BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOTE- 587 102
Academic Year: 2021-22

I[st] Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2021 – 22 academic year (2021-22 admitted regular batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1.	BSC	21UCH110C	Engineering Chemistry	3.0	3	-	-	50	50	100
2.	CV	21UCV111C	Engineering Mechanics	*3.0*	3	-	-	50	50	100
3.	HSS	21UHS106C	Communicative English	*2.0*	2	-	-	50	50	100
4.	HSS	21UHS115C	Innovation and Design Thinking	*2.0*	2	-	-	50	50	100
5.	BSC	21UMA101C	Engineering Mathematics-I	3.0	3	-	-	50	50	100
6	ME	21UME112C	Elements of Mechanical Engineering	3.0	3	-	-	50	50	100
7.	BSC	21UCH114L	Engineering Chemistry Laboratory	1.0	-	-	2	50	50	100
8.	ME	21ME113L	Computer Aided Engineering Drawing	3.0	2	-	2	50	50	100
			Total	**20**	**18**	**-**	**04**	**400**	**400**	**800**

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOTE- 587 102
Academic Year: 2022-23

IInd Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2021 – 22 academic year (2021-22 admitted regular batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1.	BSC	21UMA201C	Engineering Mathematics-II	3.0	3	-	-	50	50	100
2.	BSC	21UPH202C	Engineering Physics	*3.0*	3	-	-	50	50	100
3.	CS	21UCS203C	Principles of Programming with C	*3.0*	3	-	-	50	50	100
4.	EC	21UEC204C	Basic Electronics	*3.0*	2	2	-	50	50	100
5.	EE	21UEE205C	Basic Electrical Engineering	*3.0*	3	-	-	50	50	100
6	HSS	21UHS206C	Professional Writing Skills in English	*2.0*	2	-	-	50	50	100
7.	HSS	21UHS207C	Scientific Foundation of Health	*1.0*	-	-	2	50	50	100
8.	BSC	21UPH208L	Engineering Physics Laboratory	*1.0*	-	-	2	50	50	100
9.	CS	21UCS209L	Programming Practice Using C	1.0	-	-	2	50	50	100
			Total	**20**	**16**	**2**	**6**	**450**	**450**	**900**

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOTE- 587 102
Academic Year: 2022-23

III[rd] Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2022 – 23 academic year (2021-22 admitted regular batch and Diploma Lateral Entry 2022-23 Batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1.	BSC	21UMA302C	Numerical Techniques and Fourier Series	3.0	3	-	-	50	50	100
2.	PCC	21UME301C	Strength of Materials	*3.0*	2	2	-	50	50	100
3.	PCC	21UME308C	Engineering Thermodynamics	*3.0*	2	2	-	50	50	100
4.	PCC	21UME303C	Manufacturing Technology-I	*3.0*	3	-	-	50	50	100
5.	PCC	21UME304L	Manufacturing Technology Lab	*1.0*	-	-	2	50	50	100
6	PCC	21UME305L	Mechanical Drawing and GD & T Lab	*2.0*	-	-	3	50	50	100
7.	AEC	21UME307L	Python Programming Lab	1.0	-	-	2	50	50	100
8.	UHV	21UHS322C	UHV	1.0	1	-	-	50	50	100
9.	HSSM	21UHS324C	SK/BK or CI	1.0	1	-	-	50	50	100
			Total	**18**	**12**	**04**	**08**	**450**	**450**	**900**

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOTE- 587 102
Academic Year : 2022-23

IVth Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2022 – 23 academic year (2021-22 admitted regular batch and Diploma Lateral Entry 2022-23 Batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1.	BSC	21UMA402C	Partial differential equations and Statistics	3.0	3	-	-	50	50	100
2.	PCC	21UME 401 C	Material Science & Metallurgy	*3.0*	3	-	-	50	50	100
3.	PCC	21UME 408 C	Manufacturing Technology-II	*3.0*	3	-	-	50	50	100
4.	PCC	21UME 403 C	Fluid Mechanics	*3.0*	2	2	-	50	50	100
5.	PCC	21UME 404 C	Theory of Machines	*3.0*	2	2	-	50	50	100
6	PCC	21UME 405 L	Material Testing and Instrumentation Lab	*1.0*	-	-	2	50	50	100
7.	PCC	21UME 406 L	CAMD Lab	*1.0*	-	-	2	50	50	100
8.	PCC	21UME 407L	Fuels and IC Engine Lab	*1.0*	-	-	2	50	50	100
9.	INT	21UME422I	Internship-I	2.0	-	-	4	50	50	100
10.	HSSM	21UHS421C	Constitution of India	1.0	1	-	-	50	50	100
			Total	**21**	**14**	**4**	**10**	**500**	**500**	**1000**

INT: **Summer Internship – I. (Annexure-I A)**
For awarding B.E. (Mechanical Engineering) degree, each student is required to complete minimum of 03 weeks of Internship during 4th semester summer to earn 02 credits which will be evaluated during 5th Semester.

UHV: Question paper will be of objective type. Students have to pass the subject compulsorily, however marks will not be considered for awarding Grade/Class/Rank.

BASAVESHWAR ENGINEERING COLLEGE, BAGALKOTE- 587 102

DEPARTMENT OF MECHANICAL ENGINEERING
Academic Year: 2023-24

Vth Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2023 – 24 academic year (2021-22 admitted regular batch and Diploma Lateral Entry 2022-23 Batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1.	PCC	21UME 501 C	*Design of Machine Elements*	*3.0*	3	-	-	50	50	100
2.	PCC	21UME 502 C	*Energy Conversion Engineering*	*3.0*	3	-	-	50	50	100
3.	PCC	21UME 503 C	*Heat Transfer*	*3.0*	3	-	-	50	50	100
4.	PCC	21UME 504 L	*Fluid Mechanics and Machinery Lab*	*1.0*	-	-	2	50	50	100
5.	PEC	21UME XXX E	*Elective - I*	*3.0*	3	-	-	50	50	100
6	OEC	XXXX XXX X	*Open Elective - I*	*3.0*	3	-	-	50	50	100
7.	HSSM	21UME 507 H	*Management and Entrepreneurship*	*3.0*	3	-	-	50	50	100
8.	INT	XXXX XXX X	Summer Internship-II	*2.0*	-	-	4	50	50	100
9.	AEC	XXXX XXX X	Soft Skill 2	2.0	2	-	-	50	50	100
			Total	**23**	**20**		**6**	**450**	**450**	**900**

INT: **Summer Internship – II.**

For awarding B.E. (Mechanical Engineering) degree, each student is required to complete minimum of 04 weeks of Internship during 4th semester summer to earn 02 credits which will be awarded during 5th Semester.

OEC: Open Elective – I is offered by other departments to Mechanical Engineering Students.

PEC: Elective – I **The Students have to select any one elective from the following table**		**OEC: Elective – I** **The Students have to select any one elective from the following table**	
Course Code	**Course**	**Course Code**	**Course**
21 UME 511 E	Introduction to Artificial Intelligence	21 UME 537 N	Product Design & Rapid Prototyping
21 UME 513E	Non Traditional Machining	21 UME 534 N	Operations Research
21 UME 514E	Additive Manufacturing		

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOTE- 587 102

Academic Year : 2023-24

VIth Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2023 – 24 academic year (2021-22 admitted regular batch and Diploma Lateral Entry 2022-23 Batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1	PCC	21UME601 C	Mechanical Vibrations	3.0	3	-	-	50	50	100
2	PCC	21UME602 C	Finite Element Methods	3.0	3	-	-	50	50	100
3	PCC	21UME603 C	Operations Research	3.0	3	-	-	50	50	100
4	PCC	21UME604 L	Heat Transfer Lab	1.0	-	-	2	50	50	100
5	PCC	21UME605 L	Dynamics Lab	1.0	-	-	2	50	50	100
6	PEC	21UMEXXX E	Professional Elective Course- II	3.0	3	-	-	50	50	100
7	OEC	21UMEXXX N	Open Elective Course- II	3.0	3	-	-	50	50	100
8	OEC	21UMEXXX N	Open Elective Course- III	3.0	3	-	-	50	50	100
9	HSSM	21UHSXXX C	Environmental Studies	1.0	1	-	-	50	50	100
10	MP	21UME606 P	Mini Project	2.0	-	-	4	50	50	100
11	UVS	21UHS600 C	Indian Knowledge System	1.0	1	-	-	50	50	100
Total				24	20	-	8	550	550	1100

OEC: **Open Elective – II and III is offered by other departments to Mechanical Engineering Students**

MP: **Mini Project**

PEC: Elective – II
The Students have to select any one elective from the following table

Subject Code	Subject
21UME 611 E	Reverse Engineering
21UME 612 E	Advanced Materials Technology
21UME 614 E	Project Management
21UME 615 E	Power Plant Engineering

OEC: Elective – II
The Students have to select any one elective from the following table

Subject Code	Subject
21UME 621 N	Engineering Economics
21UME 622 N	Quality Control Engineering

OEC: Elective – III
The Students have to select any one elective from the following table

21UME 623 N	Fluid Power Automation
21UME 624 N	Advanced Manufacturing Technology
21UME 635N	Turbo Machines

BASAVESHWAR ENGINEERING COLLEGE (AUTONOMOUS), BAGALKOTE- 587 102

Academic Year: 2024-25

VIIth/VIIIth Semester B.E. (Mechanical Engineering)

Scheme of teaching and examination for B.E. I to VIII semesters (160 credits NEP) commencing from 2024 – 25 academic year (2021-22 admitted regular batch and Diploma Lateral Entry 2022-23 Batch).

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1	PEC	21UME7XXE	Elective-III	*3.0*	3	-	-	50	50	100
2	PEC	21UME7XXE	Elective-IV	*3.0*	3	-	-	50	50	100
3	PEC	21UME7XXE	Elective-V	*3.0*	3	-	-	50	50	100
3	Project	21UME7XXP	Project Work	*8.0*	-	-	4	50	50	100
4	AEC	21UME7XXL	CAE/CNC Lab	*1.0*	-	-	2	50	50	100
			Total	**18**	9	-	8	250	250	500

OR

Sl. No.	Category	Subject Code	Subject	Credits	Hours/Week			Examination Marks		
					Lecture	Tutorial	Practical	CIE	SEE	Total
1.	AEC	21UME811E	Research Methodology and IPR	2.0	2	-	-	50	50	100
2.	AEC	21UMEXXXO	MOOCs	3.0	-	-	-	-	-	-
3.	Seminar	21UME821S	Technical Seminar	1.0	-	-	-	100	--	100
4.	INT	21UME831I	Industry/Technical Internship	10.00	-	-	-	50	50	100
			Total	16				200	100	300

PEC: Elective – III (The Students have to select any one elective from the following table)		**PEC: Elective – IV** (The Students have to select any one elective from the following table)		**PEC: Elective – V** (The Students have to select any one elective from the following table)	
Subject Code	**Subject**	**Subject Code**	**Subject**	**Subject Code**	**Subject**
21UME711E	Sustainable Engineering	21UME721E	Control Engineering	21UME731E	Operations Management
21UME712E	Product Design & Rapid Prototyping	21UME722E	Hydraulics and Pneumatics	21UME732E	Supply Chain Management
21UME713E	Information Technology Approaches in Manufacturing	21UME723E	Theory of Elasticity	21UME733E	Engineering Economics
21UME714E	Composite Materials	21UME724E	Design for Manufacturing	21UME734E	Product Life Cycle Management

Swapping Facility

Students can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internships/ industry internships against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year.

At the beginning of IV years of the program i.e., after VI semester, VII semester class work and VIII semester Research Internship /Industrial Internship shall be permitted to be operated simultaneously so that students have ample opportunity for an internship. Research/Industrial Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, Centre of Excellence (CoE), Study Centre established in the reputed research organizations/Institutes.

The mandatory Research internship /Industry internship are for 14 to 20 weeks. The internship shall be considered as a head of passing and shall be considered for the award of a degree. Those, who do not take up/complete the internship shall be declared to fail and shall have to complete it during the subsequent examination after satisfying the internship requirements.

Research internship: A research internship is intended to offer the flavor of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

With the consent of the internal guide and Principal, students shall be allowed to carry out the internship at their hometown (within or outside the state or abroad), provided favorable facilities are available for the internship and the student remains regularly in contact with the internal guide. Department/College will not bear any cost involved in carrying out the internship by students. However, students can receive any financial assistance extended by the organization.

21UME 301 C	STRENGTH OF MATERIALS	03 - Credits (2 : 2 : 0)
Hrs./Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 100

Unit - I	10 Hrs

Simple stress and strain: Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – behavior in Tension for Mild steel and non ferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self weight, Principle of super position.

Stress in composite section: Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars).

UNIT - II	10 Hrs

Compound stresses: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle (introduction).

Bending moment and Shear force in beams: Types of beams, loads and reactions, shear forces and bending moments, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniform distributed load (udl) and couple for different types of beams.

Unit - III	10 Hrs

Thick and thin cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation), (compound cylinders not included).

Bending and shear stresses in beams: Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, shear streses, symmetrical I and T sections.

Unit - IV	10 Hrs

Course Outcomes

At the end of the course the student should be able to:

CO1: Analyze the different types of physical loads, properties of the materials, such as stresses, strains, elasticity, deformation for varying cross section, compound bars, self-weight and thermal stresses.

CO2: Analyze the compound stresses analytically, and graphically. And cylinders exposed to internal and external pressures from the view point of stresses developed and change in their dimensions.

CO3: Demonstrate the understanding of the shear force and bending moment and estimate bending of beams of subjected to different loads with different end conditions of beams. Analyse the bending and shear stresses for different cross sections.

CO4: Demonstrate the understanding of the concept torque, stresses developed and the rigidity of the mechanical elements transmitting power or subjected to twisting moment. Columns with different end conditions subjected to axial loading.
Reference Books: 1. “Strength of Materials”, S.S.Bhavikatti, Vikas publications House – Pvt. Ltd., 2nd Ed., 2006. 2. “Mechanics of materials” R. C. Hibbeler, Printice Hall, Pearson Edu., 2005 3. “strength of material” by Dr.R.K.Bansal,Laxmi publications,fourth edition 2010. 4. “Mechanics of Materials” by K.V. Rao, G.C. Raju, First Edition,2007 5. “Mechanics of materials” James M. Gere, Thomson, Fifth edition 2004 6 “Mechanics of materials” Ferdinand Beer & Russell Johnstan, TATA MaGrawHill-2003. 7. “Mechanics of Materials” by H. J.Sawant,Technical publications,2010

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	3	1	-	-	-	2	1	-	2	-	-	-	-
CO2	3	3	2	2	1	-	-	-	1	2	-	2	-	-	-	-
CO3	3	3	1	3	1	-	-	-	2	1	-	2	-	-	-	-
CO4	3	3	1	2	1	-	-	-	2	1	-	2	-	-	-	-

21UME 302 C	ENGINEERING THERMODYNAMICS	03 - Credits
L:T:P -26 : 26: 00		CIE Marks : 50
Total Hours : 52		SEE Marks : 50

UNIT – I	13 Hrs
Work & Heat: Definition of work-according to mechanics, according to thermodynamics, examples, sign convention; Displacement work- PdV expressions for displacement work in various processes through p-v diagrams, Other types of work- Shaft work, paddle wheel work, work in straining a bar, free expansion work, electrical work; Heat- definition, units and sign convention; Comparison and differences between work and heat. Numerical Problems First Law of Thermodynamics: Joule's experiments; Statement of the First law of thermodynamics-cyclic, non-cyclic processes; Energy- modes of energy, internal energy, internal energy as a property; Specific heat- at constant volume, at constant pressure; Enthalpy; Extension of the First law to control volume- steady state-steady flow energy equation, important applications with line diagram. Numerical Problems.	
UNIT – II	13 Hrs
Second Law of Thermodynamics: Energy- High grade, low grade; Heat reservoirs-heat source and heat sink; Heat engines-definition, schematic representation, thermal efficiency; Reversed heat engines-refrigerator, heat pump, COP; Second Law of Thermodynamics- Kelvin -Planck statement, PMM II, Clasius's statement; Equivalence of the two statements; Reversible and irreversible processes- definition, factors that make a process reversible and irreversible; Carnot cycle- processes involved in Carnot cycle, PV, TS and line diagram; Carnot principles; Thermodynamic temperature scale. Numerical Problems. Gas Power Cycles: Air standard cycles- Carnot, Otto, Diesel, Dual and Stirling cycles, PV and TS diagrams, description / process, efficiency derivation, mean effective pressure derivation, comparison of Otto, Diesel and dual cycles; Numerical Problems.	
UNIT - III	13 Hrs
Combustion Thermodynamics: Combustion- complete, incomplete; Air for combustion- theoretical, excess, problems;; problems; Enthalpy of formation – definition, determination of enthalpy of formation of compounds using tables, enthalpy and internal energy of combustion, Numerical problems; Combustion efficiency; Adiabatic flame temperature. I.C. Engines: Geometrical properties of reciprocating engines; Performance parameters - indicated work, BP, IP, MEP, SFC, SEC, A/F ratio, equivalence ratio, efficiencies (mechanical, thermal / fuel conversion, volumetric), engine specific weight, engine specific volume, relationship between performance parameters; engine design and performance data analysis; Dynamometer -definition, types (Rope break and eddy current), description; Methods of FP calculation; Measurement of fuel consumption and air consumption; Heat balance sheet; Numerical problems.	
UNIT IV	xx Hrs
Reciprocating Compressors: Air Compressor terminology; Operation of a single stage reciprocating air compressor; Work input of single stage- without clearance, representation on PV diagram for different processes, work done derivation for different process; Work input of single stage- with clearance, PV diagram, effect of clearance volume and volumetric efficiency; Adiabatic, isothermal and mechanical efficiencies; Multi-stage compressor- saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression; Numerical problems on single stage only. Refrigeration: Vapour compression refrigeration system- dry compression, wet compression, superheated & sub cooling compression, their PH, TS diagram, description/process, analysis,	

refrigerating effect, capacity, power required, COP; Air cycle refrigeration- reversed Carnot cycle, analysis for non flow system and flow system; Reversed Brayton cycle- analysis as flow system; Numerical Problems
Reference Books:
1. B.K.Venkanna,2010, Basic Thermodynamics(2 nd edition),PHI learning 2. B.K.Venkanna,2012,Applied Thermodynamics(2 nd),PHI learning 3. Rajaput,2007, Engineering Thermodynamics (2 nd),Laxmi Publications
Question paper pattern for SEE:
1. Part A: One - two marks questions covering entire syllabus for 20 marks (compulsory). 2. Part B: Four units, each unit carrying 2 questions of 20 marks each. 3. Students need to answer 4 full questions selecting one from each unit.
Course Outcomes:
After completion of the course student will be able to CO1: Define the concepts of heat, work, and energy, develop/analyze energy application device Demonstrate a basic understanding of the First Law of Thermodynamics for energy conservation analysis of different thermodynamics processes of systems and control volumes and to estimate required balances of heat, work and energy flow (heaters, coolers, pumps, turbines, pistons, etc… CO2: Demonstrate a basic knowledge of the Second Law of Thermodynamics and its corollaries to determine whether a cycle is possible, and to determine the maximum performance/efficiency of cycles and its application to systems and control volumes. CO3: To write/compute stoichiometric balance chemical reactions, calculate equivalence ratios, estimate energy transfer associated with combustion problems. Analyze the performance (BP, IP, BSFC, ISFC, BSEC, BTE, ITE, Volumetric efficiency, Mechanical Efficiency,) /heat balance sheet of internal CO4: Do thermodynamic analysis (single and multi-stage, single acting and double acting) of reciprocating compressor and optimize the power in put calculation compare and discuss single and double acting, single and multi-stage performance data. Understand the components and basic assumptions for the vapor-compression refrigeration system, demonstrate the ability to design thermodynamic cycle and to perform analysis of reversed Carnot cycle based, refrigeration and heat pump cycles using various working fluids.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	3	2	-	2	2	-	-	-	-	-	-	1	1	1	-
CO2	3	2	3	-	2	1	-	-	-	-	-	-	0	1	1	-
CO3	3	2	3	-	3	-	-	-	1	-	-	-	0	1	1	-
CO4	2	1	1	-	2	1	-	-	1	-	-	1	0	1	1	-

21UME 303 C	MANUFACTURING TECHNOLOGY-I	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 3		SEE Marks : 100

Unit - I	10 Hrs

Introduction to manufacturing process Concept of Manufacturing process, its importance. Selecting manufacturing processes.

