VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM

CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2017

B.E. Manufacturing Science & Engineering

III SEMESTER

Sl No	Subject Code	Title	Teaching Hours /week			Examination				Credits
			Theory	Tutorials	Practical	Duration	Pract/Drawing Marks	IA Marks	Total	
1	17MAT31	Engineering Mathematics -III	04			03	60	40	100	04
2	17MA32	Materials Science	04			03	60	40	100	04
3	17MA33	Thermodynamics	03	02		03	60	40	100	04
4	17MA34	Mechanics of Materials	03	02		03	60	40	100	04
5	17MA35	Foundry Technology	04			03	60	40	100	04
6	17MA36	Computer Aided Machine Drawing	02		04	03	60	40	100	04
7	17MAL37	Material Testing Laboratory	01		02	03	60	40	100	02
8	17MAL38	Foundry & Forging Lab	01		02	03	60	40	100	02
Total			22	04	08		480	320	800	28

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CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2017

B.E. Manufacturing Science & Engineering

IV SEMESTER

Sl No	Subject Code	Title	Teaching Hours /week			Examination				Credits
			Theory	Tutorials	Practical	Duration	Pract/Drawing Marks	IA Marks	Total	
1	17MAT41	Engineering Mathematics -IV	04			03	60	40	100	04
2	17MA42	Theory of Machines	03	02		03	60	40	100	04
3	17MA43	Joining Processes	04			03	60	40	100	04
4	17MA44	Fluid Mechanics & Machines	03	02		03	60	40	100	04
5	17MA45	Machine Tools and Operations	04			03	60	40	100	04
6	17MA46	Mechanical Measurements & Metrology	04			03	60	40	100	04
7	17MAL47	Metrology & Machine Tool Laboratory	01		02	03	60	40	100	02
8	17MAL48	Welding Practice	01		02	03	60	40	100	02
Total			24	04	04		480	320	800	28

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS) SCHEME OF TEACHING AND EXAMINATION 2017-2018 B. E. Manufacturing Science and Engineering

SEMESTER V

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17MA51	Management and Entrepreneurship	4			03	60	40	100	4
2	17MA52	Computer Aided Design and Manufacturing	4			03	60	40	100	4
3	17MA53	Metal Forming	4			03	60	40	100	4
4	17MA54	Elements of Machine Design	3	2		03	60	40	100	4
5	17MA55X	Professional Elective-I	3			03	60	40	100	3
6	17MA56X	Open Elective-I	3			03	60	40	100	3
7	17MAL57	Computer Aided Design and Manufacturing Lab	1		2	03	60	40	100	2
8	17MAL58	Machine Shop	1		2	03	60	40	100	2
TOTAL			23	02	04		480	320	800	26

Professional Elective-I		Open Elective-I	
17MA551	Product Design	17MA561	Optimization Techniques
17MA552	Machine Tool Design	17MA562	Knowledge Management
17MA553	Maintenance Engineering		

Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
Professional Elective: Elective relevant to chosen specialization/branch
Open Elective: Electives from other technical and/or emerging subject areas.

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B. E. Manufacturing Science and Engineering

SEMESTER VI

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17MA61	Engineering Economics	4			03	60	40	100	4
2	17MA62	Computer Integrated Manufacturing	4			03	60	40	100	4
3	17MA63	Additive Manufacturing	4			03	60	40	100	4
4	17MA64	Non Destructive Testing	4			03	60	40	100	4
5	17MA65X	Professional Elective-II	3			03	60	40	100	3
6	17MA66X	Open Elective-II	3			03	60	40	100	3
7	17MAL67	Additive Manufacturing Lab	1		2	03	60	40	100	2
8	17MAL68	Non Destructive Testing Lab	1		2	03	60	40	100	2
TOTAL			24		04		480	320	800	26

Professional Elective-II		Open Elective-II	
17MA651	Quality Assurance	17MA661	Automation and Robotics
17MA652	Jigs and Fixtures	17MA662	Supply Chain Management
17MA653	Material Handling Equipments		

Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

Professional Elective: Elective relevant to chosen specialization/branch

Open Elective: Electives from other technical and/or emerging subject areas.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

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CHOICE BASED CREDIT SYSTEM (CBCS)

