation: Requirement analysis, alternatives, life cycle, implementation methodology.

UNIT - V CAPACITY MANAGEMENT 9

Measures of capacity, Factors affecting capacity, Capacity Planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning, Capacity Requirement Planning- Business Process Outsourcing.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Chase R.B, Nicholas J. Aquilano, F.and Jacobs R, "Production and Operations Management: Manufacturing and Services, Irwin/McGraw-Hill, 2010.
2. Panneerselvam. R, "Production and operations Management", PHI, 3rd Edition, 2012.
3. Mary Sumner, "Enterprise Resource Planning", 2nd Edition, Pearson Education, 2007.

REFERENCES:

1. Lee J. Krajewski, Manoj K. Malhotra, Larry P. Ritzman, “Operations Management: Processes and Supply Chains”, Pearson Education,11th Edition,2015
2. Norman Gaither, Greg Frazier, “Operations Management”, Thomson Learning, 9th Edition, 2002.
3. William J Stevenson, “Operations Management”, McGraw Hill, 13th Edition, 2018.
4. Hiller and Liberman, “Introduction to Operations Research”, McGraw Hill, 2015.
5. Jay Heizer, Barry Render, Chuck Munson, "Operations Management: Sustainability and Supply Chain Management", Pearson, 2017.

OUTCOMES:

AT THE END OF THE COURSE, LEARNERS WILL BE ABLE TO:

Course Name : PRODUCTION AND OPERATIONS MANAGEMENT												**Course Code : 20OE104**			
CO	**Course Outcomes**											**Unit**	**K-CO**	**POs**	**PSOs**
C305E4.1	Explain the different phases in product design and development.											I	K3	1,2,3,4,10,12	1,2
C305E4.2	Forecast demand for Production and Service Systems.											II	K3	1,2,3,4,10,12	1,2
C305E4.3	Formulate and Assess Aggregate Planning strategies and Material Requirement Plan.											III	K3	1,2,3,4,5,10,12	1,2
C305E4.4	Determine the lot size of a product for the given conditions in an industry.											IV	K3	1,2,3,4,5,10,12	1,2
C305E4.5	Describe the ERP implementation methodology with an example.											IV	K3	1,2,3,4,5,10,12	1,2
C305E4.6	Calculate capacity requirements and developing capacity alternatives.											V	K3	1,2,3,4,10,12	1,2
CO-PO Mapping															
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C305E4.1	3	2	1	1	-	-	-	-	-	1	-	1	2	1	-
C305E4.2	3	2	1	1	-	-	-	-	-	1	-	1	2	1	-
C305E4.3	3	2	1	1	-	-	-	-	-	1	-	1	2	1	-
C305E4.4	3	2	1	1	1	-	-	-	-	1	-	1	2	1	-
C305E4.5	3	2	1	1	1	-	-	-	-	1	-	1	2	1	-
C305E4.6	3	2	1	1	-	-	-	-	-	1	-	1	2	1	-