Casting: Introduction to Casting process steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process. Moulding sands - Types and Properties, patterns - types of patterns, selection of patterns - pattern allowances - Classifications of castings - according to mould materials and moulding methods. Special casting techniques

Gating System: Gating and Risering: Elements of gating system. Types of gates .Gate design , riser design. Numericals on gating and risering

UNIT - II	10 Hrs

Welding: Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding. Classification of welding process: TIG, MIG, SMAW, Flux cored arc welding, Thermite welding, Numericals

Unit - III	10 Hrs

Forming Types of forming: Classification of forging processes-forging defects and inspection. Rolling: Classification of rolling processes- rolling mill-rolling of bars and shapes. Extrusion: Classification of extrusion processes-extrusion equipments-examples.

Drawing: Drawing of rods, wires and tubes. Sheet metal forming methods, shearing, blanking, bending , stretch forming, deep forming. Spinning: spinning processes- Numericals on drawing load and sheet metal work.

High Velocity forming: Introduction to Explosive, Electro hydraulic and Electromagnetic forming.

Unit - IV	10 Hrs

Theory of Metal Cutting: Single point cutting tool nomenclature, geometry, Merchants circle diagram and analysis, Ernst Merchant's solution (Relation of orthogonal cutting forces), shear angle relationship, Stresses and strain in the chip, Power and Energy relations in metal cutting, problems of Merchant's analysis, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Causes of wear, Taylor's tool life equation, problems on tool life evaluation.

Reference Books:

1. **"Production Technology"** by R K Jain, Khanna Publishers,

2. **"Production Technology"**by HMT, Tata McGraw-Hill-2006

3. **"A Text book of Production Technology",** Vol II, Dhanpat rai & sons, 1992

4. "**Elements workshop Technology"** vol 1 &2 by Hajra & Choudhary

Course Outcomes:

At the end of the course the student should be able to:

CO1-The student will be having the capability of select and apply suitable manufacturing process to manufacture the product optimally.

CO2-The student will be able to recommend the appropriate apply and design of gating systems , forming processes, welding process.

CO3-Based on the type of different products the students will select and apply the required forming process.

CO4-Select and apply required tools, fluids, materials and analyze the cutting forces, tool life also summarize the effect of cutting parameters.

Question paper pattern for SEE:

1. Part A: 1 to 2 marks questions covering entire syllabus for 20 marks (compulsory).
2. Part B: Four units, each unit carrying 2 questions of 20 marks each.
3. Students need to answer 4 full questions selecting one from each unit.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

Course Outcomes (COs)	Programme Outcomes (Pos)/Programme Specific Outcomes (PSO)															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	-	-	-	2	1	2	2	1	2	2	2	1	-
CO2	2	2	2	-	-	-	2	1	2	2	1	2	2	2	2	-
CO3	2	2	1	-	-	-	2	1	2	2	1	2	1	1	2	-
CO4	2	2	2	-	-	-	2	1	2	2	1	2	2	2	1	-
	High -3, Medium – 2, Low - 1															

21UME 304 L	III Semester MANUFACTURING TECHNOLOGY LAB-I	01 - Credits
L:T:P - 0-0-2		CIE Marks : 50
Total Hours/Week: 2		SEE Marks : 50

Part – A

Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning. Determination of gear train for thread cutting. Preparation of the process chart for the component.

PART - B

Cutting of V Groove/ dovetail / Rectangular groove using Shaping and Cutting of Gear Teeth using Milling Machine. Planning machine. Estimation of stroke length, Number of stroke, Estimation of rpm, Preparation of process chart for the component.

PART - C

1. Preparation of green sand moulds using two molding boxes kept ready for pouring. Using
   1.patterns (Single piece pattern and Split pattern)
   2.Without patterns.
   3. Incorporating core in the mould. (Core boxes).
   4. Preparation of one casting (Aluminium or cast iron-Demonstration only)

Question paper pattern for SEE:

1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE).
2. The CIE in laboratory in classes is carried out for 50 marks (30 marks for the performance and term work)
3. For remaining 20 marks one practical test to be conducted.
   The SEE practical is conducted for 50 marks two question to be set from each Part A (Process chart five marks + 15 marks for job) and Part B (Process chart and programming 15 marks + Virtual machining 5 marks). for 20 marks each and 10 marks Viva voce.

Course Outcomes

After completion of the lab student will be able to

CO1: Know the various machining operations and its application
CO2: Know the various modern machining processes.
CO3: Know the machining calculations.
CO4: Use the techniques, skills and modern engineering tools necessary for engineering practice.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	1	1	2	1	2	1	1	2	-	-	-	2	2	1	2
CO2	2	3	1	2	-	1	1	-	-	-	-	-	2	2	1	1
CO3	3	1	2	1	-	1	-	-	-	-	-	-	3	1	3	1
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

21UME305L	**MECHANICAL DRAWING and GD & T LAB**	**02 - Credits**
L:T:P : 0 : 0: 4		**CIE Marks : 50**
Total Hours/Week: 04		**SEE Marks : 50**

Part – A	**xx Hrs**
Drafting ○ Dimensioning and Tolerance ○ Surface finish ○ Conventions, abbreviations and symbols ○ Applications of GD & T in Engineering practice ○ Sections of solids ○ Orthographic conversion (Miscellaneous Problems) ○ Component drawing reading 3 examples	
PART - B	**xx Hrs**
Assembly Drawing ○ Valves (Any one), Plummer block **Free hand sketching of the following** (Any Two) Carburetor, Fuel pump, differential, power transmission, couplings, screw jack, knuckle joint	
Question paper pattern for SEE: 1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE). 2. The CIE in laboratory in classes is carried out for 50 marks (30 marks for the performance and term work) 3. For remaining 20 marks one practical test to be conducted The SEE practical is conducted for 50 marks two question to be set from each Part A 20 Part B 20 Marks and 10 marks Viva voce.	
References: 1. Machine Drawing, By K.R.GOPALAKRISHNA (Revised Syllabus 2003-2004)	
Course Outcomes**	
After completion of the course student will be able to **CO1:** Proficient in using engineering drawing instruments, materials and techniques **CO2:** Draw freehand sketches, orthographic projections, and use of surface texture symbols and dimensioning styles in the drawing **CO3:** Create drawings to industrial standard and draw the assembly from the individual part drawing **CO4:** Familiar with freehand sketching, conventions used in engineering drawing, geometrical dimensioning and tolerance etc	

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-

21UME XXX X	III Semester SUMMER INTERNSHIP - I	02 - Credits (X : X : X)
L:T:P : 0 : 0: 4		CIE Marks : 00
Total Hours/Week: 04		SEE Marks : 100

Course Outcomes

1. Explore career alternatives prior to graduation
2. Integrate theory and practice
3. Develop communication, interpersonal and other critical skills in the job interview process
4. Learn to appreciate work and its function in the economy.
5. Build a record of work experience.

Content of Activities:

1. Learning at Departmental Lab/Tinkering Lab/ Institutional workshop.
2. Learning MS Word, Excel, Microsoft equations, MS drawing tools, MS Power point, etc.
3. Essay competitions: Both in Kannada and English on technical topics already studied.
4. Survey and study of published literature on the assigned topic: Technical paper survey, preparation of synopsis. Exposure to technical paper publications.
5. Athletics and Sports.
6. Solar energy connected activities that help common man.
7. Cultural activities: Dram, Dance.
8. Industrial safety, fire safety, electrical safety, chemical process safety, food safety, etc.
9. Industrial visits/Small Scale Industries/Factories/Cottage Industries/substation visit/short project tour, etc., and submission of report.

Evaluation:

Student's Diary

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details.

The students shall record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any, and activities carried out.

It should contain the sketches and drawings related to the observations made by the students.

The daily training diary should be signed after every day or at least twice a week by the Faculty/ in charge of the section (external expert) where the student has been working.

Student's Diary should be submitted by the students along with attendance record. It shall be evaluated on the basis of the following criteria:

1. Regularity in the maintenance of the diary.
2. Adequacy and quality of information recorded.
3. Drawings, sketches and data recorded.
4. Thought process and recording techniques used.
5. Organization of the information

Internship report:

After completion of Internship, the student shall prepare, with daily diary as reference, a comprehensive report in consultation with the mentor/s to indicate what he has observed and learnt in the training period along with the internship outcomes. The training report should be signed by the mentor.

The Internship report shall be evaluated on the basis of following criteria and/or other relevant criteria pertaining to the activity completed.

1. Originality.
2. Adequacy and purposeful write-up.
3. Organization, format, drawings, sketches, style, language etc.
4. Practical applications, relationships with basic theory and concepts taught in the appropriate course.
5. Variety and relevance of learning experience.

Assessment Rubrics:

Proposed Document as Evidence:

1. Students dairy
2. Internship report along with the certificate issued, if any.

21UME 307 L	III Semester PYTHON PROGRAMMING LAB	01 - Credits (0 : 0 : 2)
L:T:P : 0 : 0: 2		CIE Marks : 50
Total Hours/Week: 02		SEE Marks : 100

Course Outcomes

By the end of course with aid of design data handbook students shall be able to,

1. Understand syntax and semantics of Python programming structure
2. Demonstrate the use of strings, files, lists, dictionaries, set and tuple in simple applications.
3. Write simple applications using regular expressions, files, dictionaries etc.
4. Analyze the given problem and select appropriate data types and modules to develop the solution..

List of Programs	20 Hrs

1. Check given number is divisible by seven or not
2. Check a given number is positive, negative or zero is not
3. Accept three marks find the percentage of three marks and print the grade obtained by student. Grade is assigned as A grade for marks>=80, B grade for marks>=60, C grade for marks>=40 otherwise D grade
4. Find smallest of four numbers accept numbers from keyboard
5. Read string from keyboard if it is alphabetic then check is it in uppercase if not convert it to uppercase otherwise is it numeric if numeric print its binary representation
6. Check the x and y coordinates lies on which quadrant or axis or on origin
7. Find the roots of a quadratic equation $ax^2+bx+c=0$
8. Count the number of vowels and consonant in the given input string
9. Check given number is prime or composite
10. Check given number is palindrome or not
11. Generate multiplication table between m to n. Read m and n from keyboard
12. Generate all prime numbers between n to m excluding those prime that end with digit 3. Use while with else and continue statement
13. Generate the first n terms of the Fibonacci series
14. Print alphabet pattern 'T' and 'U'

Expected Output:

T pattern

```
*****
  *
  *
  *
  *
  *
  *
```

Z pattern

```
*******
   *
  *
```

```
  *
 *
*
*******
```

16. Print the pattern

```
1                 * * * *
1 2               * * *
1 2 3             * *
1 2 3 4           *
```

17. Check given number is Armstrong number or not

18. Evaluate the following sine series

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \ldots$$

19. Evaluate the following cosine series

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots$$

20. Find sum of the numbers and odd and even count between the limit n and m

Reference Books:

1. Learning Python-B Nagesh Rao Python -Cyberplus Publication-1 edition 17 May 2017
2. Core Python Applications Programming-Wesley J. Chun-Pearson Education India, -Third Edition, 2015.
3. Introduction to Python Programming-Gowrishankar S. Veena A.-CRC Press Taylor & Francis Group-1st Edition 2019
4. Python Programming using problem solving approach-Reema Thareja-Oxford university press,-1st Edition 2017
5. Python for Everybody: Exploring Data Using Python 3-Charles R. Severance-CreateSpace Independent Publishing Platform-1st Edition, 2016.
6. Python Programming -Michael Urban and Joel Murach-Mike Murach Elizabeth Drake-1st Edition,2016

Question paper pattern for SEE:

1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE).
2. The CIE in laboratory in classes is carried out for 50 marks (30 marks for the performance and term work)
3. For remaining 20 marks one practical test to be conducted.

   The SEE practical is conducted for 50 marks two question to be set from each Part A (Process chart five marks + 15 marks for job) and Part B (Process chart and programming 15 marks + Virtual machining 5 marks). for 20 marks each and 10 marks Viva voce.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	-	-	-	3	-	-	-	-	-	-	-	1	1	-	-
CO2	1	-	-	-	3	-	-	-	-	-	-	-	1	1	-	-
CO3	1	-	-	-	3	-	-	-	-	-	-	-	1	1	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

21UME 401 C	MATERIALS SCIENCE AND METALLURGY	03 - Credits
L: T: P: 3-0-0		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	10 Hrs
MECHANICAL TESTING OF MATERIALS: Hardness – Rockwell, Vickers and Brinell hardness testing. Fatigue: fracture tests, S-N curves, factors affecting fatigue life and protection methods. Creep: the creep curves, mechanism of creep, creep resistant materials. Stages in cup and cone fracture. **SOLID SOLUTIONS:** Types, rules of governing the formation of solid solutions. Phase diagrams: basic terms, Gibbs phase rules, cooling curves, construction of phase diagrams, interpretation of equilibrium diagrams (use of tie line and Lever rule), types of phase diagrams (Eutectic systems, peritectic, eutectoid, peritectoid reactions).	
UNIT – II	**10 Hrs**
EQUILIBRIUM PHASE DIAGRAMS: Iron – iron carbide equilibrium phase diagram, phases in Fe-Fe3C system, invariant reactions, microstructure of slowly cooled steels, effect of alloying elements on Fe-Fe3C diagram. The TTT diagrams, drawing of TTT diagrams, TTT diagrams for eutectoid steels, effect of alloying elements. **HEAT TREATMENT:** Annealing, normalizing, hardening, hardenability, Jominy end-quench test. **ENGINEERING ALLOYS:** Properties, composition and uses of low carbon, mild medium and high carbon steels, cast Irons, gray CI, white CI, malleable CI, SG iron.	
UNIT - III	**10 Hrs**
STANDARDS OF MEASUREMENT: Definition and Objectives of metrology, Standards of length - International prototype meter, Imperial standard yard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena. **SYSTEM OF LIMITS, FITS, TOLERANCES AND GAUGING:** Definition of tolerance, Specification in assembly, Principle of inter changeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963), geometrical tolerance, positional - tolerances, hole basis system, shaft basis of system. Numericals.	
UNIT IV	**10 Hrs**
MEASUREMENTS AND MEASUREMENT SYSTEMS: Definition, Significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hystersis, repeatability, linearity, loading effect. Transducers, Primary and Secondary transducers, Electrical and Mechanical transducers. **INTERMEDIATE MODIFYING AND TERMINATING DEVICES:** Mechanical systems, inherent problems, Electrical intermediate modifying devices: ballast circuit and vaccum tube amplifiers. Cathode Ray Oscilloscope, Oscillographs, X-Y Plotters. **MEASUREMENT OF TORQUE, PRESSURE AND TEMPERATURE:** Prony brake, hydraulic dynamometer. Principle, use of elastic members, thermal Conductivity Gauge: Pirani Gauge. Pyrometer, Optical Pyrometer	
Reference Books:	

1. "Introduction to Material Science for Engineering", 6th edition James F. Shackel ford. Pearson, Prentice Hall, New Jersy, 2006.
2. "Physical Metallurgy, Principles & Practices", V Raghavan.PHI 2nd Edition 2006, New Delhi.
3. "Foundation of Material Science and Engineering", Smith, 3rd Edition McGraw Hill, 1997.

Course Outcomes**

After completion of the course student will be able to

CO1: Calculate atomic packing factor of different crystal structures and determine the hardness, true stress and true strain.

CO2: Solve problems on phase diagrams and interpret the phase diagrams. Analyze various modes of failures in materials.

CO3: Synthesize heat treated ferrous metal by annealing and normalising and illustrate iron – iron carbide equilibrium and non equilibrium phase diagrams.

CO4: Illustrate the composition and properties of various engineering alloys, smart materials, composite materials and the process of corrosion, its causes and preventive methods.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	-	1	-	-	-	-	-	1	-	1	2	1	-	1
CO2	2	2	-	2	-	-	-	-	-	1	-	1	2	2	-	2
CO3	-		1	2	-	-	-	-	-	1	-	1	-	-	1	2
CO4	-	1	1		-	-	-	-	-	1	-	1	-	1	1	-

21UME 402 C	IV Semester MANUFACTURING TECHNOLOGY-II	03 - Credits (3 : 0 : 0)
Hrs./Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 100

UNIT – I	10 Hrs

NC and CNC Machines:
Fundamentals of NC Technology: Basic Components of NC System, NC Co-Ordinate system, Motion control system,

Computer Numerical Control (CNC) : Features of CNC, The machine control units of CNC,CNC Software, DNC: Direct numerical control, Distributed numerical control.

Engineering Analysis of NC positioning System: Open Loop positioning system, Closed Loop Positioning systems, Precision in NC Positioning.

NC Part programming: NC Coding system (EIA/ISO Format),Manual and Computer assisted Part programming.

APT programming, Basic Principles of APT Programming language.
Applications of NC : Machine tool application, other NC applications. Programming Examples.

UNIT – II	10 Hrs

Rapid Prototyping:
Fundamentals, definition of Prototypes, types of prototypes, basic principle of rapid prototyping processes, classification of RP systems, RP wheel, applications of RP, Growth of RP industry, advantages and disadvantages of rapid prototyping. Basics principles of Stereolithography systems Selective Laser sintering, Fused deposition modelling, Laminated object manufacturing.

UNIT - III	10 Hrs

Group Technology
Group Technology: History of group technology, Role of GT in CAD/CAM integration, Part families - classification and coding, DCLASS, MICLASS and OPITZ coding systems, Facility design using GT, Benefits of GT, Cellular manufacturing.
Agile Manufacturing:
Definition, business need, conceptual frame work, characteristics, generic features. Developing Agile Manufacturing(Enterprise, Strategies, integration of organization, workforce and technology, reference models, examples.).

CAPP:
Introduction of Computer Aided Process Planning (CAPP), Variant & Generative methods of CAPP, advantages of CAPP. [Only theory].
TPS: Introduction & History of the Toyota Production System, Goals of the Toyota Production System, TPS Model Overview, Focus Areas of TPS, Eliminating Waste, Quality, Cost, Productivity, Safety & Morale, Jidoka, Standardization, Just in Time, Pull Production, Kanban, Flow Production, Equipment Reliability.

UNIT IV	10 Hrs

Flexible Manufacturing System

What is FMS, FMS components, FMS applications and benefits, FMS planning and implementation issues, Quantitative analysis of FMS, Numericals.