SCHEME OF TEACHING AND EXAMINATION 2017-2018

VII Semester

Sl No	Sub Code	Subject Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17MA71	Control Engineering	3	2		3	60	40	100	4
2	17MA72	Hydraulic Circuits & Programable Logic Controllers	4			3	60	40	100	4
3	17MA73	Statistical Quality Control	3	2		3	60	40	100	4
4	17MA74X	Professional Elective-III	3			3	60	40	100	3
5	17MA75X	Professional Elective-IV	3			3	60	40	100	3
6	17MAL76	Hydraulic Circuits & Program Logic Controllers Lab	1		2	3	60	40	100	2
7	17MAL77	Computer Intefrated manufacturing lab	1		2	3	60	40	100	2
8	17MAP78	Project Phase-I						100	100	2
		Total					**420**	**380**	**800**	**24**

Professional Elective-III

Sl No	Sub Code	Subject Title
1	17MA741	Facility Planning & Design
2	17MA742	Process Planning
3	17MA743	Precision Engineering

Professional Elective-III

Sl No	Sub Code	Subject Title
1	17MA751	Operational management
2	17MA752	Reliability Engineering
3	17MA753	Materials Management

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SCHEME OF TEACHING AND EXAMINATION 2017-2018

VIII Semester

Sl No	Sub Code	Subject Title	Teaching Hours /Week				Examination			Credits
			Lecture	Tutorial	Practical	Duration (Hours)		SEE Marks	CIE Marks	Total Marks
1	17MA81	Operations Research	3	2		3	60	40	100	4
2	17MA82	Total Quality Management	4			3	60	40	100	4
3	17MA83X	Professional Elective - V	3			3	60	40	100	3
4	17MA84	Internship / Professional Practice(Industry oriented)				3	50	50	100	2
5	17MA85	Project Phase – II			12	3	100	100	200	6
6	17MA86	Seminar		2				100	100	1
		TOTAL	**10**	**4**	**12**	**15**	**330**	**370**	**700**	**20**

Professional Elective-V		
Sl No	Sub Code	Subject Title
1	17MA831	Product Life Cycle Management
2	17MA832	Project management
3	17MA833	Flexible Manufacturing System

	MATERIALS SCIENCE		
Subject Code	:17MA32	Exam Hours	:03
Hours/Week	:04, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Common to 17ME32

THERMODYNAMICS

Subject Code	:17MA33	Exam Hours	:03
Hours/Week	:03 L + 02 T, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

COURSE OBJECTIVES

The course intends to:

1. Impart fundamental concepts and laws of thermodynamics
2. Study PV and TS diagrams for various thermodynamic cycles
3. Make students understand entropy changes and write Tds relation.
4. Provide knowledge of phase changes in water
5. Introduce the concepts of refrigeration, psychrometry and air conditioning system.

COURSE OUTCOMES

After completion of course students are able to

1. Apply the laws of thermodynamics in analysis of thermodynamic systems.
2. Use PV and TS diagrams for analysis of different thermodynamic processes.
3. Evaluate entropy changes
4. Calculate enthalpy of water at its different phases
5. Calculate the refrigeration and air conditioning loads

COURSE OUTCOMES

UNIT - 1

Fundamental Concepts & Definitions: Thermodynamics definition. Characteristics of system boundary and control surface, examples. Thermodynamic properties - definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes; Thermodynamic equilibrium; Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements.

Work and Heat: Thermodynamic definition of work; examples, sign convention, p-v diagrams.

10 Hours

UNIT – 2

First Law of Thermodynamics: Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes. Specific heat at constant volume, enthalpy, specific heat at constant pressure, important applications.

Second Law of Thermodynamics: Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and irrevesible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. **10 Hours**

UNIT - 3

Gas power cycle: Air Standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and dual cycles.

Vapour Power Cycles: Carnot vapour power cycles, Simple Rankine cycle, T- S diagram, comparison of Carnot and Rankine cycles.

10 Hours

UNIT – 4

Entropy: Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, calculation of entropy using Tds relations.

Pure Substances: P-T and P-V diagrams, triple point and critical points. Subcooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), Steam tables and its use.

10 Hours

UNIT - 5

Refrigeration: Vapour compression refrigeration system ; description, analysis, refrigerating effect, capacity , power required, units of refrigeration, COP , Refrigerants and their desirable properties. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system. Calculation of refrigeration load with examples.

Psychometry: Atmospheric air and psychometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures, specific and relative humidities. Construction and use of psychometric chart . Analysis of various processes; heating, cooling , dehumidifying and humidifying. Summer and winter air conditioning. Calculation of air conditioning load with examples.

10 Hours

TEXT BOOKS:

1. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002
2. Applied Thermodynamics, Rajput, Laxmi Publication
3. Fundamentals of Classical Thermodynamics, G.J.Van Wylen and R.E.Sonntag, Wiley Eastern.

REFERENCE BOOKS:

1. Thermodynamics, An Engineering Approach, Yunus A.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002

2. Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, John Wiley and Sons.