Reference Books:

1. Automation, Production system, And Computer Integrated Manufacturing Mikell P. Grover Prentice hall of India Pvt. Ltd Second,2006
2. Rapid Prototyping, Principles and Application C K Chau, K F Leong and C S LIM World Scientific Publishing Co. Pte. Ltd. Second Edition, 2003
3. Group Technology: Inyong Ham, Katsundo Hitomi, Springer Science & Business Media, 2012 - Business & Economics - 208 pages.
4. Flexible Manufacturing System H. K. Shivanand New Age International, 2006
5. Rapid Prototyping Dr. M. Adithan Atlantic Publishers and Distributors Pvt Ltd Edition (1 January 2015).
6. CAD/CAM/CIM P Radhakrishna,S Subramanian, V. Raju New Age International Publisher Third Edition,
7. Mastering CAD/CAM,Ibrahim zeid Tata McGraw Hill Second Edition 2009

Course Outcomes:

At the end of the course the student will be able to:

CO-1 Understand and apply the knowledge of NC Technology, CNC, DNC, NC Part programming, Engineering Analysis of NC positioning System, Applications of NC for simple required products and mechanical models .

CO-2 Understand and apply the knowledge of Rapid Prototyping, basic principle of rapid prototyping processes, Stereolithography systems Selective Laser sintering, Fused deposition modelling, Laminated object manufacturing, applications and for simple required products and mechanical models .

CO-3 Understand and apply the knowledge of Group Technology in CAD/CAM integration, Facility design using GT, Agile Manufacturing(Enterprise, Strategies, integration of organization, workforce and technology, reference models, examples.), Computer Aided Process Planning (CAPP), TPS(Toyota Production System) for simple required products and mechanical models .

CO-4 Understand and apply the knowledge of Flexible Manufacturing System, FMS planning and implementation issues, Quantitative analysis of FMS for simple required products and mechanical models .

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

Course Outcomes (COs)	Programme Outcomes (Pos)/Programme Specific Outcomes (PSO)															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
1	2	2	-	-	-	-	2	1	2	2	1	2	2	2	1	-
2	2	2	2	-	-	-	2	1	2	2	1	2	2	2	2	-
3	2	2	1	-	-	-	2	1	2	2	1	2	1	1	2	-
4	2	2	2	-	-	-	2	1	2	2	1	2	2	2	1	-
	High -3, Medium – 2, Low - 1															

21UME403C	FLUID MECHANICS	03 - Credits
L:T:P 2:2:0		CIE Marks : 50
Total Hours/Week : 04		SEE Marks : 100

UNIT – I	13 Hrs

Properties of Fluids: Introduction, properties of fluids, viscosity, thermodynamic properties, Surface tension and Capillarity, Vapour pressure and Cavitation, Numerical problems.

Fluid Statics: Fluid pressure at a point, Pascal's law, Pressure variation in a static fluid, Absolute, gauge, atmospheric and vacuum pressures, Simple manometers, differential manometers, Total pressure and center of pressure, Vertical plane surface submerged in a liquid, Horizontal plane surface submerged in a liquid, Inclined plane surface submerged in a liquid, Curved surface submerged in a liquid, Buoyancy, center of buoyancy, metacenter and metacentric height, Conditions of equilibrium for floating and submerged bodies, Numerical problems.

UNIT – II	13 Hrs

Fluid Kinematics: Introduction, Types of fluid flow, Continuity equation, continuity equation in three dimensions (Cartesian co-ordinate system only), Velocity and acceleration, Velocity potential function and stream function, Numerical problems.

Dimensional Analysis: Introduction, Derived quantities, Dimensions of physical quantities, Dimensional homogeneity, Buckingham's ∏ theorem, Raleigh's method, Dimensionless numbers, Similitude and types of similitude, Numerical problems.

UNIT – III	13Hrs

Fluid Dynamics: Introduction, Equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Bernoulli's equation for real fluids, Numerical problems.

Fluid flow measurements: Introduction, Venturimeter, Orifice meter and Pitot tube, Discharge over rectangular and triangular notches, Numerical problems.

Flow through pipes: Frictional loss in pipe flow, Darcy- Equation for loss of head due to friction in pipes, Chezy's equation for loss of head due to friction in pipes, Hydraulic gradient and total energy line, Minor loses in pipes, Sudden enlargement, Sudden contraction, Obstruction, Bend, Elbow, Numerical problems.

UNIT – IV	13 Hrs

Laminar flow and viscous effects: Reynold's number, Critical Reynold's number, Laminar flow through circular pipe-Hagen Poiseulle's equation, Laminar flow between parallel stationery plates, Numerical problems.

Flow past immersed bodies: Drag, Lift, Expression for lift and drag, Pressure drag, Friction drag, Boundary layer concept, Displacement thickness, Momentum thickness and energy thickness, Numerical problems.

Introduction to compressible flow: Velocity of sound in a fluid, Velocity of sound in terms of Bulk modules, Velocity of sound for isothermal process, Velocity of sound for adiabatic process.
Mach number, Subsonic, Sonic and Supersonic flows, Propagation of disturbance for different

Mach numbers, Mach cone, Stagnation properties, Stagnation Pressure, Stagnation temperature, Area velocity relationship for compressible flow, Numerical problems

Reference Books:

1. Fluid Mechanics by Dr. Bansal.R.K, Lakshmi Publications, 2004
2. Fluid Mechanics (SI Units), Yunus A. Cingel John M. Oimbala. Tata McGraw-Hill, 2006
3. Fluid Mechanics and hydraulics, Dr. Jagadishlal: Metropolitan Book Co-Ltd., 1997.
4. Fluid Mechanics by OijushK.Kundu, IramCochen, Elsevier 3rd Edition. 2005.
5. Fluid Mechanics by John F.Douglas, Janul and M.Gasiosek and john A. Swaffield, Pearson Education Asia, 5th edition., 2006.
6. Fluid Mechanics and Fluid Power Engineering," Kumar.D.S Kataria and Sons.,2004.
7. Essential Computational Fluid Dynamics by Oleg ZiaanovPub: Jhon Wiley.

1000 Solved problems in Fluid Mechanics by Subramanya K, TMH, 2006.

Course Outcomes:

After completion of the course students shall be able to

CO1: Classify the types of fluids and calculate shear stress, pressure intensity, total pressure, centre of pressure, metacentre and metacentric height.
CO2: Differentiate between the types of fluid flow, similitude and calculate the velocity and acceleration aspects in a fluid flow applying continuity equation and dimensional analysis.
CO3: Evaluate the velocity as well as theoretical discharge using flow meters and losses in a pipes and conduits by applying Bernoulli's, Euler's, Darcy-Weisbach and Chezy's equations.
CO4: Differentiate between the viscous and compressible flows and evaluate the pressure loss, lift and drag and velocity of sound in a fluid flow.

Course Outcomes	Programme Outcomes (Pos)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	-	1	-	-	-	-	1	-	-	1	1	1	-	-
CO2	2	1	-	1	-	-	-	-	1	-	-	1	1	1	-	-
CO3	2	1	-	1	-	-	-	-	1	-	-	1	1	1	-	-
CO4	2	1	-	1	-	-	-	-	1	-	-	1	1	1	-	-

21UME404C	IV Semester THEORY OF MACHINES	03 - Credits
L:T:P - 2 : 2: 0		CIE Marks : 50
Total Hours/Week: 4		SEE Marks : 50

UNIT – I	10 Hrs

Introduction: DEFINITIONS: Link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, structure, Mobility of Mechanism, Inversion, Machine. kinematic chains and inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

MECHANISMS: Quick return motion mechanisms -Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms – Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms – Geneva mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.

UNIT – II	10 Hrs

STATIC FORCE ANALYSIS: Introduction: Static Equilibrium. Equilibrium of Two and Three Force Members. Members with Two Forces and Torque, Free Body Diagrams, Principle of Virtual Work. Static Force Analysis of Four Bar Mechanism and Slider-Crank Mechanism with and without friction.

BALANCING OF ROTATING MASS: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses by Balancing Masses in Same plane and in Different planes.

UNIT – III	10 Hrs

GOVERNORS: Types of Governors: Force Analysis of Porter and Hartnell Governors. Controlling Force,Stability,Sensitiveness,Isochronism,Effort and Power

GYROSCOPE: Vectorial Representation of Angular Motion, Gyroscopic Couple. Effect of Gyroscopic Couple on Ship, Plane Disc, Aeroplane, Stability of Two Wheelers and Four Wheelers.

UNIT – IV	10 Hrs

GEAR TRAINS: Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.

CAMS: Types of cams, Types of followers, Displacement, Velocity and Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife -edge, roller and flat-faced follower, Disc cam with oscillating roller follower, Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.

Reference Bok:

1. Theory of Machines, Rattan S.S. McGraw-Hill Education, 2nd edition, 2005.
2. Theory of Machines, Sadhu Singh Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi, 2nd edition, 2006.
3. Theory of Machines & Mechanisms, Shigley. J. V. and Uickers, J. OXFORDUniversity press.J, 3rd edition 2004
1. Theory of Machines, Robert L. Norton, McGraw-Hill Higher Education, 3rd edition 2006

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Construct or Compose mechanisms to provide specific motion.

CO2: Apply the concepts of forces acting on the mechanisms.

CO3: Analyze the effect of a gyroscopic couple on Ship, Aeroplane and an Automobile.

CO4: Analyze the concepts of gear trains and construct cam profile for the specific follower motion.

Question paper pattern for SEE:

1. Total of eight questions with two from each unit to be set uniformly covering the entire syllabus.
2. Each question should not have more than four subdivisions.
3. Any five full questions are to be answered choosing at least one from each unit.

Table: Matrix to describe the mapping of POs with Cos

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	2	2	2	-	1	-	-	1	-	-	-	1	2	2	-	-
CO2	2	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-
CO3	3	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-
CO4	3	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-
	High -3, Medium – 2, Low - 1															

21UME 405 L	IV Semester MATERIAL TESTING & INSTRUMENTATION LAB	01 - Credits (0 : 0 : 2)
Hrs./Week : 02		CIE Marks : 50
Total Hours : 20		SEE Marks : 50

Part – A Material Testing	10 Hrs

1. Brinell hardness test
2. Vickers hardness test
3. Tensile test
4. Compression test
5. Izod impact test

PART – B Metrology and Instrumentation	10 Hrs

1 To calibrate load cell using standard loads
2 To calibrate LVDT using micrometer screw gauge
3 To calibrate the micrometer screw gauge suing standard slip gauges
4 To find the effective diameter of the screw thread by three wire method
5 To measure the taper angle of the conical specimen using standard roller set and slip gauges

Scheme for Examination:
One Question from Part A - 15 Marks (05 Writeup+10)
One Question from Part B - 25 Marks (05 Writeup+20)
Viva-Voce - 10 Marks

Total 50 Marks

Course Outcomes**

CO1: Determine the tensile and compression strength of materials using UTM
CO2: Determine the various mechanical properties like hardness and impact strength of the materials
CO3: Calibrate various measuring instruments like LVDT micrometer screw gauge load cell
CO4: Develop the ability to apply the principles in instruments and measuring techniques

Table: Matrix to describe the mapping of POs with COs

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	-	-	1	-	-	-	-	-	1	1	3	2	-	-
CO2	3	2	-	-	1	-	-	-	-	-	1	1	3	2	-	-
CO3	1	1	-	-	1	-	-	-	-	-	1	1	1	1	-	-
CO4	1	1	-	-	1	-	-	-	-	-	1	1	1	1	-	-

21UME 406 L	**IV Semester CAMD LAB**	**02 - Credits**
L:T:P - 0 : 0: 2		**CIE Marks : 50**
Total Hours /Week: 2		**SEE Marks : 50**

Part – A	**5 Hrs**
Orthographic views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.	
PART - B	**6 Hrs**
Keys, Joints & Couplings: Parallel key, Taper key, Feather key, Gibhead key and Woodruff key. Flanged coupling and universal coupling (Hooks' Joint)	
PART - C	**9 Hrs**
Assembly Modeling and Drafting (Part drawings should be given) Any four 1. Plummer block (Pedestal Bearing) 2. I.C. Engine connecting rod 3. Screw jack (Bottle type) 4. Tailstock of lathe 5. Machine vice 6. Tool Head of shaper	
Reference Books: 1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum. 2. 'Machine Drawing', N.D.Bhat& V. M. Panchal 3. 'Machine Drawing' , N. Siddeshwar, P. Kanniah, V.V.S. Sastri,published by Tata Mc GrawHill,2006 4. 'A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007 5. 'Machine Drawing' , K.R. Gopala Krishna, Subhash Publication.	
Question paper pattern for SEE: 1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE). 2. The CIE in laboratory in classes is carried out for 50 marks (30 marks for the performance and term work) 3. For remaining 20 marks one practical test to be conducted. The SEE practical is conducted for 50 marks two question to be set from each Part A (Process chart five marks + 15 marks for job) and Part B (Process chart and programming 15 marks + Virtual machining 5 marks). for 20 marks each and 10 marks Viva voce. **Note: There is no Theory Examination. Examination is only for CAMD Laboratory.**	

Laboratory Assessment:

1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE).
2. The CIE in laboratory in classes is carried out for 50 marks (30 marks for the performance and term work)
3. For remaining 20 marks one practical test to be conducted for sketching and printouts from SOLID EDGE.

The SEE practical is conducted for 50 marks of three hour duration one question to be set from Part A or Part B and one assembly question from Part C. Student has to answer all the question.Part A or Part B for 20 marks and Part C for 30 marks.

Course Outcomes

CO1: Summarize the sketching, navigational, modeling, assembly commands used in SOLID EDGE software.

CO2: Predict the conversion of pictorial views into orthographic projections of simple machine parts with or without section.

CO3: Model solid models (3D drawings) of machine parts like joints and couplings

CO4: Analyze and assemble the machine components and convert to 2D drawings in assembly or in single unit.

CO5: Employ the information prepared by industry/customer to construct functioning of the mechanical system

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	-	-	-	2	-	-	-	-	-	-	1	1	-	-	1
CO2	1	-	-	-	2	-	-	-	-	-	-	1	1	-	-	1
CO3	1	-	-	-	2	-	-	-	-	-	-	1	1	-	-	1
CO4	1	-	-	-	2	-	-	-	-	-	-	1	1	-	-	1
CO5	1	-	-	-	2	-	-	-	-	-	-	1	1	-	-	1

21UME 407 C	IV Semester FUELS & IC ENGINE LAB	01 - Credits
L: T: P: 0: 0: 2		CIE Marks : 50
Teaching Hours/ Week : 02		SEE Marks : 50

Part – A

Individual Experiments

1. Determination of Flash point and Fire point using Abel / Clevland / Pensky Martins Apparatus.
2. Determination of Viscosity using Redwood viscometer
3. Determination of Viscosity using Saybolt's viscometer.
4. Determination of Cloud and Pour point
5. Determination of Carbon residue by Conradson fuel apparatus.
6. Determination of Density of oil/fuel.
7. Distillation of fuel.

PART - B

Group experiments

1. Performance tests on I. C. Engines, calculations of IP, BP, FP, thermal efficiencies, mechanical efficiency, volumetric efficiency, air fuel ratio, SFC, BSEC, heat balance sheet for Twin cylinder four stroke diesel engine .
2. Performance tests on I. C. Engines, calculations of IP, BP, FP, thermal efficiencies, mechanical efficiency, volumetric efficiency, air fuel ratio, SFC, BSEC, heat balance sheet for Single cylinder four stroke diesel engine.
3. Performance tests on I. C. Engines, calculations of IP, BP, FP, thermal efficiencies, mechanical efficiency, volumetric efficiency, air fuel ratio, SFC, BSEC, heat balance sheet for four stroke petrol engine.

Scheme for Examination:
One Question from Part A - 15 Marks (05 Writeup+10)
One Question from Part B - 25 Marks (05 Writeup+20)
Viva-Voce - 10 Marks

Total 50 Marks

Course Outcomes:

Course Outcomes (COs)	Programme Outcomes (POs)															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
1	1	1	-	-	-	1	-	1	1	-	-	-	-	1	-	-
2	1	1	-	-	-	1	-	1	1	-	-	-	-	1	-	-
3	1	2	-	1	-	1	-	1	1	-	-	1	1	1	-	-
4	1	2	-	1	-	1	-	1	1	-	-	1	1	1	-	-

21UME501 C	DESIGN OF MACHINE ELEMENTS	03 - Credits
L:T:P - 2 : 2: 0		CIE Marks : 50
Total Hours/Week: 4		SEE Marks : 50

Unit - I	12 Hrs

Introduction

Definitions: Normal, Shear, Biaxial and Triaxial Stresses, Stress Tensor, Principal Stresses

Engineering Materials and their Mechanical properties, Stress-Strain diagrams, Stress Analysis, Design considerations: Codes and Standards.

Design for Static strength

Static loads and Factor of Safety, Theories of failure. Maximum Normal Stress Theory, Maximum Shear Stress Theory, Distortion Energy Theory Failure of Brittle Materials, Failure of Ductile Materials, Stress Concentration, Determination of Stress Concentration Factor.

UNIT - II	8Hrs

Design for Fatigue strength

Design For Fatigue Strength: Introduction- S-N Diagram, Low Cycle Fatigue, High Cycle Fatigue, Endurance Limit, Endurance Limit Factors: Size effect, Surface effect, Stress Concentration effects. Fluctuating Stresses, Goodman and Soderberg relationship, Stresses due to Combined Loading, Cumulative Fatigue Damage.

Design of Threaded Fasteners:

Stresses in Threaded Fasteners, Effect of Initial Tension, Design of Threaded Fasteners under Static, Dynamic and Impact loads, Design of Eccentrically loaded Bolted Joints.

Unit - III	10 Hrs

Design of Shafts:

Torsion of Shafts, Design for strength and Rigidity with Steady loading, ASME & BIS codes for Power Transmission shafting, Shafts under Fluctuating loads and Combined loads.

Unit - IV	12 Hrs

Design of Springs

Definitions, Types of springs, Stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads, Energy stored in springs, Torsion, Belleville and Rubber springs. Leaf Springs: Stresses in leaf springs. Equalized stresses,

Design of Spur Gears:

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

Reference books:

1. V.B. Bhandari (2007), Design of Machine Elements, (2nd Edition) Tata McGraw Hill Publishing Company Ltd
2. S. C. Sharma (2002), Design of Machine Elements, PHI Learning Pvt. Ltd
3. Robert L. Norton (2001) Machine Design, Pearson Education Asia
4. M. F. Spotts, T. E. Shoup, L. E. Hornberger, (2006) Design of Machine Elements, Pearson Education
5. Robert C. Juvinall and Kurt M Marshek, (2007)Fundamentals of Machine Component

Design (3rd Edition), Wiley India Pvt. Ltd., New Delhi
6. Joseph E Shigley and Charles R. Mischke (2003), Mechanical Engineering Design (6th Edition). McGraw Hill International edition

Course Outcomes:

At the end of the course the student should be able to:

CO 1. Summarize the terminologies and preliminary concepts related to normal, shear, biaxial, tri axial and principal stresses.

CO 2. Apply the concepts of stress analysis, theories of failure and material science to select commonly used machine components under different condition of failure.

CO 3. Design the shafts subject to combined static and dynamic load failures

CO 4. Design the springs, gears by identifying the failure modes

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1	2	-	1	-	-	1	-	-	-	1	2	2	-	-
CO2	2	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-
CO3	3	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-
CO4	3	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-

21UME 502 C	ENERGY CONVERSION ENGINEERING	03 - Credits
L:T:P - 2_L : 2_T: 0_P		CIE Marks : 50
Total Hours/Week: 04		SEE Marks : 50

Unit - I	10 Hrs

Introduction:

Definition of turbomachine, Parts of a turbo machine, Comparison with positive displacement machine, Classification of turbomachines, Application of dimensional analysis to turbomachines and their physical significance, specific speed for power absorbing and power developing machines, Numerical problems on dimensional analysis and model studies.

Energy Transfer in Turbomachines:

Euler turbine equation, Alternate form of Euler turbine equation, Components of energy transfer, Degree of reaction, General analysis of a turbo machine, Effect of blade discharge angle on energy transfer and degree of reaction, General analysis of turbines (axial flow machines), Utilization factor, Relation between utilization factor and degree of reaction, Condition for maximum efficiency, Condition for maximum utilization factor, Optimum blade speed ratio and maximum energy transfer, Numerical problems on above topics

UNIT - II	10 Hrs

General analysis of power absorbing turbomachines:

General analysis of centrifugal pumps and compressors, Effect of blade discharge angle, Analysis on performance, Theoretical head capacity relationship, Centrifugal machines stage parameters, Work done, Power, Stage pressure rise, Degree of reaction, Numerical problems on above topics.

Centrifugal

Working principle, Main parts of a centrifugal pump, Classification, Head, Static head, Manometric head, Pump Efficiencies, Manometric, Mechanical, Hydraulic, Volumetric and Overall efficiency; Work done by the pump, Pressure rise in a pump, Minimum starting speed, Multistage pumps; Cavitation, Numerical problems on above topics.

Unit - III	10 Hrs

Steam and Gas Turbines:

Impulse staging and need for compounding, Compounding, Velocity, Pressure, Velocity and pressure compounding, Impulse turbine, Performance parameters, Effects of friction and blade angles on blade efficiency, Condition for maximum efficiency, Maximum efficiency and work done, Numerical problems on above topics.

Multistage impulse turbine (two stage):

Work done, Blade efficiency, Condition for maximum efficiency, Maximum blade efficiency, Maximum work done, Maximum utilization factor with equiangular blades, Numerical problems on above topics.

Reaction turbines:

Degree of reaction, Condition for maximum efficiency (without carry over efficiency), Maximum efficiency, Maximum work done, Utilization for factor, Condition for maximum utilization factor, Maximum utilization factor, Blade design parameters, Numerical problems on above topics.

Unit - IV	10 Hrs

Hydraulic Turbine:

Unit quantities, Terminology,Pelton Wheel, Velocity triangle, Power developed, Hydraulic efficiency, Condition for maximum hydraulic efficiency, Maximum hydraulic efficiency, Turbine efficiency, Hydraulic, Mechanical, Volumetric and Overall efficiency, important design parameters. Numerical problems on above topics.

Francis and Kaplan turbines:

Velocity triangle, Runner shapes for different blade speeds (blade angles), Design parameters, Draft tube and types draft tubes, functions of a draft tube, Efficiency of a draft tube, Kaplan and Propeller turbines, Velocity triangles, Design parameters, Numerical problems on above topics.

Reference Books:

1. Principles of Turbomachinery, D.G.Shephered, The Macmillan Company, Newyork, 1964.
2. An Introduction to energy Conversion - Volume III – Turbo machinery, A. Kadambi and Manohar Prasad, New Age International publishers, 1977.
3. Turbines, Compressors and Fans, S.M.Yahya, Tata McGraw Hill Company ,2nd Edition, 2002.
4. Gas Turbine Theory, H.Cohen, GFC Rogers and HIH Saravanamuttoo, Thomson Press (India) Ltd. 4th Edition, 1998.
5. Gas Turbines, V.Ganeshan, Tata Mc Graw Hill, 2nd edition, 2002.
6. A Treatise on Turbo machines, G.Gopalaksrihsna and D. Prithiviraj, Scitech Publications (India) PVT., Limited, 2002.
7. Text book of Turbomachines, By M.S. Govindegowda and A.M. Nagaraj, M.M.Publishers, Davangere, Karnataka.

Course Outcomes:

After completion of the course student will be able to

CO1: Understanding of basics of Turbo Machines and their functioning and selection. Identify various types of rotating machines and discuss the importance of dimensionless numbers in turbo machines.

CO2: Develop a governing equation for rotating machinery and Apply the energy governing equation to analyze energy transfer in power producing turbomachines.

CO3: Understand the principle of operation of pumps and Apply the knowledge to analyze the power absorbing turbomachine (Centrifugal machines)

Co4: Understand the principle of compounding and analyze performance and energy transfer in impulse and reaction steam turbines.

Co5: Understand the functioning of hydraulic turbines and analyze the performance of the hydraulic turbines (Pelton, Francis and Kaplan water turbines)

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	2	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	3	2	1	-	-	1	1	1	-	-	-	1	3	2	1	1
CO3	3	2	3	-	-	1	1	1	-	-	-	1	3	2	1	1
CO4	3	2	2	-	-	1	1	1	-	-	-	1	3	2	1	1
CO5	3	2	2	-	-	1	1	1	-	-	-	1	3	2	1	1

21UME 503 C	OPERATIONS RESEARCH	03 - Credits
L:T:P – 2: 2 : 0		CIE Marks : 50
Total Hours/Week: 04		SEE Marks : 50

Unit - I	10 Hrs

INTRODUCTION

Definition, scope of Operations Research (OR) approach and limitations of OR Models, Characteristics and phases of OR

LINEAR PROGRAMMING PROBLEMS

09 Hours Linear programming, graphical method, simplex method, Two-phase method, duality theory, dual simplex method.

UNIT - II	10 Hrs

TRANSPORTATION PROBLEMS

Mathematical model for Transportation problem, balanced and unbalanced transportation problem. Methods to solve transportation problem, finding basic feasible solution, testing solution for optimality

ASSIGNMENT PROBLEMS

Formulation, unbalanced assignment problem, travelling salesman problem

Unit - III	10 Hrs

SEQUENCING

Johnson's algorithm, n - jobs to 2 machines, n - jobs 3machines, n -jobs m machines without passing sequence. 2 jobs n machines with passing. Graphical solutions priority rules.

PERT-CPM TECHNIQUES:

Project network construction, Critical Path Method (CPM), determination of critical path, Project Evaluation and Review Technique (PERT), probability of completing a project in a scheduled date.

Unit - IV	10 Hrs

GAME THEORY

Laws of Probability, Formulation of games, two people-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), and dominance property.

REPLACEMENT MODELS

Introduction, replacement of items whose maintenance and repair costs increase with time, ignoring changes in the value of money during the period, replacement of items whose maintenance costs increase with time and value of money also changes with time, replacement of items that fail suddenly, group replacement policy.

REFERENCE BOOKS:

1. Operations Research, Prem Kumar Gupta, D S Hira, 3rd Edition, S Chand and Company Ltd., New Delhi, 2008.
2. Introduction to O.R , Taha - PHI 2010
3. Operations Research, Panneerselvam R, Prentice – Hall of India, New Delhi, 2002

4. Operation Research, A M Natarajan, P. Balasubramani, A Tamilaravari Pearson 2005
5. Operations Research, S. D. Sharma, Kedarnath Ramanath and Co, 2002
6. Operations Research, Manohar Mahajan, Dhanpat Rai & Co. New Delhi, 2009
7. Operation Research, J.K.Sharma-, MacMilan 2010

Course Outcomes:

Course Outcomes: At the ed of the course, the student will be able to:

CO1: Identify and appropriately formulate Linear Programming models for service and manufacturing systems from the verbal description of the real system, and apply operations research techniques and algorithms to solve these LP problems.

CO2: Identify and understand the mathematical models and apply operations research techniques and algorithms to solve optimization problems like assignment, transportation, travelling salesman etc.

CO3: Appropriately formulate Network and sequencing models for service and manufacturing systems, and apply operations research techniques and algorithms to analyse these problems.

CO4: Enlighten to understand Multi-criteria decision techniques for the conflicts situation management and decision making under uncertainty and risk for the replacement of varied items.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	1	1	-	2	1	-	-	1	-	1	-	2	-	1	1
CO2	2	1	-	-	1	1	-	-	1	-	1	-	2	-	1	1
CO3	2	1	1	-	2	1	-	-	1	-	2	-	2	-	1	1
CO4	1	1	1	-	1	1	-	-	1	-	-	1	2	-	1	1

21UME 504 L	FLUID MECHANICS AND MACHINERY LAB	01 - Credits
L: T: P: 0: 0: 2		CIE Marks : 50
Total Hours/Week: 02		SEE Marks : 50

Part – A	10 Hrs
Calibration of flow measuring device: (any 3) Calibration of flow measuring device: (any 3) Orifice plate Flow nozzle Venturimeter Rotameter V- Notch Determination of co efficient of friction of flow through pipe Determination of minor losses (Sudden Expansion, Sudden Contraction, Bend and Elbow) in flow through pipes Determination of force developed by impact of jets on vanes	
PART - B	**10 Hrs**
Group experiments Performance testing of turbines Pelton wheel, Francis turbine Performance testing of pumps centrifugal pump Reciprocating pump Performance test on two/single stage reciprocating air compressor Performance test on air blower	
Course Outcomes:	
CO1 Defne, apply and analyse coefficient of discharge of Venturimeter and Orificemeter. **CO2** Aanalyse efficiency of centrifugal pump and Reciprocating pump. **CO3** Aanalyse efficiency of Pelton wheel and Francis Turbine. **CO4** Analyse major losses and minor losses	
Scheme for Examination: One Question from Part A - 15 Marks (05 Writeup+10) One Question from Part B - 25 Marks (05 Writeup+20) Viva-Voce - 10 Marks ---------- Total 50 Marks	

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	2	1	1	3	1	2	2	3	1	1	1	1	2	1	--
CO2	3	2	3	-	1	2	-	1	3	2	3	2	1	2	2	--
CO3	1	1	2	1	1	3	-	1	2	2	3	1	1	1	1	--
CO4	3	2	3	2	3	1	2	-	3	1	2	1	1	1	2	--

21UME 507 H	MANAGEMENT & ENTREPRENEURSHIP	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 40		SEE Marks : 50

UNIT – I	10 Hrs

Management: Introduction, Meaning, nature and characteristics of Management, Scope and Functional areas of management, Management as a science, art of profession, Roles of Manager, Levels of Management, Development of Management Thought: early management approaches.

Planning : Nature, importance and purpose of planning process, Objectives, Types of plans (Meaning only), Importance of planning – steps in planning & planning premises

UNIT – II	10 Hrs

Organizing and Staffing: Nature and purpose of organization, Principles of organization, Types of organization, Departmentation, Committees, Nature and importance of staffing, Process of Selection & Recruitment (in brief).

Motivation and Behavior: Hawthorns studies and its findings, Maslow's theory, X and Y theory, Immaturity theory motivation hygiene theory, McClelland‟s theory of motivation.

UNIT - III	10 Hrs

Directing & Controlling: Meaning and nature of directing, Leadership styles, Communication: Meaning and importance, Coordination: meaning and importance and Techniques of Co–Ordination. Controlling: Meaning and steps in controlling, Essentials of a sound control system, Methods of establishing control (in brief).

Entrepreneur: Meaning of Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur (only types), Role of entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship: its Barriers.

UNIT IV	10 Hrs

Small Scale Industries (SSI): Definition, Characteristics, Need and rationale, Objectives, Scope, role of SSI in Economic Development. Advantages of SSI Steps to start and SSI, Government policy towards SSI, Different Policies of SSI, Government Support for SSI during 5 year plans. Supporting Agencies of Government for SSI, Meaning, Nature of support, Objectives, Functions (brief).

Quality Philosophy: The Meaning of Quality and Quality Improvement, Brief History of Quality Methodology, Statistical Methods for Quality Control and Improvement

Reference Books:

1. Harold Koontz, (2010), Essentials of Management, (Eighth edition), Tata McGraw-Hill
2. Poornima M. Charantimath, (2015), Entrepreneurship Development and Small Business Enterprises, (Third edition), Pearson Education India
3. Harold Koontz, Cyril O'Donnell, (2018), Principles of Management, (Fifth edition), McGraw Hill
4. P. C. Tripathi and P. N. Reddy, (2012), Principles of Management (Fifth edition), Tata McGraw Hill
5. Douglas C. Montgomery, (2019), Introduction to Statistical Quality Control (Eighth edition), Wiley international

Course Outcomes:**

At the end of the course, the student will be able to:

CO1 Demonstrate the ability of understanding, the nature, purpose, evolution, patterns of management. Analyze the purpose of planning, distinguish different plans and able to describe the detailed process of planning.

CO2 Identify and apply the nature and purpose of organizing, Departmentation, Staffing, Human factors and motivation.

CO3 Express the need of Leadership, concepts of directing and controlling, Demonstrate the importance of Entrepreneurship, role of Entrepreneur, Characteristics, and Classification of Entrepreneurs.

CO4 Develop the knowledge of small-scale industries, characteristics, role, and government support and quality philosophy.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-
CO3	1	-	-	-	-	2	2	-	-	3	1	-	-	1	1	-
CO4	1	-	-	-	-	2	2	-	-	-	-	1	1	2	1	-

21UME 511 E	NON-TRADITIONAL MACHINING	03 - Credits
3-0-0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 50

UNIT – I	09 Hrs
Introduction to ND Testing: Information gathered from NDT, Defects in manufacturing Advantages and disadvantages of NDT, Comparison of destructive & Non-destructive tests, Methods of NDT, Common application of NDT, Flaw detection & evaluation, leak detection & evaluation, Non Destructive Evaluation, visual inspection **Replication microscopy technique for Non Destructive Evaluation**: Specimen preparation, replication techniques, and micro structural analysis	
UNIT – II	**09 Hrs**
Liquid Penetrant Inspection: Principles, penetrant methods, procedure, materials used, equipment, parameters and applications **Magnetic Particle Inspection:** Principle, general procedure, advantages & limitations , applications , magnetic field generation, types of magnetic particles and suspension liquids, Direction of the Magnetic Field ,Importance of Magnetic Field Direction	
UNIT - III	**09 Hrs**
Radiography Inspection: principle, X-ray radiography, equipment, Gamma-ray radiography, real time radiography & film radiography , radiation safety ,advantages, disadvantages and applications of radiography **Computed tomography**: Principles, capabilities, comparison to other NDE methods, CT equipments, industrial computed tomography applications	
UNIT IV	**12 Hrs**
Ultrasonic inspection: Basic equipment, advantages & limitations, inspection methods pulse echo A, B, C scans transmission transducers & couplants **Thermal Inspection**: Principles, equipment, inspection methods applications. **Eddy Current Inspection:** Principles of operation, procedure, advantages & limitations, operating variables, inspection coils, eddy current instruments, application examples.	
Reference Books: 1. Mc Gonnagle Jj, Non Destructive –Garden And Reach Newyork. 2. Non Destructive Evalution And Quality Control Volume 17 Metals Hand Book 9th Edition , American Society Of Metals 2001.	
Course Outcomes **:	
At the end of the course student will be able to **CO1:** To have a basic knowledge of surface N D E techniques which enable to carry out various inspection in accordance with the established procedures. **CO2:** Differentiate various defect types and select the appropriate N D T methods for better evaluation **CO3:** Documentation of the testing and evaluation of the results for further analysis, disadvantages and limitations. **CO4:** Students will be able to understand significance and suitability of various non destructive testing methods in industrial application.	

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	1	-	3	2	-	3	1	3	1	-	3	2	3	3	3
CO2	2	1	-	1	1	-	2	-	3	-	-	3	2	2	-	3
CO3	3	-	-	2	-	1	1	2	2	-	-	2	1	-	2	2
CO4	1	2	1	2	-	-	-	1	-	2	1	1	1	2	2	-

21UME 512 E	Theory of Automotive Engines	03 - Credits
L:T:P - 3 : 0 : 0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 50

UNIT – I	10 Hrs

Introduction: Historical development of automobiles. Types of power plant, principle of engine operation. Classification of engines; V- engines, stratified charge engines, variable compression ratio engine.

Fuel air cycles: Uses of fuel air cycle, variation of specific heats, dissociation, comparison of PV diagram of air standard cycle and fuel air cycle for SI engine, thermal efficiency and fuel consumption, effect of variables.

Two stroke and four stroke engines: Principles of engine operation(SI and CI), scavenging -systems, theoretical processes, parameters, relative merits and demerits, valve and port timing diagrams.

UNIT – II	10 Hrs

Liquid fuels: Properties and tests: specific gravity, viscosity, flash and fire points, calorific value, rating of fuels.

Petrol fuel: Octane number, chemical energy of fuels, reaction equation, volatility properties of A/F mixture, combustion temp, combustion charts.

Combustion in SI engines: Ignition limits, stages of combustion, ignition lag, effect of engine variables on ignition lag, effect of variables on flame propagation, abnormal combustion, detonation, theory of detonation, effect of engine variables on detonation, control of detonation, CFR engine, knock rating of SI engine fuels, surface ignition, SI engine.

UNIT - III	10 Hrs

Diesel fuels: Properties and rating of fuels; cetane number, chemical energy of fuels, reaction equation, properties of A/F mixture, combustion temp, combustion charts. Vapor pressure, cloud and pour point, annealing point, diesel index, carbon residue.

Combustion in CI engines: Stages of combustion, air fuel ratio in CI engines, delay period, variables affecting delay period, diesel knock, methods of controlling diesel knock, CI combustion chambers, open and divided. Induction swirl, turbulent combustion chambers, types, M - combustion chamber.

UNIT IV	10 Hrs

Dual fuel and multi-fuel engines: Combustion in dual fuel engines, factors affecting combustion. Main types of gaseous fuels, supercharge knock control and performance of diesel fuel engines. Characteristics of multi fuel engines, modification of fuel system, suitability of various engines as multi fuel unit, performance of multi fuel engines.

Engine performance: Performance parameters BHP, FHP, IHP, specific fuel consumption, volumetric efficiency, thermal efficiency, specific weight, heat balance sheet, testing of engines, numerical problems.

Reference Books:

1. I.C. Engines & Air pollution by Obert, Harper & Row Roni publishers, New york, 1973 Fuels &Combustion by
2. Smith & Stinson,
3. I.C. Engines by Lichty
4. I.C. Engines by Maleev, CBS Pub.
5. 4. Combustion fundamentals by Roger A Strehlow

Course Outcomes**

At the end of the course student will be able to

CO1: Compare and correlate between principles of engine operation, theoretical and actual cycle diagrams

CO2: Correlate between different types of power plants and operational fuel air cycle and valve timing diagrams of CI and SI engines

CO3: Analyse different phases of combustion and their significance in engine performance and study of combustion chambers

CO4: Analyse the onset abnormal combustion and its impact on the engine performance and emissions

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	1	-	-	-	1	-	-	-	-	1	1	-	-	-
CO2	1	2	1	-	-	-	1	-	-	-	-	1	1	-	-	-
CO3	2	1	1	-	-	-	1	-	-	-	-	1	1	-	-	-
CO4	2	1	1	-	-	-	1	-	-	-	-	1	1	-	-	-

21UME513E	Non-Conventional Energy	Credits: 03
L:T:P - 2 : 2: 0		CIE Marks: 50
Total Hours/Week: 4		SEE Marks: 50

UNIT-I	10 Hrs

Introduction

Energy sources, need for non-conventional energy sources, energy alternatives, advantages, and disadvantages.