3. An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993,

4. B.K Venkanna, Swati B. Wadavadagi “Basic Thermod yn amics, PHI, New Delhi, 2010

Data Hand Book:

1. Thermodynamic data hand book, B.T. Nijaguna.

2. Properties of Refrigerant & Psychometric (tables & Charts in SI Units), Dr. S.S. Banwait, Dr. S.C. Laroiya, Birla Pub. Pvt. Ltd., Delhi, 2008

MECHANICS OF MATERIALS

Subject Code	:17MA34	Exam Hours	:03
Hours/Week	:03L+02T, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Common to 17ME34

FOUNDRY TECHNOLGY

Subject Code	:17MA35	Exam Hours	:03
Hours/Week	:04 L, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Course Objectives:

This course provides:

1. A basic understanding of foundry practice and metal casting as one of the important manufacturing processes.
2. An explanation of the fundamental process of solidification of pure metals and alloys.
3. Sand molding and permanent die molding are explained in detail.
4. The standard foundry practices for casting of ferrous and non-ferrous alloys elaborated.
5. An overview of the designing of molds, casting defects, inspection and testing of castings and modernization of foundries

Course outcomes:

The student shall:

1. Have an Understand the technology, variables and complexity involved in producing a casting.

2. Be able to make selection of the type of furnace required for any specific casting problem and design the pattern requirement.
3. Have the basic knowledge for selecting the type of sand, for molds and cores as well as the molding process.
4. Know about the special molding processes and when their use is warranted.
5. Have a broad knowledge of casting of ferrous and non-ferrous alloys and of the inspection techniques to detect casting defects.

UNIT-1

Introduction: Introduction to casting process and the steps involved; Components produced by casting process, Comparison of metal casting with metal joining, Advantages and limitations of casting process; Overview of the industry

Solidification of metals: Introduction, freezing of pure metals; Nucleation and Growth, shrinkage, solidification of alloys; dendritic growth and segregation; shrinkage in alloys; Alloys freezing in two stages; solidification process in eutectic and non-eutectic alloys; Properties related to the solidification mechanism – Fluidity, Hot tea ring or hot cracking, Evolution of dissolved gases, Effect of inoculation; Solidification of actual castings; Progressive and directional solidification; Centerline feeding resistance; Rate of solidification; Chvorinov's Rule.

10 Hours

UNIT-2

Foundry Furnaces: Types of foundry furnaces – crucible, pot and rever beratory furnace; Cupola; Electric arc furnace, Induction furnace.

Patterns and pattern making: Definition, functions; Materials used for patterns, pattern allowances and their significance; Classification of patterns; BIS colour coding of patterns, Core boxes. .

10 Hours

UNIT-3

Sand molding: Types and requirements of base sand; Binders and additives used – types and properties; Molding tools and equipment – hand mold ing tools, molding machines – Jolt type, squeeze type, Jolt and Squeeze type and Sand slinger; Cores – types, core prints, core venting and baking, core shifting and chaplets, method of making cores, binders used, core sand molding; Gating systems - principles and types of gates and risers, gating ratios and chills, riser location and design in actual casting; Molding processes – bench molding, floor molding, pit molding, stack molding, green sand molding, dry sand molding, loam molding, machine molding.

10 Hours

UNIT-4

Special Molding Processes: Study of important molding processes, No bake molds, Flask less molds, Sweep mold, CO2 mold, Shell mold, Investment mold. Metal Molds: Gravity die casting, Pressure die casting, Centrifugal casting, Squeeze casting, Slush casting, Thixo-casting, Continuous casting.Non-metal molding, Plaster and Ceramic molding; Expandable pattern mold casting. Finishing processes: Fettling and cleaning of castings; removal of gates and risers, grinding. Non-Ferrous Foundry practice: Casting of Al-Si and Al-Mg alloys, Cu-base casting alloys.

10 Hours

UNIT – 5

Foundry Practices of Cast Irons, Steels, Inspection and Testing of Castings: Foundry practice for cast irons – gray iron, white cast iro n; Ducti le iron, malleable iron, SG iron, Steel castings – steel melting in the foundry; Metallurgy of cast steel; Casting design considerations; Inspection and testing of castings: Defects in castings – type s, causes and remedies; Inspection and non-destructive testing of castings. Modernization and mechanization of foundry; Material handling; Pollution control in foundry; Application of computers in casting process; Software available for casting process simulation.