Solar Radiation 5 Hours

Extra-Terrestrial radiation, solar constant, beam, diffuse and global radiation, Measurement of Solar Radiation: Pyranometer, shading ring pyrheliometer, sunshine recorder, principle of working.

UNIT–II	10 Hrs

Solar Radiation Geometry

Solar time, latitude, declination angle, altitude, surface azimuth angle, hour angle, zenith angle, angle of incidence, day length, simple problems.

Solar Thermal Conversion

Collection and storage, thermal collection devices, liquid flat plate collectors, concentrating collectors (cylindrical, parabolic, paraboloid) power generation.

UNIT–III	10 Hrs.

Wind and tidal energy

Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills.

Fundamental characteristics of tidal power, harnessing tidal energy, limitations.

Ocean Thermal Energy Conversion: Principle of working, problems associated with OTEC

UNIT–IV	9 Hrs.

Energy from Biomass:

Biogas production from waste biomass, Use of biogas in IC engines, advantages of anaerobic digestion, floating drum (constant pressure) type, fixed dome (constant volume) type biogas plants, comparison.

Hydrogen energy: Production, delivery, transportation and safety

Fuel cell: Principle of working. Applications.

Photovoltaics: Solar cells, efficiency, applications, advantages,and disadvantages.

Reference Books

1. Non-Convention Energy Resources B H Khan McGraw Hill Education (India) Pvt. Ltd. 3rd Edition.
2. Solar energy Subhas P Sukhatme Tata McGraw Hill 2nd Edition, 1996.
3. Non-Conventional Energy Sources G.D Rai Khanna Publishers 2003.
4. Ramesh R & Kumar K U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 2004
5. Wakil MM, Power Plant Technology, Mc Graw Hill Book Co, New Delhi, 2004.
7. Non – Conventional Energy Sources. Rai.

Course Outcomes

At the end of the course, the student will be able to

CO1: Calculate the day length (number of sunshine hours) depending on the day of the year, location's latitude and longitude. Illustrate radiation types.

CO2: Use the sunshine recorder, pyranometer and pyrheliometer for measurement of beam and diffuse radiations. Illustrate solar thermal devices. Describe solar radiation geometry.

CO3: Solve the problems on wind energy e.g. the power produced by wind mill considering the air temperature, pressure of air and wind speed. Illustrate different wind mills, tidal plants and OTEC plants

CO4: Illustrate biogas plants, fuel cells and their uses, hydrogen energy and uses of PV cells

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	1	-	-	-	-	1	-	1	-	-	2	1	1	-
CO2	1	-	1	-	2	-	-	1	-	1	-	-	1	2	1	-
CO3	2	1	1	-	-	-	-	1	-	1	-	-	2	1	1	-
CO4	2	1	1	-	-	-	-	1	-	1	-	-	2	1	1	-

21UME 521 N	OPERATIONS RESEARCH (Open Elective)	03 - Credits
L:T:P - 3 : 0 : 0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 50

Unit - I	10 Hrs

INTRODUCTION

Definition, scope of Operations Research (OR) approach and limitations of OR Models, Characteristics and phases of OR

LINEAR PROGRAMMING PROBLEMS

09 Hours Linear programming, graphical method, simplex method, Two-phase method, duality theory, dual simplex method.

UNIT - II	10 Hrs

TRANSPORTATION PROBLEMS

Mathematical model for Transportation problem, balanced and unbalanced transportation problem. Methods to solve transportation problem, finding basic feasible solution, testing solution for optimality

ASSIGNMENT PROBLEMS

Formulation, unbalanced assignment problem, travelling salesman problem

Unit - III	10 Hrs

SEQUENCING

Johnson's algorithm, n - jobs to 2 machines, n - jobs 3machines, n -jobs m machines without passing sequence. 2 jobs n machines with passing. Graphical solutions priority rules.

PERT-CPM TECHNIQUES:

Project network construction, Critical Path Method (CPM), determination of critical path, Project Evaluation and Review Technique (PERT), probability of completing a project in a scheduled date.

Unit - IV	10 Hrs

GAME THEORY

Laws of Probability, Formulation of games, two people-Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), and dominance property.

REPLACEMENT MODELS

Introduction, replacement of items whose maintenance and repair costs increase with time, ignoring changes in the value of money during the period, replacement of items whose maintenance costs increase with time and value of money also changes with time, replacement of items that fail suddenly, group replacement policy.

REFERENCE BOOKS:

1. Operations Research, Prem Kumar Gupta, D S Hira, 3rd Edition, S Chand and Company Ltd., New Delhi, 2008.
2. Introduction to O.R , Taha - PHI 2010
3. Operations Research, Panneerselvam R, Prentice – Hall of India, New Delhi, 2002
4. Operation Research, A M Natarajan, P. Balasubramani, A Tamilaravari Pearson 2005

5. Operations Research, S. D. Sharma, Kedarnath Ramanath and Co, 2002
6. Operations Research, Manohar Mahajan, Dhanpat Rai & Co. New Delhi, 2009
7. Operation Research, J.K.Sharma-, MacMilan 2010
8.

Course Outcomes**

Course Outcomes: At the ed of the course, the student will be able to:

CO1: Identify and appropriately formulate Linear Programming models for service and manufacturing systems from the verbal description of the real system, and apply operations research techniques and algorithms to solve these LP problems.

CO2: Identify and understand the mathematical models and apply operations research techniques and algorithms to solve optimization problems like assignment, transportation, travelling salesman etc.

CO3: Appropriately formulate Network and sequencing models for service and manufacturing systems, and apply operations research techniques and algorithms to analyse these problems.

CO4: Enlighten to understand Multi-criteria decision techniques for the conflicts situation management and decision making under uncertainty and risk for the replacement of varied items.

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	1	1	-	2	1	-	-	1	-	1	-	2	-	1	1
CO2	2	1	-	-	1	1	-	-	1	-	1	-	2	-	1	1
CO3	2	1	1	-	2	1	-	-	1	-	2	-	2	-	1	1
CO4	1	1	1	-	1	1	-	-	1	-	-	1	2	-	1	1

21UME 522 N	Product Design & Rapid Prototyping (Open elective)	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 100

Unit - I	10 Hrs

Introduction : Definition , importance of PD, Objectives of PD,essential requirements of PD, who designs product, Project team, steps in new PD, Characteristics of successful product development, duration and cost of product development , challenges of product development, Design for manufacture, remanufacturing , sequential and concurrent engineering .

Design for manufacture & assembly: Design for Manufacture and Assembly, History , Implementation of Design for Assembly , Design for Manufacture , How Does DFMA Work, Advantages of Applying DFMA during Product Design design for Maintainability, Design for Environment Design for safety, Vision and Illumination design

UNIT - II	10 Hrs

Development processes and organizations :A generic development process,Usefulness of a well-defined Development Process, task & responsibilities for marketing, design and manufacturing , concept development: the front end process, adopting the generic product development process, process flow diagram for variant of products, product development organizations (functional, project & matrix)

Unit - III	10 Hrs

Introduction: Prototype fundamentals,definition of Prototypes, types of prototypes, need for the compression in product development, RP fundamentals , RP wheel, history of RP systems, applications of RP, growth of RP industry, basic principle of rapid prototyping processes, classification of RP systems . advantages and disadvantages of rapid prototyping

Stereolithogrphy systems: principle, process details , advantages and disadvantages, applications

Unit - IV	10 Hrs

Selective Laser sintering: principle, process details , advantages and disadvantages, applications

Fused deposition modeling: principle, , process details , advantages and disadvantages, applications

Laminated object manufacturing : principle, process details, LOM materials advantages and disadvantages, applications

Solid Ground curing: principle of operation , machine details, advantages and disadvantages, applications

Reference books:

1. Karl T Ulrich and Steven D Eppinger,2020, Product design & development, McGraw Hill
2. C K Chua, K F Leong and C S Lim,2010 Rapid Prototyping principles and applications, book world

Course Outcomes:

At the end of the course the student should be able to:

CO1: Use basics of product design as a means to manage the development of an idea from concept to production

CO2: Analyze ,evaluate and apply the generic method for product development

CO3: Use basics of prototyping in Product development **CO4:** Identify different rapid prototyping methods for types of raw materials

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	2	1	-	-	1	1	-	-	-	-	-	2	2	1	2
CO2	2	3	1	-	-	1	1	-	-	-	-	-	2	3	1	1
CO3	3	1	2	1	-	1	-	-	-	-	-	-	2	1	2	1
CO4	2	2	2	2	-	1	1	-	-	-	-	-	3	1	1	1

21UME 601 C	MECHANICAL VIBRATIONS	03 - Credits
L:T:P - 2 : 2: 0		CIE Marks : 50
Total Hours/Week: 04		SEE Marks : 50

UNIT – I	10 Hrs

Introduction: Types of vibrations, Simple Harmonic Motion (S.H.M), principle of super position applied to Simple Harmonic Motions. Beat's phenomena.

UNDAMPED FREE VIBRATIONS: Single degree of freedom systems. Undamped free vibration-natural f free vibration, stiffness of spring elements, effect of mass of spring, Compound Pendulum, Determinat frequency using Newton's law and energy method.

UNIT – II	10 Hrs

DAMPED FREE VIBRATIONS: Single degree freedom systems, different types of damping, concept of cr and its importance, study of response of viscous damped systems for cases of under damping, critical a damping, Logarithmic decrement.

FORCED VIBRATION: Single degree freedom systems, steady state solution with viscous damping due t force. Reciprocating and rotating unbalance, vibration isolation transmissibility ratio due to harmonic e support motion.

UNIT - III	10 Hrs

VIBRATION MEASURING INSTRUMENTS & WHIRLING OF SHAFTS: Vibrometer meter and accelerometer. Whirling of shafts with and without air damping. Discussion of speeds above and below critical speeds.

SYSTEMS WITH TWO DEGREES OF FREEDOM: Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates,. Applications: a) Vehicle suspension. b) Dynamic vibration absorber.

UNIT IV	10 Hrs

NUMERICAL METHODS FOR MULTI DEGREE FREEDOM SYSTEMS: Introduction, Influence coefficients, Maxwell reciprocal theorem, Reyleigh's method, Dunkerley's equation. Stodola method, Method of matrix iteration - Method of determination of the fundamental natural frequency,. Holzer's method.

Introduction to Noise, Vibration, Harshness (NVH) and control: Subjective response of sound: Frequer dependent human response; the decibel scale; relationship between, sound pressure level (SPL), sounc and sound intensity scale; auditory effects of noise; hazardous noise.

Course Outcomes:**

By the end of course with aid of design data handbook students shall be able to,

CO1: Understand the fundamentals, causes and the need of mechanical vibrations and mathematical models for undammed single degree of freedom systems.

CO2: Analyze the mechanical model of damped free and forced vibratory system and formulating mathematical models for different damping systems.

CO3: Analyze and discus on different vibration measuring instruments. Ability to understand and formulate mathematical models for two degree of freedom systems of theoretical and real life engineering systems.

CO4: Analyze and formulate mathematical models for several degree of freedom systems using different numerical techniques. Able to understand causes and effects of Noise, Vibration, Harshness (NVH) and control.

Question paper pattern for SEE:

1. Total of eight questions with two from each unit to be set uniformly covering the entire syllabus.
2. Each question carries 20 Marks and should not have more than 4 subdivisions
3. Any five full questions are to be answered choosing at least one from each unit.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	3	2	1	-	1	1	-	1	-	-	1	3	2	-	-
CO2	3	3	2	1	-	1	1	-	1	-	-	1	3	2	-	-
CO3	3	3	2	1	-	1	1	-	1	-	-	1	3	2	-	-
CO4	3	3	2	1	-	1	2	-	1	-	-	2	3	2	2	2

21UME 602 C	FINITE ELEMENT METHODS	03 - Credits
L:T:P - 2 : 2: 0		CIE Marks : 50
Total Hours/Week: 04		SEE Marks : 50

UNIT – I	12 Hrs

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, stress strain relations for plane stress and plane strain, Boundary conditions, Initial conditions, Euler's Lagrange's equations of bar, beams, Principle of a minimum potential energy, principle of virtual work, Rayleigh-Ritz method Galerkins method and Matrix techniques .

Basic Procedure: General description of Finite Element Method, , Discretization process; types of elements 1D, 2D and 3D elements, size of the elements, location of nodes, node numbering scheme, half Bandwidth, Stiffness matrix of bar element by direct method, Properties of stiffness matrix, Preprocessing, post processing. Engineering applications of finite element method. Advantages & Disadvantages of FEM.

UNIT – II	08 Hrs

Interpolation Models: Polynomial form of interpolation functions- linear, quadratic and cubic, Simplex, Complex, Multiplex elements, Selection of the order of the interpolation polynomial, Convergence requirements, , static condensation. penalty approach and elimination method.

one dimensional bar element: Recall of 1D linear bar element. Lagrangian interpolation, Higher order one dimensional elements- quadratic, Cubic element and their shape functions, properties of shape functions, Effect of temperature on 1D elements and stress calculation.

UNIT – III	10 Hrs

TWO dimensional elements: Shape functions and stiffness matrix of 2D elements four-Node quadrilateral, Nine-Node quadrilateral Eight-Node quadrilateral, serendipity and lagrange comparison with 2D pascals triangle. CST and LST shape functions ,jacobian matrix , stiffness matix, force terms, stress calculation and Numerical integration. Introduction to 3-D elements shape function of tetrahedron element

UNIT – IV	12 Hrs

TRUSSES AND BEAM ELEMENTS: Analysis of trusses and beam elements its shape functions, stiffnesmatrix and stress calculation

Heat Transfer Problems: Steady state heat transfer, 1D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for heat conduction, Galerkin approach for heat conduction, heat flux boundary condition, 1D heat transfer in thin fins

DESIGN DATA HAND BOOKS:

1. Design Data Hand Book – K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
2. Design Data Hand Book – K. Mahadevan and Balaveera Reddy, CBS Publication
3. Machine Design Data Hand Book – H.G. Patil, Shri Shashi Prakashan, Belgaum.
4. PSG Design Data Handbook PSG College of Technology, Coimbatore.

Reference Books:

1. The FEM its basics and fundamentals: O.C.Zienkiewicz, Elsevier, 6e.
2. Finite Element Method,J.N.Reddy, McGraw –Hill International Edition.
3. Finite Element Methods, by Daryl. L. Logon, Thomson Learning 3rd edition, 2001.
4. Finite Element Analysis, by H.V. Lalshminarayana,universities press, 2004.

Course Outcomes:

CO1: Generate the governing FE equations for engineering problems /Mechanical systems.
CO2: Apply FEM to solve bars subjected to static load and thermal load
CO3: Apply the concept of lagrange interpolation for 2D and 3D elements and solve problems.
CO4: Apply FEM to solve trusses and beam problems

Question paper pattern for SEE:

1. Total of eight questions with two from each unit to be set uniformly covering the entire syllabus.
2. Each question carries 20 Marks and should not have more than 4 subdivisions
3. Any five full questions are to be answered choosing at least one from each unit.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1	1	1	-	-	-	-	-	-	-	-	1	-	-	-
CO2	2	1	2	1	3	-	-	-	-	-	-	-	1	-	-	-
CO3	2	1	2	1	3	-	-	-	-	-	-	-	1	-	-	-
CO4	2	1	2	1	3	-	-	-	-	-	-	-	1	-	-	-

21UME603C	HEAT TRANSFER	03 - Credits
L:T:P - 2_L : 2_T: 0_P		CIE Marks : 50
Total Hours/Week: 04		SEE Marks : 100

Unit - I	10 Hrs

INTRODUCTION:

Modes of heat transfer, Basic laws governing conduction, convection, and radiation heat transfer,Combined heat transfer mechanism, Overall heat transfer coefficient, Boundary conditions of 1st, 2nd and 3rd Kind. Mathematical formulation of heat conduction problems.

CONDUCTION:

Derivation of general three-dimensional heat conduction equation in Cartesian coordinate system, Special cases, 3-D conduction equation in cylindrical and spherical coordinate systems (No derivation).

ONE DIMENSIONAL CONDUCTION:

Derivation for heat flow and temperature distribution in a plane wall, Hollow cylinder and hollow sphere without heat generation, Thermal resistance concept & its importance. Composite wall, cylinder and sphere, Contact resistance, Critical thickness of insulation without heat generation, Heat transfer in extended surfaces of uniform cross-section without heat generation, Long fin, Tip insulated fin and fin with heat transfer from the tip, Fin efficiency and effectiveness, Numerical problems on above topics.

UNIT - II	10 Hrs

ONE-DIMENSIONAL TRANSIENT CONDUCTION:

Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler's charts) for slab, long cylinder and sphere, Numerical Problems

CONCEPTS AND BASIC RELATIONS IN BOUNDARY LAYERS:

Flow over a body, Velocity and thermal boundary layer,Critical Reynolds number,General expressions for drag coefficient and drag force,General expression for local heat transfer coefficient, Average heat transfer coefficient, Nusselt number, Flow inside a duct- velocity boundary layer, Hydrodynamic entrance length and hydro dynamically developed flow, Numerical problems based on empirical relations given in the data handbook.

FREE OR NATURAL CONVECTION:

Application of dimensional analysis for free convection, Physical significance of Grashoff number, Use of correlations of free convection for vertical, horizontal and inclined flat plates, Vertical and horizontal cylinders and spheres, Numerical problemsbased on empirical relations given in the data handbook.

Unit - III	10 Hrs

FORCED CONVECTION:

Application of dimensional analysis for forced convection, Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers, Use of various correlations for hydro dynamically and thermally developed flow inside a duct, Use of correlations for flow over a flat plate, cylinder and sphere. Numerical problemsbased on empirical relations given in the data handbook.

HEAT EXCHANGERS:

Classification of heat exchangers, Overall heat transfer coefficient, Fouling and fouling factor, LMTD

analysis of heat exchangers, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problemsbased on empirical relations given in the data handbook.

Unit - IV	10 Hrs

RADIATION HEAT TRANSFER:

Thermal radiation, Definitions of various terms used in radiation heat transfer, Stefan-Boltzmann law, Kirchhoff's law, Planck's law and Wien's displacement law. Radiation heat exchange between two parallel infinite black surfaces, Configuration factor or view factor, Intensity of radiation and solid angle; Lambert's law, Radiation heat exchange between two parallel infinite gray surfaces, Effect of radiation shield (only discussion on nonblack surfaces), Numerical problems based on empirical relations given in the data handbook.

CONDENSATION AND BOILING:

Types of condensation (discussion only), Nusselt theory for laminar condensation on a vertical flat surface (no derivation), Use of correlations for condensation on vertical flat surfaces, Horizontal tube and horizontal tube banks, Reynolds number for condensate flow, Regimes of pool boiling, Pool boiling correlations,Numerical problemsbased on empirical relations given in the data handbook.

Reference books:

1. Heat Transfer – A Basic approach by M. Necati Ozisik Tata Mc Graw Hill International ed. 1998
2. Heat Transfer by Tirumaleshwar, Pearson education, 2006
3. Heat Transfer – A Practical approach by Yunus A. Cenegal Tata Mc Graw Hill 2002
4. Principles of Heat Transfer by Kreith Thomson learning 2001
5. Fundamentals of Heat and Mass transfer By Frank P. Incropera and David P. Dewitt Johm Wiley and Sons 4th ed. 1995
6. Heat transfer, P.K. Nag, Tata Mc Graw Hill 2002

Course Outcomes:

At the end of the course student will be able to

CO1: Understand and correctly use the heat transfer terminology and governing laws. Formulate the steady and unsteady state unidirectional conduction heat transfer to analyze the conditions..

CO2: Understand the boundary layer concepts as applied to fluid flow fundamentals and analyze heat transfer as applied to convection heat transfer..

CO3: Analyze and design the heat exchanger equipment based on the need that fit to application.

CO4: Analyze the radiation heat transfer, radiation heat exchange between gray body surfaces and design the heat transfer systems like radiation shields etc.

CO5: Understand and evaluate the heat transfer rate in the phase change process

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	1	-	2	-	-	-	-	-	2	3	2	2	1
CO2	3	3	2	1	-	1	-	-	-	-	-	2	3	2	2	1
CO3	3	2	2	1	-	1	-	-	-	-	-	2	3	2	2	1
CO4	3	3	2	1	-	1	1	-	-	-	-	2	3	2	2	1
CO5	3	2	2	1	-	1	1	-	-	-	-	2	3	2	2	1

21UME 604 L	HEAT & MASS TRANSFER LABORATORY LAB	01 - Credits
L: T: P: 0: 0: 2		CIE Marks : 50
Total Hours/Week: 02		SEE Marks : 50

Part – A	10 Hrs
1. Determination of Thermal Conductivity of a Metal Rod. 2. Determination of Overall Heat Transfer Coefficient of a Composite wall. 3. Determination of Effectiveness on a Metallic fin. 4. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube. 5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe. 6. Determination of Emissivity of a Surface.	
PART - B	**10 Hrs**
Group experiments Determination of Stefan Boltzman Constant. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers Experiments on Boiling of Liquid and Condensation of Vapour Performance Test on a Vapour Compression Refrigeration. Performance Test on a Vapour Compression Air – Conditioner Experiment on Transient Conduction Heat Transfer	
Course Outcomes:	
CO1: To be able to Define, understand, apply and analyze conduction heat transfer principles **CO2:** To be able to Define, understand and analyze transient heat 56 transfer principles **CO3:** To be able to Define, understand and analyze forced and free convection heat transfer principles **CO4:** To be able to Define, understand and analyze the heat radiation, phase change heat transfer and mass transfer principles	
Scheme for Examination: One Question from Part A - 15 Marks (05 Writeup+10) One Question from Part B - 25 Marks (05 Writeup+20) Viva-Voce - 10 Marks ---------- Total 50 Marks	

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	-	-	1	-	-	-	-	-	1	1	3	2	-	-
CO2	3	2	-	-	1	-	-	-	-	-	1	1	3	2	-	-
CO3	1	1	-	-	1	-	-	-	-	-	1	1	1	1	-	-
CO4	1	1	-	-	1	-	-	-	-	-	1	1	1	1	-	-

21UME 605 L	**DYNAMICS LABORATORY**	**01 - Credits**
L: T: P: 0: 0: 2		**CIE Marks : 50**
Total Hours/Week: 02		**SEE Marks : 50**

Part – A	**10 Hrs**

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in
    a. single degree of freedom vibrating systems (longitudinal and torsional)
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft.
4. Determination of Fringe constant of Photo elastic material using.
5. Circular disc subjected to diametric compression.
6. Pure bending specimen (four point bending)
7. Determination of stress concentration using Photo elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression.

PART - B	**10 Hrs**

Group experiments

1. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Prowel /Hartnel Governor. (Only one or more)
2. Determination of Pressure distribution in Journal bearing.
3. Determination of Principal Stresses and strains in a member subjected to combined loading using Strain rosettes.
4. Determination of natural frequency of compound pendulum.
5. Experiments on Gyroscope

Course Outcomes:

CO1: Students are able to understand Degree of freedom and distinguish longitudinal vibration and Torsional Vibration.
CO2: Students realize the importance of damping
CO3: Students will be observe the working of gyroscopic principal
CO4: Students will observe the various fringe pattern from photo elastic material and calculate fringe constant.

Scheme for Examination:

One Question from Part A - 15 Marks (05 Writeup+10)
One Question from Part B - 25 Marks (05 Writeup+20)
Viva-Voce - 10 Marks

Total 50 Marks

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	1	1	2	1	2	1	1	2	-	-	-	2	2	1	2
CO2	2	3	1	2	-	1	1	-	-	-	-	-	2	2	1	1
CO3	3	1	2	1	-	1	-	-	-	-	-	-	3	1	3	1
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

21UME611C	NON DESTRUCTIVE TESTING	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 50

UNIT – I	10 Hrs
Introduction to ND Testing: Information gathered from NDT, Defects in manufacturing Advantages and disadvantages of NDT, Comparison of destructive & Non-destructive tests, Methods of NDT, Common application of NDT, Flaw detection & evaluation, leak detection & evaluation, Non Destructive Evaluation, visual inspection Replication microscopy technique for Non Destructive Evaluation: Specimen preparation, replication techniques, and micro structural analysis	
UNIT – II	**10 Hrs**
Liquid Penetrant Inspection: Principles, penetrant methods, procedure, materials used,equipment, parameters and applications Magnetic Particle Inspection: Principle, general procedure, advantages & limitations , applications , magnetic field generation, types of magnetic particles and suspension liquids, Direction of the Magnetic Field ,Importance of Magnetic Field Direction	
UNIT - III	**10 Hrs**
Radiography Inspection: principle, X-ray radiography, equipment, Gamma-ray radiography, real time radiography & film radiography , radiation safety ,advantages, disadvantages and applications of radiography Computed tomography: Principles, capabilities, comparison to other NDE methods, CT equipments, industrial computed tomography applications	
UNIT IV	**10 Hrs**
Ultrasonic inspection: Basic equipment, advantages & limitations, inspection methods pulse echo A, B, C scans transmission transducers & couplants Thermal Inspection: Principles, equipment, inspection methods applications Eddy Current Inspection: Principles of operation, procedure, advantages & limitations, operating variables, inspection coils, eddy current instruments, application examples	
Reference Books: 1. NON DESTRUCTIVE EVALUTION AND QUALITY CONTROL, METALS HAND BOOK, AMERICAN SOCIETY OF METALS, 9^{TH} , EDITION 2001 2. NON DESTRUCTIVE –GARDEN AND REACH, MC GONNAGLE JJ NEWYORK	
Course Outcomes:	
By the end of course with aid of design data handbook students shall be able to, **CO1:** To have a basic knowledge of surface N D E techniques which enable to carry out various inspection in accordance with the established procedures. **CO2:** Differentiate various defect types and select the appropriate N D T methods for better evaluation **CO3:** Documentation of the testing and evaluation of the results for further analysis **CO4:** Students will be able to understand significance and suitability of various non destructive testing methods in industrial application.	

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1																
CO2																
CO3																
CO4																

21UME 612 E	ADVANCED MANUFACTURING TECHN0LOGY	03 - Credits
L: T: P:- 3 : 0 : 0		CIE Marks : 50
Hrs./Week : 03		SEE Marks : 50

UNIT – I	10 Hrs

Introduction: Introduction to CAD/CAM, product system facilities: Low, medium and high. Manufacturing support systems, Automation in production systems. Automated manufacturing systems. Computerized manufacturing systems. Reasons for automating, Automation principles and strategies. Discussions.

Fundamentals of Automated Production Lines: Introduction, System configurations, Workpart transfer mechanisms, Storage buffers, Control of the production line.

UNIT – II	10 Hrs

Analysis of Transfer Lines: Analysis of Transfer Lines with no internal storage: Basic terminology and Performance measures, Workstation breakdown analysis: Upper bound approach, Lower bound approach, and Analysis of Transfer Lines with storage buffers. Numerical examples.

Automated Assembly System: Introduction, System configurations, Parts delivery at workstations, Applications. Quantitative analysis: Parts delivery system, Multi-station and single station assembly machines. Partial automation.

UNIT - III	10 Hrs

NC Part Programming: Basic components of an NC system, EIA and ISO coding standards, NC part programming exercises.

Computer Assisted Part Programming: Defining part geometry**,** Specifying tool path and operation sequence, Computer task in computer-assisted part programming, Part programming with APT exercises.

UNIT IV	10 Hrs

Product life cycle management: Introduction, Product information, PLM framework, Benefits, Implementation, Enabling technologies, Example of business problem. Product data management: Evolution of PDM systems, Scope, Benefits, Implementation, Software capabilities, software functions

Advances in Automated Factory: Industry 4.0**:** functions, applications and benefits, Components of Industry 4.0, Internet of things (IoT), IoT applications in manufacturing, Big-Data and cloud computing for IoT, IoT for smart manufacturing

Reference Books:

1. Groover M. P., Automation, Production Systems and CIM, Prentice Hall of India, 2008.
2. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill, 2008.
3. P. N. Rao, CAD/CAM Principles and Applications, 2nd Edition
4. Computer Integrated Manufacturing, Bharat Vijamuri, Sunstar Publisher, 4th Edition, 2018.

Course Outcomes:**

At the end of the course student will be able to

CO1: Read and demonstrate good comprehensionof study of two aspects of production systems and how they are sometimes automated and /or computerized in modern industrial

practice

CO2: Apply basic methods of examination of the technology of automated production lines and develop several mathematical models that can be used to analyze their operation

CO3: Evaluate, integrate, and apply programmable automation in which the mechanical actions of the machine tool or other equipment are controlled by a program containing coded alphanumeric data.

CO4: Properly understand PLM; why it is crucial for companies to implement, what a PLM system offers, what PDM is and its relationship to PLM and study the functions and components, applications and benefits of Industry 4.0, Concept of IoT.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	2	1	-	-	-	2	1	2	2	1	2	2	2	1	-
CO2	2	2	2	-	-	-	2	1	2	2	1	2	2	2	2	-
CO3	2	2	1	-	-	-	2	1	2	2	1	2	1	1	2	-
CO4	2	2	2	-	-	-	2	1	2	2	1	2	2	2	1	-
	High -3, Medium – 2, Low - 1															

21UME 613 E	OPERATION MANAGEMENT	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 3		SEE Marks : 50

UNIT – I	10 Hrs

Introduction: Functional subsystems of organization, System concept of production, Types of production system, Productivity, strategic management, World class manufacturing.

Product Design and Analysis: New product development concepts, Process planning and design, Value analysis/Value engineering, Make or buy decision, Ergonomic consideration in product design

UNIT – II	12 Hrs

Forecasting: Nature and use of forecasting, Sources of data, Demand patterns, Factors affecting forecast, types of forecasting, Forecasting Models – Linear Regression, Simple moving average, weighted moving average, e, Single exponential smoothing, Double exponential smoothing, Adjusted exponential smoothing and Delphi method.

Facility Location: Introduction, factors influencing plant location, break even analysis, single facility location problem, Minimax location problem and gravity location problem.

UNIT - III	10 Hrs

Plant Layout and Materials Handling: Introduction, Classification of layout, Layout design procedures – Computerized Relative Allocation of Facilities Technique (CRAFT), Automated Layout Design Program (ALDEP) and, Computerized Relationship Layout Planning (CORELAP).

Line Balancing: Concept of mass production system, objective of assembly line balancing, rank positional weight method and the COMSOL Algorithm.

UNIT IV	14 Hrs

Modern Production Management Tools: Just-In-Time manufacturing – introduction and overvies of JIT, basic principles, push/pull production, kanban systems (pull systems). Total Quality Management – scope of TQM, benefits of TQM, quality control activities during product cycle, operating quality costs. Kaizen – Key elements of kaizen, classification of kaizen, steps of implementation of kaizen Blitz, guidelines of kaizen team, benefits of kaizen. Lean Manufacturing – steps of lean manufacturing, components of lean manufacturing.

Reference Books:

1. Production and Operations Management, R. Panneerselvam. Prentice Hall of India Pvt Ltd. 2005.
2. Analysis and Control of Production Systems, 2nd Edition, Elsayed A. Elsayed, Thomas O. Boucher, Pearson, 1994
3. Production and Operations Management, R. B. Khanna, PHI, 2010.
4. Modern Production/Operations Management, Buffa, Wiley Eastern Ltd.2001
5. Operations Management, Joseph G MonksMc Graw Hill 1987.

Course Outcomes:
At the ed of the course, the student will be able to: **CO1:** Contribute to the development of a team-oriented and collaborative environment. **CO2**: Solve business problems using decision-supported tools and/or research skills. **CO3**: Demonstrate professional communication skills using a variety of delivery methods **CO4:** Analyze business concepts and apply strategic planning skills to effect change in an integrated

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-
CO2	2	1	-	1	-	-	-	-	1	1	-	1	-	-	-	-
CO3	1	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-
CO4	1	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-

21UME621 N	ENGINEERING ECONOMICS	Credits: 03
L:T:P 3 : 0 : 0		CIE Marks : 50
Total Hours/Week : 03		SEE Marks : 100

UNIT – I	10 Hrs
Introduction: Engineering and Economics, Definition, Engineering Decision-Makers, Problem solving and Decision making, Law of demand and supply, Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Exercises and Discussion. **Present Worth Comparisons:** Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Pay-back comparison, Exercises and Discussion.	
UNIT – II	**10 Hrs**
Equivalent Annual worth Comparisons: Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Use of shrinking fund method, Annuity contract for guaranteed income, Exercises and Discussion. **Rate of Return Calculations:** Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Exercises and Discussion.	
UNIT - III	**10 Hrs**
Depreciation: Causes of Depreciation, Basic methods of computing depreciation charges. **Estimating and Costing:** Components of costs such as Direct Material Costs, Direct Labor Costs, Fixed Over-Heads, Factory cost, Administrative Over-Heads, First cost, Marginal cost, Selling price, Estimation for simple components.	
UNIT IV	**10 Hrs**
Introduction Financial Statements: Statements of Financial Information: Introduction, Source of financial information, financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. **Financial Ratio Analysis:** Introduction, Nature of ratio analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Evaluation of a firm's earning power. Comparative statements analysis.	
Reference Books:	
1. James L. Riggs, David D. Bedworth, Sabah U. Randhawa, Thirteenth reprint (2010) Engineering Economics, 4th Ed, Tata McGraw Hill. 2. Leland Blank & Anthony Tarquin (2019) Basics of Engineering Economy, 8th Edition, McGraw Hill Publication (India) Private Limited., 3. Panneerselvam, R. (2013), Engineering Economics, Second edition, PHI Learning. 4. Thuesen H.G. (2002), Engineering economy, Second edition, PHI Learning. 5. Banga, T. R. & Sharma S. C. (2001) Mechanical Estimating and Costing, Seventeenth edition Khanna Publishers; 6. Pandey I M, (2016) Financial Management, Eleventh edition, Vikas Publishing House. 7. Jawahar Lal, Seema Srivastava, (2014) Financial Accounting: Principles and Practices, Third edition, S Chand Publishing.	

Course Outcomes:

After completion of the course students shall be able to

CO1: Apply time value of money concepts to enhance decision-making processes.

CO2: Evaluate the economic worth of alternatives based on present worth / annual equivalent-worth / rate-of return.

CO3: Determine by adopting accounting principles depreciation charges / estimation and cost

CO4: Interpret data sets and ***prepare*** accounting & financial statements in accordance with accounting principles and regulations. Also ***Analyze*** various financial ratios and draw conclusions.

Course Outcomes	Programme Outcomes (Pos)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	1	2	-	1		-	-	-	-	1	2	-	1	-	-	1
CO2	1	2	-	2	1	-	-	-	-	-	3	-	1	-	--	1
CO3	1	2	-	-	-	-	-	1	-	--	2	-	1	-	1	1
CO4	1	1	-	-	1	-	-	-	-	-	2	-	1	-	1	1

21UME622N	Statistical Quality Control	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 100

Unit - I	10 Hrs

INTRODUCTION :

The meaning of quality and quality improvement, Quality of design, factors controlling quality of design, quality of conformance, factors controlling quality of conformance, Quality of performance,The quality function,Quality control, Aims of quality control, Quality characteristicsCost of quality Statistical methods for quality control Benefits of statistical quality control Variables and attributes

MODELING PROCESS QUALITY :

The concept of variation Gathering of data, Tabular summarization of data Classification and tabulation Objects of classification The frequency distribution Diagrammatic and graphic presentation Graphical representation of frequency distribution (Histogram ,frequency polygon, bar chart, ogive curve) Measures of central values(averages) Types of averages (Mean, median and mode) Measures of dispersion (Range, standard deviation variance)

UNIT - II	10 Hrs

CONTROL CHARTS: Introduction to control charts

Chance and assignable causes of variation Types of control charts

Control charts for variables Control chart for average and range ($\overline{x}$ R) Control chart for average and standard deviation ($\overline{x}$ σ) Process capability Numerical problems

Unit - III	10 Hrs

CONTROL CHARTS FOR ATTRIBUTES:

Construction and use of p np c and u charts Numerical problems

- Control Chart for Fraction Nonconforming — p chart
- Control Chart for Nonconforming — np chart
- Control Chart for Nonconformities — c chart
- Control Chart for Nonconformities per unit — u chart

Unit - IV	10 Hrs

ACCEPTANCE SAMPLING :

Lot by lot acceptance sampling for attributes The acceptance sampling problems Advantages & disadvantages of sampling plans single sampling plan for attributes The OC curve Designing a single sampling plan Double sampling plan Multiple sampling plan Sequential sampling plan Dodge and roming sampling plan, LTPD plan AOQL curves

Reference books:

1. Statistical quality control : RC Gupta , khanna Publishers New Delhi 2005
2. Statistical quality control : E. L.Grant and R.S.Leavenworth, 7 edition Mc Graw Hill
3. Statistical quality control : Mahajan

Course Outcomes:

At the end of the course the student should be able to:

CO1: Apply the philosophy and basic concepts of quality improvement

CO2: Develop skills to analyse quality related data using advanced statistical methods

CO3: Acquire knowledge on the traditional statistical quality control methods and develop charting techniques

CO4: Perform analysis to design, use, and interpret control charts for attributes

Course Outcomes (COs)	Programme Outcomes (POs)/ Programme Specific Outcomes (Pso)															
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
1	1	3	2	2	-	-	-	-	-	-	-	-	3	2	1	3
2	2	3	2	3	-	-	-	-	-	-	-	-	1	2	1	1
3	2	3	3	3	-	-	-	-	-	-	-	-	2	3	2	1
4	2	3	3	2	-	-	-	-	-	-	-	-	3	1	2	1

21UME 711 E	THEORY OF ELASTICITY	03 – Credits
L: T: P – 3: 0: 0		CIE Marks : 50
Hrs./Week : 03		SEE Marks : 50

UNIT – I	10 Hrs

DEFINITIONAND NOTATION: Stress, Stress at a Point, Equilibrium Equations, Principal Stresses, Mohr's Diagram, Maximum Shear Stress, Boundary Conditions.

STRAIN AT A POINT: Compatibility Equations, Principal Strains, Generalized Hooke's law, Methods of Solution of Elasticity Problems – Plane Stress-Plane Strain Problems.