10 Hours

TEXT BOOKS:

1. R.A.Flinn, “Fundamentals of Metal casting”, Addi so n Wesley, 1963.
2. R.W. Heine, C.R.Loper & P.C. Rosenthal, “Princip le s of Metal casting”, Tata McGraw Hill, 2001.

REFERENCE BOOKS

1. R.A. Lindberg, “Processes and Materials for Manufac turing”, 4th Ed, Pearson Education, 2006.
2. P.N.Rao, “Manufacturing Technology: Foundry, fo rmin g and welding”, 3rd Ed., Tata McGraw Hill, 2003.
3. “ASM Handbook: Volume 15: Casting” 9th Ed., American Society of Metals, Ohio, 2008.

COMPUTER AIDED MACHINE DRAWING

Subject Code	: 17MA36	Exam Hours	:03
Hours/Week	:01L+04P, No. of Credits:03	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Common to 17ME36A / 46A

MATERIAL TESTING LABORATORY

Subject Code	: 17MAL37	Exam Hours	:03
Hours/Week	:01L+02P, No. of Credits:02	CIE Marks	:40
Total Hours	:42	SEE Marks	:60

Common to 17MEL37A / 47A

FOUNDRY AND FORGING LAB

Subject Code	: 17MAL38	Exam Hours	:03
Hours/Week	:01L+02P, No. of Credits:02	CIE Marks	:40
Total Hours	:42	SEE Marks	:60

Common to 17MEL38A / 48A

THEORY OF MACHINES

Subject Code	:17MA42	Exam Hours	:03
Hours/Week	:03L + 2T, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Course objectives

1. Familiarize with common mechanisms and carryout mobility and motion analysis of mechanisms.
2. Understand gears and analyze gear train.
3. Emphasize the concept of friction and friction drives
4. Understand various cam motion profiles and follower mechanism, analyze cam motions.

Course outcomes

Students will be able

1. To identify mechanisms with basic understanding of motion.
2. To choose the gear trains for a different speed and torque transmission.
3. Assimilate friction and its use in power transmission.
4. Design and evaluate the performance of different cams and followers.

UNIT – 1

Introduction: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

Quick return motion mechanisms - Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. **10 Hours**

UNIT – 2

Velocity and Acceleration Analysis of Mechanisms (Graphical and Analytical Methods): Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **10 Hours**

UNIT – 3

Spur Gears: Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Rack & Pinion

Gear Trains: Simple gear trains, Compound gear trains. Epicyclic gear trains - Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains.

10 Hours

UNIT – 4

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension and power transmitted. V-Belt Drive : Ratio of belt tensions, power transmitted.

10 Hours

UNIT – 5

Cams: Types of cams, Types of followers. Displacement, Velocity and Acceleration curves for SHM. Cam profiles - Disc cam with reciprocating follower having knife-edge, roller and flat-face follower.

Analysis of Cams: Analysis of Tangent cam with roller follower.

10 Hours

TEXT BOOKS:

1. "Theory of Machines", Rattan S.S, Tata McGraw-Hi ll Publishing Company Ltd., New Delhi, and 3rd edition -2009.

2. "Theory of Machines", Sadhu Singh, Pearson Educa ti on (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

REFERENCE BOOKS:

1. "Theory of Machines & Mechanisms ", J.J. Uicker, , G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. Mechanism and Machine theory , Ambekar, PHI, 2007

JOINING PROCESS

Subject Code	:17MA43	Exam Hours	:03
Hours/Week	:04, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Course Objectives:

This course intended to equip the student with:

1. The basic concepts of welding brazing and soldering of metals and alloys.
2. Explanations of various welding processes.
3. Fundamentals of changes that take place during welding of metals.
4. Specific requirements for welding, brazing, soldering and adhesive bonding.
5. Insight into the defects that occur in welded joints, their inspection and mitigating techniques.

Course outcomes:

The student is expected to:

1. Have idea of the concepts involved in welding of metals.
2. Know the various welding processes and techniques
3. Be able to select welding processes for specific requirements for different metals
4. Be conversant with the techniques, usage, and limitations of brazing, soldering and adhesive bonding.
5. Be able to understand welding specifications and procedure qualifications and comprehend the causes for defects in welds, their remedies.

Unit 1:

Introduction and Concepts: Definition, principles, classification, applications, advantages and limitations and safety considerations in welding; Basic principles of sound welding design,

representation of weld symbols, edge preparation methods; Concepts of dissimilar metal welding and its metallurgical problems, principle of welding plastics, plastic welding processes; Welding jigs and fixtures, automation in welding, welding cost estimation and factors involved in it; Heat flow in arc welding: Heat flow equations, cooling rate equations; Peak temperate equation, weld thermal cycles and their effects; Structural changes in different materials during welding; Residual stresses and distortion; Weldability: Definition of weldability, factors affecting weldability; Weldability tests-mechanical tests; Cold cracking tests and hot cracking tests.