UNIT – II	10 Hrs

TWO DIMENSIONAL PROBLEMS: Cartesian co-ordinates – Airy's stress functions – Investigation of Airy's Stress function for simple beam problems – Bending of a narrow cantilever beam of rectangular cross section under edge load – method of Fourier analysis – pin ended beam under uniform pressure.

GENERAL EQUATIONS IN CYLINDRICAL CO-ORDINATE: Thick cylinder under uniform internal and / or external pressure, shrink and force fit, stress

UNIT - III	10 Hrs

STRESSES IN AN INFINITE PLATE: Stress in infinite plate with a circular hole subjected to uniaxial and biaxial loads, stress concentration, stresses in rotating discs and cylinders.

TORSION OF CIRCULAR, ELLIPTICAL AND TRIANGULAR BARS: Torsion of circular, elliptical and triangular bars, membrane analogy, torsion of thin open sections and thin tubes.

UNIT IV	10 Hrs

THERMAL STRESSES: Thermo elastic stress strain relationship, Equations of equilibrium Thermal stresses in thin circular discs.

UNIQUENESS THEOREM: Principle of super position, reciprocal theorem, Saint Venant principle.

Reference Books:

1. Applied Elasticity-C.T. Wang-Tata Mc. Graw Hill-1953
2. Theory of Elasticity -Sadhu Singh-Khanna Publishers-1997.
3. Elasticity in Engineering Mechanics, , -A. P. Boresi and K. P. Chong- John Wiley &Sons-2nd Edition, 2000.
4. Advanced Strength and Applied Elasticity.-A. C. Ugural and S. K. Fenster-Elsevier-2nd Edition, 1987
5. Theory of elasticity -T.G.Sitaram-Springer-2021
6. Advanced Mechanics of solids -L. S. Srinath-Tata Mc. Graw Hill-2003
7. Theory of Elasticity-S. P. Timoshenko and J. N Goodier-Tata Mc. Graw Hill-2006
8. Elasticity: Theory, Applications and Numeric's-Martin H. Sadd,-Academic Press, -2010

Course Outcomes:

By the end of course with aid of design data handbook students shall be able to,

CO1: Formulate concepts in continuum mechanics of solids, including of strain, internal force, stress and equilibrium in solids

CO2: Apply and solve the basic problems of the theory of elasticity by using Airy function expressed as biharmonic function. And in polar coordinate system.
CO3: Apply and solve torsion problems in bars and thin walled members.
CO4: Formulate index notation of equations, tensor and matrix notation applied to thermal Problems

Question paper pattern for SEE:

1. Total of eight questions with two from each unit to be set uniformly covering the entire syllabus.
2. Each question carries 20 Marks and should not have more than 4 subdivisions
3. Any five full questions are to be answered choosing at least one from each unit.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1	1	1	-	-	-	-	-	-	-	-	1	-	-	-
CO2	2	1	2	1	3	-	-	-	-	-	-	-	1	-	-	-
CO3	2	1	2	1	3	-	-	-	-	-	-	-	1	-	-	-
CO4	2	1	2	1	3	-	-	-	-	-	-	-	1	-	-	-

21UME712E	Product Design & Rapid Prototyping	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 100

Unit - I	10 Hrs

Introduction : Definition , importance of PD, Objectives of PD,essential requirements of PD, who designs product, Project team, steps in new PD, Characteristics of successful product development, duration and cost of product development , challenges of product development, Design for manufacture, remanufacturing , sequential and concurrent engineering .

Design for manufacture & assembly: Design for Manufacture and Assembly, History , Implementation of Design for Assembly , Design for Manufacture , How Does DFMA Work, Advantages of Applying DFMA during Product Design design for Maintainability, Design for Environment Design for safety, Vision and Illumination design

UNIT - II	10 Hrs

Development processes and organizations :A generic development process,Usefulness of a well-defined Development Process, task & responsibilities for marketing, design and manufacturing , concept development: the front end process, adopting the generic product development process, process flow diagram for variant of products, product development organizations (functional, project & matrix)

Unit - III	10 Hrs

Introduction: Prototype fundamentals,definition of Prototypes, types of prototypes, need for the compression in product development, RP fundamentals , RP wheel, history of RP systems, applications of RP, growth of RP industry, basic principle of rapid prototyping processes, classification of RP systems . advantages and disadvantages of rapid prototyping

Stereolithogrphy systems: principle, process details , advantages and disadvantages, applications

Unit - IV	10 Hrs

Selective Laser sintering: principle, process details , advantages and disadvantages, applications

Fused deposition modeling: principle, , process details , advantages and disadvantages, applications

Laminated object manufacturing : principle, process details, LOM materials advantages and disadvantages, applications

Solid Ground curing: principle of operation , machine details, advantages and disadvantages, applications

Text-Books:

3. Product design & development by Karl T Ulrich and Steven D Eppinger
4. Rapid Prototyping principles and applications by C K Chua, K F Leong and C S Lim

Reference Books:

- The design of everyday things by Don Norman
- Product designs from concept to Manufacture by Jennifer Hudson

- Additive manufacturing by Brent Stucker, David W. Rosen, and Ian Gibson
- Engineering design and rapid prototyping by Ali K. Kamrani and EmadAbouel Nasr

Course Outcomes:

At the end of the course the student should be able to:

CO1: Learning basics of product design as a means to manage the development of an idea from concept through to production

CO2: Analyse ,evaluate and apply the generic method for product development

CO3: Learning basics of prototyping

CO4: Demonstrate Stereolithogrphy , selective laser sintering , fused deposition modeling , laminated object manufacturing & solid ground curing

Scheme of Examination:

Student has to solve PART-A compulsorily and from PART-B any ONE full question from each of the four UNITS.

Course Outcomes (COs)	Programme Outcomes (POs)												Programme Specific Outcomes (Pso)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4
1	3	2	1	-	-	1	1	-	-	-	-	-	2	2	1	2
2	2	3	1	-	-	1	1	-	-	-	-	-	2	3	1	1
3	3	1	2	1	-	1	-	-	-	-	-	-	2	1	2	1
4	2	2	2	2	-	1	1	-	-	-	-	-	3	1	1	1

21UME713 E	INFORMATION TECHNOLOGY APPROACH IN MANUFACTURING	03 - Credits (3 : 0 : 0)
L:T:P - $3_L : 0_T : 0_P$		CIE Marks : 50
Total Hours/Week: 03		SEE Marks : 50

UNIT – I	10 Hrs

Information Technology and the Increasing Complexity of Manufacturing: Introduction, Information Technology for Manufacturing- Definition and Elements, Flexibility for the future, Recognizing Information Technology's Increasing Capability in a Changing World, New Manufacturing Styles.

IT Systems: Computer Hardware- Fundamentals, Classification of Computers, Design Workstations, Principles of Networking, Private Computer Communication Networks, (VPN, PSDN,ISDN), Network Topologies, Transmission Media, Intranet, Internet.

UNIT – II	10 Hrs

Introduction to CIM Database: Database requirements of Manufacturing, Database, Features of Database Management System, Database Models-Hierarchical, Network and Relational, DBMS architecture, Query Language. SQL as a knowledge base query language.

Product Data Exchange: Introduction, Types of Translators, IGES, STEP, ACIS and DXF, Processors, Case Study on STEP.

UNIT - III	10 Hrs

Concurrent Engineering: Introduction, Implementation of concurrent engineering,Concurrent engineering and Information Technology, Soft and Hard prototyping, Characteristics of Concurrent Engineering, Key factors influencing the success of CE, Examples of CE.

Collaborative Design: Introduction, Distributed Computing, Intranets and Extranets, Instant Messaging, Virtual Reality Modeling Language, Traditional Design, Collaborative Design, Collaborative Principles,Collaborative approaches, Collaboration Tools, Collaborative Design Systems.

UNIT IV	10 Hrs

Planning of Resources for Manufacturing through Information Systems: Introduction, Role of MRP-II in a CIM system, Manufacturing Applications, Engineering Applications, Dynamic Enterprises, ERP, SCM, Selection of an ERP package, ERP in India, Dynamic Enterprise Modelling (DEM).
IoT: IoT Overview, IoT Hardware, Iot Software, IoT Technology and Protocols, IoT Common Uses, IoT Manufacturing Applications, Energy applications.

Reference Books:

1. Radhakrishnan, Subramanyan, V. Raju, "CAD/CAM/CIM", NewAge International Publishers,Third Edition.
2. Mikell P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Prentice-Hall of India Pvt. Ltd. Second Edition.
3. Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw-Hill Publishing Company Ltd.
4. www.tutorialpoint.com , "Internet of Things", Tutorials Point, Simply easy learning.
5. https://www.nap.edu/read/4815/chapter/1

Course Outcomes:

After completion of the course, the students

CO1: Understand and identify the manufacturing sector with the application of Information

Technology theory and tools. Learn the IT system ingredients to understand concepts, specifications, and applications.

CO2: Understand the method of transforming the design and manufacturing information into data, identify the classification and application of different data management methods. Gain knowledge of Query language and knowledge of handling manufacturing data using different types of file systems.

CO3: Study the role of Information Technology in manufacturing sequences comprising of various production activities. Apply the concepts of concurrent engineering, collaborative design in manufacturing network

CO4: Apply the concept of the ERP in manufacturing, understand the concept of IoT and its applications

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	1	2	2	1	2	1	2	2	3	2	1	1	2	2	1	2
CO2	2	2	1	1	1	1	2	1	2	1	2	2	1	3	3	2
CO3	2	1	2	1	1	3		1	2	2	1	2	2	2	2	1
CO4	2	2	2	3	1	1	2		2	1	1	2	3	3	3	3

21UME 714 E	HYDRAULICS AND PNEUMATICS	03 - Credits
L:T:P – 3: 0: 0		CIE Marks : 50
Total Hours		SEE Marks : 50

UNIT – I	10 Hrs

Introduction to Fluid Power:
Pascal's law, Applications of Pascal's law with problems using hand operated hydraulic jack and air to hydraulic pressure booster, Structure of hydraulic system

Source of Hydraulic Power:
Pumping theory, pump classification and difference between positive displacement and non-positive displacement pumps, working of external gear pump and variable displacement vane pump and axial piston pump, Problems on pump flow rate, efficiency and torque.

UNIT – II	10 Hrs

Hydraulic Actuators and Motors:
Linear Hydraulic Actuators [cylinders], Problems on pressure, HP and piston velocity. Rotary gear motor and variable displacement vane motor and axial piston motor. Problems on efficiency, power, speed, displacement and torque of the motor.

Control Components in Hydraulic Systems:
Directional Control Valves – Symbolic representation, Constructional features, pressure relief valve, flow control valve and check valve, valve actuation symbols.

UNIT - III	10 Hrs

Hydraulic Circuit Design and Analysis:
Control of single and Double – acting Hydraulic cylinder, regenerative circuit, drilling machine application, Metre-in and Metre-out circuits, pump unloading circuit and double pump hydraulic system, Hydraulic Braking and Antilock Braking System (ABS) of an Automobile.

Pneumatic Controls:
Structure of pneumatic system, Pneumatic Actuators: Linear cylinders and Rod less cylinders –types, working, advantages and disadvantages. Rotary external gear motor

Directional and Flow Control valves of pneumatics:

Poppet valves, spool valve, rotary valve, pilot operated valve, pilot operated check valve, and flow control valve

UNIT IV	10 Hrs

Pneumatic Circuit Design:
Direct and indirect actuation pneumatic cylinders. Flow control valves, speed control of cylinders, supply air throttling and exhaust air throttling, quick exhaust valve and shuttle valve
Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates
Multi- Cylinder Application:

Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams.

Reference Books:

1. Fluid Power with applications Anthony Esposito Pearson education 2000
2. Hydraulics and Pneumatics Andrew Parr Jaico Publishing Co. 2000
3. Industrial Hydraulics Pippenger Hicks McGraw Hill, New York. 2001
4. Hydraulic Systems – Principles and Maintenance Tata S. R. Majumdar McGraw Hill publishing company Ltd. 2001
5. Pneumatic systems S. R. Majumdar McGraw Hill publishing company Ltd.1995

Course Outcomes:

CO1: Apply the concepts of Pascals law to determine the force required to lift the load using hand operated hydraulic jack, air to hydraulic pressure booster and hydraulic system.

CO2: Determine the overall efficiency, flow rate, speed and torque of the pump and motor for the given specifications of the pump and motor.

CO3: Integrate control components into a hydraulic system using FluidSIM hydraulics simulation software teaching tool for meter-in, meter-out, drilling machine, regenerative circuit, double pump system, pump unloading circuits and ABS system applications.

CO4: Design pneumatic systems for speed control, multi cylinder sequential control and logic gates applications using FluidSIM pneumatics simulation software teaching tool..

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-
CO2	2	1	-	1	-	-	-	-	1	1	-	1	-	-	-	-
CO3	1	1	2	-	3	-	-	-	1	1	-	1	1	-	-	-
CO4	1	1	2	-	3	-	-	-	1	1	-	1	1	-	-	-

21UME 715 E	COMPOSITE MATERIALS	03 - Credits
L: T: P: 2 : 2 : 0		CIE Marks : 50
Hrs./Week : 03		SEE Marks : 50

UNIT – I	10 Hrs

Introduction to composite materials:

Definition and classification of composites based on matrix and reinforcement, Characteristics of composite materials, Fibrous composites, Laminate composites and particulate composites. Factors which determine the properties of composites, Benefits of composites, properties and types of reinforcements and matrices, Reinforcement-matrix interface.

UNIT – II	10 Hrs

Polymer matrix composites:

Introduction, Polymer matrices, Processing methods like Lay up and curing, open and closed mold process- hand lay up techniques, laminate bag molding, production procedures for bag molding, filame winding, pultrusion, pulforming, thermo-forming, molding methods, properties of PMCs and applicatio Some commercial PMCs.

UNIT - III	10 Hrs

Metal matrix composites:

Introduction, Metallic matrices, Classification of MMCs, Need for production of MMCs, Interface reactions, processing methods like Powder metallurgy, diffusion bonding, Melt stirring, Compo/Rheo casting, Squeeze casting, Liquid melt infiltration, Spray deposition and In situ Processes, Properties of metal matrix composites, Applications, Some commercial MMCs.

UNIT IV	10 Hrs

Cutting, Machining and Joining of Composites

Continuous fibers, Iso-stress condition, Iso-strain condition, critical volume fraction of fiber and minimum volume fraction of fiber, Numericals on modulus of rigidity, and mechanics of discontinuous fibers.

Cutting and machining of composites: Reciprocating knife cutting, cutting of cured composite, Joining o composites: Mechanical fastening, Adhesive bonding.

Reference Books:

1. Composite Science and Engineering, K. K. Chawla, Springer Verlag, 1998
2. Introduction to composite materials Hull and Clyne Cambridge University Press, 2nd Edition, 1990
3. Composite Materials: Engineering and Science F. L. Mathew and R. D. Rawlings, Woodhead Publishing Limited, 1999
4. Composite materials handbook, MeingSchwaitz, McGraw Hill Book Company, 1984
5. Mechanics of Composite Materials, Robert M. Jones, McGraw Hill Kogakusha Ltd, 1998
6. Composite materials, S. C. Sharma, Narosa Publishing House, 2000
7. Mechanics of composites, Artar Kaw,CEC Press, 2002

Course Outcomes:**

At the end of the course student will be able to

CO1: Solve the numerical problems on modulus of elasticity of the FRP composites.
Illustrate the types of composites. Factors influencing the mechanical behaviour.

CO2: Analyse the critical volume fraction of fibres in the FRP composites.

CO3: Synthesize polymer matrix and metal matrix composites.
CO4: Use the abrasive water jet machining of composites. Illustrate the cutting and joining of composites.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	1	-	-	-	-	1		1	-	-	2	1	1	-
CO2	1	2	1	-	-	-	-	1		1	-	-	1	2	1	-
CO3	-	1	1	2		-	-	1		1	-	-	-	1	1	2
CO4	-	-	1	1	2	-	-	1		1	-	-	-	-	1	2

21UME812E	CONTROL ENGINEERING	Credits: 03
L:T:P - 3 : 0: 0		CIE Marks: 50
Total Hours/Week: 3		SEE Marks: 50

UNIT – I	10 Hrs

INTRODUCTION: **5 Hours**

Concept of automatic controls, open and closed loop systems, concepts of feedback, requirement of an ideal control system. Types of controllers – Proportional, Integral, Proportional Integral, Proportional Integral Differential controllers.

MATHEMATICAL MODELS: **5 Hours**

Transfer function, Mathematical Models of Mechanical systems, and Hydraulic systems.

UNIT – II	10 Hrs

BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS: **4 Hours**

Transfer Functions definition, function, blocks representation of system elements, reduction of block diagrams, signal flow graphs: Mason's gain formula.

TRANSIENT AND STEADY STATE RESPONSE ANALYSIS: **6 Hours**

Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's –Hurwitz Criterion.

UNIT - III	10 Hrs

FREQUENCY RESPONSE ANALYSIS:

Polar plots: Stability Analysis, Relative stability concepts, phase and gain margin. **5Hours**

Bode Plots: stability analysis using Bode plots, Simplified Bode Diagrams. **5Hours**

UNIT IV	10 Hrs

ROOT LOCUS PLOTS: **6 Hours**

Definition of root loci, general rules for constructing root loci, Analysis using root locus.

CONTROL ACTION AND SYSTEM COMPENSATION: **4 Hours**

Series and feedback compensation, Physical devices for system compensation.

Reference Books:

1. Modern Control Engineering, Katsuhiko Ogata University of Minnesota. Prentice Hall, New Jersey, 5th edition, 2010.
2. Control systems Engineering, I.J. Nagrath and M. Gopal, New Age International Publisher, 6th edition, 2018
3. Control systems Engineering, U.A. Bakshi and V.U.Bakshi, Technical Publications Pune, 3rd edition 2011
4. Solutions and Problems of Control Systems, Jairath, CBS Publications Delhi, 5th edition 2019

Course Outcomes:
At the end of the course, the student will be able to: **CO1:** Apply the mathematical modeling for the mechanical and Hydraulic systems **CO2:**Apply the rules of block diagrams and signal flow graphs and formulating the transfer function **CO3:** Analyze the accuracy of the systems by using graphical methods(Polar plot and Bode plot) **CO4:** Analyze the accuracy of the systems by using root locus
Question paper pattern for SEE: 1Total of eight questions with two from each unit to be set uniformly covering the entire syllabus. 4. Each question carries 20 Marks and should not have more than 4 subdivisions 5. Any five full questions are to be answered choosing at least one from each unit.

Table: Matrix to describe the mapping of POs with Cos

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	2	3	2	-	1	-	-	1	-	-	-	1	2	2	-	-
CO2	2	3	3	-	1	-	-	1	-	-	-	1	2	2	-	-
CO3	3	3	3	-	1	-	-	1	-	-	-	1	2	2	-	-
CO4	3	2	3	-	1	-	-	1	-	-	-	1	2	2	-	-
	High -3, Medium – 2, Low - 1															

21UME 813 E	SUPPLY CHAIN MANAGEMENT	03 - Credits (3 : 0 : 0)
Hrs./Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – I	10 Hrs

Framework of Supply Chains: Introduction to supply chain,The objective of a supply chain, The importance of supply chain decisions, Decision phases in a supply chain, Process views of a supply chain: Cycle view of supply chain processes, Push/Pull view of supply chain processes, Examples (minimum two) of Supply Chains.

Performance of Supply Chains: Competitive and supply chain strategies, Achieving strategic fit: Understanding the customer and supply chain uncertainty, Understanding the supply chain capabilities, Achieving strategic fit, Issues affecting strategic fit, Expanding strategic scope, Drivers of supply chain performance, Framework for structuring drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing.

UNIT – II	10 Hrs

Designing the Supply Chain Network: The role of distribution in the supply chain, Factors influencing distribution network design, Design options for a distribution network: Manufacturer storage with direct shipping (MSWDS), MSWDS and in-transit merge, Distributor storage with package carrier delivery, Distributor storage with last-mile delivery, Manufacturer or Distributor storage with customer pick-up, Retail storage with customer pickup, Selecting a distributor network design.

Transportation in a Supply Chain: The role of transportation in a Supply Chain, Modes of transportation, Design options for a transportation network: Direct shipment network, Direct shipping with milk-runs, All shipments via central-DC, Shipping via DC using milk-runs, Tailored network, Tailored transportation: By customer density and distance, By size of customer, The Role of IT in transportation, Risk management in transportation, Making transportation decisions in practice.

UNIT - III	10 Hrs

Demand forecasting in a Supply Chain: The role of forecasting in a supply chain, Characteristics of forecasts, Components of a forecast and forecasting methods, Basic approach to demand forecasting, The role of IT in forecasting, Risk management in forecasting, Forecasting in practice.

Sourcing and Cross-Functional Drivers in a Supply Chain: The role of sourcing in a supply chain, In-house or Outsource, Risks of using a Third-party, Supplier scoring and assessment, The procurement process, Sourcing planning and analysis, The Role of IT in Sourcing, Risk Management in Sourcing, Making Sourcing Decisions in Practice.

UNIT IV	10 Hrs

Information Technology in a Supply Chain: The Role of IT in a supply chain, The supply chain IT framework, Customer Relationship Management (CRM), Internal supply chain management, Supplier Relationship Management (SRM), The Transaction Management Foundation, The future of IT in the supply chain, Risk Management in IT, Supply Chain IT in Practice.

Coordination in a Supply Chain: Lack of Supply Chain Coordination and the Bullwhip Effect, The Effect on performance of lack of coordination, Obstacles to coordination in a supply chain, Managerial levers to achieve coordination, Building strategic partnerships and trust within a supply chain, The Role of IT in Coordination, Achieving Coordination in Practice

Reference Books:

1. Supply Chain Management–Strategy, Planning & Operation. -Sunil Chopra, Peter Meindl& D V Kalra-Pearson Prentice Hall (Education, South Asia)-Third Edition 2007
2. Supply Chain Redesign–Transforming Supply Chains into Integrated Value Systems.-Robert B Handfield, Ernest L Nichols, Jr-Pearson Education/Financial Times Prentice Hall PTR-2002
3. Modelling the Supply Chain -Jeremy F Shapiro, Duxbury, Thomson Learning, 2002, ISBN 0-534-37363
4. Designing & Managing the Supply Chain. David Simchi Levi, Philip Kaminsky & Edith Simchi Levi; McGraw Hill

Course Outcomes:

By the end of course with aid of design data handbook students shall be able to,

CO1: Demonstrate the supply chain objectives, importance, decision phases, process views, performance with strategic fit and their impact on success of a supply chain.

CO2: Develop a distribution network with different modes of transportation, understanding the effect of e-business on the design of distribution networks in different industries.

CO3: Express the role of forecasting and sourcing with their risk management.

CO4: Analyze technology and coordination in a supply chain, applications of IT for supply chain drivers and the processes that enable supply chain performance.

Table: Matrix to describe the mapping of POs with Cos

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	2	-	2	3	-	2	2	3	2	1	2	2	3	2	3
CO2	3	2	-	2	1	-	3	-	2	-	-	3	2	1	-	3
CO3	2	-	-	3	-	2	1	1	3	-	-	3	1	-	2	2
CO4	3	1	2	3	-	-	-	2	-	3	1	2	1	1	2	-
	High -3, Medium – 2, Low - 1															

21UME 814 E	TOOL DESIGN	03 - Credits
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 3		SEE Marks : 50

UNIT – I	11 Hrs

Tool Design Methods: Introduction, the de sign procedure, drafting, and design techniques in tooling drawing.

Design of Cutting Tools: Introduction, the metal cutting process, revision of metal cutting tools-single point cutting tools, milling cutters, drills and drilling, reamers, taps, selection of carbide tools, determining the insert thickness for carbide tools.

UNIT – II	11 Hrs

Locating and Clamping Methods: Introduction, basic principle of location, locating methods and devices, basic principle of clamping.

Design of Drill Jigs: Introduction, types of drill jigs, general considerations in the design of drill jigs, drill bushings, methods of construction.

UNIT - III	10 Hrs

Design of Fixtures: Introduction, types of fixtures, fixtures and economic.

Design of Press-working Tools: Power presses, cutting operations, types of die – cutting operations and their design, evolution of blanking and progressive blanking.

UNIT IV	12 Hrs

Design of Sheet Metal Bending, Forming and Drawing Dies: Introduction, bending dies, forming dies, drawing dies, evolution of a draw die, progressive dies and selection of progressive dies. Strip development for progressive dies, evolution of progressive dies, examples of progressive dies. Extrusion dies, drop forging dies and auxiliary tools, problems.

Plastics as Tooling Materials: Introduction, plastics commonly used as tooling materials, application of epoxy plastic tools, construction methods, metal forming operations with Urethane dies, calculating forces for Urethane pressure pads, problems.

Reference Books:

1. Cyril Donaldson, G H Lecain and V C Gold. Tool Design, 3rd edition, TMH Publishing Co. Ltd. New Delhi, 2000
2. ASTME, Fundamentals of Tool Design, PHI (P) Ltd. New Delhi, 1983
3. Machine Tool Design and Numerical Control N. K. Mehta Tata McGraw Hill Publisher (P) Ltd, New Delhi 2006
4. Fundamentals of tool design Wilson F. W. ASME PHI, New Delhi 1984

Course Outcomes:

At the end of the course student will be able to

CO1: Apply *the tool design procedure for cutting tools.*

CO2: Analyze *the locating and clamping methods for tool and work piece*

CO3: Design *the fixtures and jigs for press working tools, press tool operations*

CO4: Design *of sheet metal bending, forming and drawing dies*

CO5: Analyze *the commonly used polymer tooling materials with design aspects like pressure and forces*

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	1	2	1	-	-	-	-	-	-	-	-	-	**2**	**2**	-	-
CO2	1	2	1	-	-	-	-	-	-	-	-	-	**2**	**2**	-	-
CO3	1	2	2	-	-	-	-	-	-	-	-	-	**2**	**2**	-	-
CO4	1	2	2	-	-	-	-	-	-	-	-	-	**2**	**2**	-	-
CO5	1	2	2	-	-	-	-	-	-	-	-	-	**2**	**2**	-	-

21UME 814 E	**POWER PLANT ENGINEERING**	**03 - Credits (3 : 0 : 0)**
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 3		SEE Marks : 50

UNIT – I	**10 Hrs**

Introduction

Energy and power, Sources of power, Need power generation, Power plant cycles and classification of power plant cycles, Layout of modern steam power plant, Essential requirements of steam power station, Selection of site for steam power station, Capacity of steam power plant, Choice of steam conditions.

Steam Power Plant:

Different types of fuels used for steam generation, Coal handling, Requirements of good coal handling plant, Coal handling systems, Equipment for burning coal in lump form, Strokers, Different types of stokers, Advantages and disadvantages of using pulverized fuel, Equipment for preparation and burning of pulverized coal, Unit system and bin system, Coal burners, Fluidized bed combustion.

UNIT – II	**10 Hrs**

Ash and dust handling:

Ash handling equipment and ash handling systems, Dust collection, Removal of smoke and dust, Dust collectors, Efficiency of dust collectors, Uses of ash and dust, General layout of ash and dust collection systems, Fly ash, Fly ash composition, disposal and application.

Chimney draught:

Classification, Naturaldraught, Chimney height and diameter, Condition for maximum discharge through chimney, Efficiency of chimney, Draught losses, Artificial draught, Forced, Induced and Balanced draught, Advantages of mechanical draught, Numerical problems on chimney draught.

UNIT - III	**10 Hrs**

Boilers:

Classification and comparison, Selection of a boiler, Essentials of good boiler, Generation of steam using forced circulation, High and supercritical pressures, L Mont, Benson, Velox, Schmidt, Loeffler and Ramson steam generators.

Accessories:

Accessories for the Steam Generator such as super-heaters, Desuperheater, Control of super heaters, Economisers, Air Pre-heaters and re-heaters, Feed water heaters and evaporators.

Performance of boilers:

Evaporative capacity, Equivalent evaporation, Factor of evaporation, Boiler efficiency, Heat losses in a boiler plant, Numerical problems on boiler performance.

UNIT IV	**10 Hrs**

Steam turbines:

Steam nozzles, Nozzle efficiency, Compounding of steam turbines, Difference between impulse and reaction steam turbines, Turbine efficiencies. Steam condensers; Classification, Comparison between jet and surface condensers, Numerical problems on steam turbines.

Cooling ponds and Cooling towers:

Introduction, Natural and artificial ponds, Cooling ponds, Spray ponds. Cooling towers: Introduction, Natural and forced draft cooling towers, Comparison between natural and forced draft cooling

towers. Feed water treatment: Impurities in water and troubles caused by the impurities, Methods of feed water treatment, pH value of water.

Cogeneration power plants:

Classification, Topping and bottoming cycles, Advantages and disadvantages of steam power plants.

Reference Books:

1. Power Plant Technology ,M.M. EL-Wakil,McGraw Hill, International, 1994.
2. Power Plant Engineering , P.K Nag, Tata McGraw Hill, 3rd Ed. 2001
3. Power Plant Engineering , R.K.Rajput, Laxmi Publications, 4th Ed. 2008.
4. Power Plant Engineering , Domakundawar, Dhanpath Rai and sons, New delhi, 2003.

Course Outcomes:**

At the end of the course student will be able to

CO1: *Apply* the knowledge of power plant engineering in selecting the types of fuels and burning methods to produce steam.

CO2: *Apply* the knowledge of power plant engineering in selecting ash handling system, dust handling system and chimney draught for a steam power plant.

CO3: *Apply* the knowledge of power plant engineering to *analyze* boilers, boiler accessories and performance of boilers.

CO4: *Apply* the knowledge of power plant engineering to *analyze* steam turbines, cooling ponds, cooling towers and co-generation power plants.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	2	1	1	1	2	1	3	3	1	1	2	2	1	2	2
CO2	3	2	1	1	1	2	1	3	3	1	1	2	2	1	2	2
CO3	3	2	1	1	1	2	1	3	3	1	1	2	2	1	2	2
CO4	3	2	1	1	1	2	1	3	3	1	1	2	2	1	2	2

21UME 821N	Fluid Power Automation (Open Elective)	03 Credits (3:0:0)
L:T:P - 3 : 0: 0		CIE Marks:50
Total Hours/Week: 3		SEE Marks:50

Unit-I	10 Hours

Introduction to Automation and Pascal's law:

Fixed Automation, Programmable Automation, Flexible Automation, Structure of hydraulic system. Pascal's law, Applications of Pascal's law with problems using hand operated hydraulic jack and air to hydraulic pressure booster

Source of Hydraulic Power:

Pumping theory, pump classification, working of external gear pump and variable displacement vane pump, Problems on pump flow rate.

Hydraulic Actuators and Motors:

Linear Hydraulic Actuators [cylinders], Hydraulic Rotary external gear motor and vane motor.

Unit-II	10 Hours

Control Components in Hydraulic Systems:

Directional Control Valves – Symbolic representation, Constructional features, pressure relief valve, flow control valve and check valve, valve actuation symbols

Electrical components required to operate Hydraulic system

Normally open contact switch and normally closed contact switch, Relays and solenoids, proximity sensors

Electro Hydraulic Circuit Design and Analysis:

Control of single and Double – acting Hydraulic cylinder, regenerative circuit, drilling machine application, Metre-in and Metre-out circuits, pump unloading circuit and double pump hydraulic system, Hydraulic Braking and Antilock Braking System (ABS) of an Automobile.

Unit-III	10 Hours

Pneumatic Controls:

Structure of pneumatic system, Pneumatic Actuators: Linear cylinders and Rod less cylinders –types, working, advantages and disadvantages. Rotary external gear motor

Directional and Flow Control valves:

Poppet valves, spool valve, rotary valve, pilot operated valve, pilot operated check valve, and flow control valve

Unit-IV	10 Hours

Electro-Pneumatic Circuit Design:

Direct and indirect actuation pneumatic cylinders. Flow control valves, speed control of cylinders, supply air throttling and exhaust air throttling, quick exhaust valve and shuttle valve

Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates

Multi- Cylinder Application:

Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams.

Introduction to Programmable Logic Controller:

Components of PLC, Operation, constructing logic gates using Ladder logic programming. Operating DCV of cylinder using PLC, proximity switch and timer.

Reference Books:

1. Fluid Power with applications Anthony Esposito Pearson education 2000
2.Hydraulics and Pneumatics Andrew Parr Jaico Publishing Co. 2000
3. Industrial Hydraulics Pippenger Hicks McGraw Hill, New York. 2001
4. Hydraulic Systems – Principles and Maintenance Tata S. R. Majumdar McGraw Hill Publishing Company Ltd. 2001
5. Pneumatic systems S. R. Majumdar McGraw Hill publishing company Ltd.1995

Course Outcomes:

After completion of the course, student will be able to:

CO1: Apply the concepts of Pascal's law to hand operated hydraulic jack, air to hydraulic pressure booster and hydraulic system

CO2: Determine the pressure, velocity and power for double acting cylinder.

CO3: Design electro hydraulic circuits for meter-in, meter-out, drilling machine, regenerative circuit, double pump system, pump unloading circuits and ABS system applications.

CO4: Design electro pneumatic systems for speed control of cylinder and apply logic gates and PLC programming for pneumatic systems.

*** Books to be listed as per the format with decreasing level of coverage of syllabus**

**** Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-
CO2	2	1	-	1	-	-	-	-	1	1	-	1	-	-	-	-
CO3	1	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-
CO4	1	1	2	-	-	-	-	-	1	1	-	1	1	-	-	-

21UME 822N	ADVANCED MANUFACTURING TECHNOLOGY (Open Elective)	03 - Credits (3 : 0 : 0)
L:T:P - 3 : 0: 0		CIE Marks : 50
Total Hours/Week: 3		SEE Marks : 100

Unit - I	10 Hrs
Introduction: Introduction to CAD/CAM, product system facilities: Low, medium and high. Manufacturing support systems, Automation in production systems. Automated manufacturing systems. Computerized manufacturing systems. Reasons for automating, Automation principles and strategies. Discussions. **Fundamentals of Automated Production Lines:** Introduction, System configurations, Work part transfer mechanisms, Storage buffers, Control of the production line.	
UNIT - II	**10 Hrs**
Analysis of Transfer Lines: Analysis of Transfer Lines with no internal storage: Basic terminology and Performance measures, Workstation breakdown analysis: Upper bound approach, Lower bound approach, and Analysis of Transfer Lines with storage buffers. Numerical examples. **Automated Assembly System:** Introduction,System configurations, Parts delivery at workstations, Applications. Quantitative analysis: Parts delivery system, Multi-station and single station assembly machines. Partial automation.	
Unit - III	**10 Hrs**
NC Part Programming: Basic components of an NC system, EIA and ISO coding standards, NC part programming exercises. **Computer Assisted Part Programming:05 Hours** Definingpart geometry**,** Specifying tool path and operation sequence, Computer task in computer-assisted part programming, Part programming with APT exercises.	
Unit - IV	**10 Hrs**
Product life cycle management: Introduction, Product information, PLM framework, Benefits, Implementation, Enabling technologies, Example of business problem. Product data management: Evolution of PDM systems, Scope, Benefits, Implementation, Software capabilities, software functions **Advances in Automated Factory** **Industry 4.0:** functions, applications and benefits, Components of Industry 4.0, Internet of things (IoT), IoT applications in manufacturing, Big-Data and cloud computing for IoT, IoT for smart manufacturing.	

Reference Books

1. Automation, Production Systems and CIM Groover M. P Prentice Hall of India 2006
2. Mastering CAD/CAM Ibrahim Zeid Tata McGraw Hill 2008
3. CAD/CAM Principles and Applications P. N. Rao Tata McGraw Hill 2nd Edition
4. Computer Integrated Manufacturing Bharat Vijamuri Sunstar Publisher 4th Edition, 2018

Course Outcomes:

At the end of the course the student should be able to:

CO1: Understand and apply good comprehension study of two aspects of production systems and how they are sometimes automated and /or computerized in modern industrial practice.

CO2: Understand and apply the basic methods of examination of the technology of automated production lines and develop several mathematical models that can be used to analyze their operation. Use of mechanized and automated devices to perform the various assembly tasks in an assembly line or cell.

CO3 :Understand, apply and integrate, programmable automation in which the mechanical actions of the machine tool or other equipment are controlled by a program containing coded alphanumeric data.

CO4: Understand and apply the basic methods of PLM; why it is crucial for companies to implement, what a PLM system offers, what PDM is and its relationship to PLM. Study and apply the functions and components, applications and benefits of Industry 4.0, Concept of IoT.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

Course Outcomes (COs)	Programme Outcomes (Pos)/Programme Specific Outcomes (PSO)															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
1	2	2	-	-	-	-	2	1	2	2	1	2	2	2	1	-
2	2	2	2	-	-	-	2	1	2	2	1	2	2	2	2	-
3	2	2	1	-	-	-	2	1	2	2	1	2	1	1	2	-
4	2	2	2	-	-	-	2	1	2	2	1	2	2	2	1	-
	High -3, Medium – 2, Low - 1															

NUME 702 L	VII SEMESTER CNC LABORATORY	01 - Credits (0 : 0 : 2)
Hrs./Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

Part-A

1. Programming on lathe for facing
2. Programming on lathe for simple turning
3. Programming on lathe for step turning
4. Programming on lathe for groove cutting

Part-B

5. Programming on milling with drill tap attachment for facing
6. Programming on milling with drill tap attachment for drilling
7. Programming on milling with drill tap attachment for tool path movement

Scheme for Examination:

1. Each laboratory subject is evaluated for 100 marks (50 CIE and 50 SEE).
2. The CIE in laboratory in classes is carried out for 50 marks (30 marks for the performance and term work).
3. For remaining 20 marks one practical test to be conducted.

The SEE practical is conducted for 50 marks two question to be set from each Part A, and Part B. for 20 marks each and 10 marks Viva voce.

1. Understand the basic procedures and concepts of programming, set up and operation of a CNC Machining Center.
2. Identify and understand the basic programming codes.
3. Create geometry and tool paths from the specifications for simple parts
4. Identify and define the functions of the CNC machine control.
5. Set up the CNC machining center for manufacturing simple parts
6. Manufacture simple parts on the CNC machining center.

Table: Matrix to describe the mapping of POs with Cos

Course Outcomes (COs)	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
1	2	3	3	3	3	1	2	1	3	2	2	3
2	3	3	3	3	3	1	1	2	3	3	3	3
3	2	2	2	2	1	1	2	1	3	1	2	1
4	3	3	3	2	3	3	1	3	3	2	3	2