10 Hours

Unit 2:

Arc Welding -, principles, equipment, safety recommendations for installation and operation of arc welding equipments; Coated electrodes: electrode coatings, classification of coatings of electrodes for SMAW, SAW ; Fluxes, role of flux ingredients and shielding gases; Classification of solid and flux code wires; Flux shielded metal arc welding(FSMAW), inert gas welding(TIG & MIG); Submerged arc welding, atomic hydrogen welding, electro slag welding;

Gas Welding - principle, equipment, Safety considerations for installation and operation of gas welding equipments; Oxy-acetylene welding, oxy-hydrogen welding; Chemical reactions in gas welding, flame characteristics; Gas torch construction and working, forward and backward welding.

10 Hours

Unit 3:

Special Types of Welding, Welding of Steels and other Materials: Resistance welding - principles, variables in resistance welding, spot welding, seam welding, resistance butt welding, projection welding, resistance welding of tubes; Solid state welding – principles, cold welding, diffusion welding, ultrasonic welding; Explosive welding, friction welding, forge welding; Radiant energy welding – electron beam welding, las er beam welding explosive welding; thermit welding, under water welding, friction stir welding; Welding of steels and low alloy steels**:** problems encountered in welding of carbon steels and low alloy steels; Hydrogen induced cracking, hot cracking, lamellar tearing and reheat cracking; Welding of stainless steels**:** metallurgical difficulties in welding of austenitic, ferritic and martensitic stainless steels;

Austenitic stainless steel welding, constitution diagrams; Welding of other metals and alloys: brief description on metallurgical difficulties in welding of cast irons, aluminium alloys, copper alloys nickel alloys and titanium alloys.

10 Hours

Module 4:

Soldering – definition, principles, soldering joint design; S oldering alloys, Soldering fluxes, different soldering methods; Metallurgical aspects of soldering; Applications, Advantages and limitations of soldering;

Brazing– Definition, principles, brazing joint design; Bra zing alloys, brazing fluxes; Brazing processes- torch brazing, furnace brazing, vacuum brazing; Induction brazing, dip brazing, silver brazing; Metallurgical aspects of brazing , Applications, advantages and limitations of brazing;

Adhesive bonding- steps involved in adhesive bonding; Selection and types of adhesives, applications, advantages and limitations of adhesive bonding.

10 Hours

Module 5:

Metallurgical aspects in welding- structure of welds;Formation of different zones during welding, heat affected zone(HAZ) and Parameters; Effect of carbon content on structure and properties of steel; Shrinkage in welding, residual stresses and stress relief techniques. **Welding defects**- types of defects, causes and remedies.

Inspection methods- visual, magnetic particle, fluorescent particle; Ultrasonic, radiographic, eddy current, holography techniques; Basics of welding acceptance standards; Introduction to welding procedure specification; Welding procedure qualification and performance qualification.

10 Hours

TEXT BOOKS:

1. Howard B Cary, "Modern Welding Technology", Prentice Hall, 2005.

2. P.N.Rao, “Manufacturing Technology: Foundry Form in g and welding”, 3rd Ed., Tata McGraw Hill, 2003.

REFERENCES:

1. ASM Metals Handbook, Vol. 6,"Welding Brazing and Soldering", ASM International, Ohio, 2003.
2. AWS Welding hand book, “Welding Science and Technol ogy”, American Welding Society, 2001.
3. Lancaster J F, “Metallurgy of welding”, Woodhead Pu blishing, 1999.

FLUID MECHANICS AND MACHINES

Subject Code	:17MA44	Exam Hours	:03
Hours/Week	:03 L + 02 T, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

Course Objectives: The students should be able to have:

1. Conceptual understanding of fluid properties and fluid statistics.
2. Understanding of fluid kinematics and fluid dynamics.
3. Basic knowledge of dimensional analysis and similitude.
4. Understanding of laminar and turbulent flows in closed conduits
5. Understanding flow measurement.
6. Evaluate the performance of centrifugal pumps and compressors

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

1. Understand properties of fluids and hydrostatics.
2. Formulate and solve equations of the control volume for fluid flow systems.
3. Develop basic knowledge of dimensional analysis and similitude.
4. Calculate resistance to flow of incompressible fluids through closed conduits.
5. Solve field problems in flow measurement
6. Select pumps and compressors for different applications.

UNIT – 1

Properties of Fluids: Types of fluid, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation.

Fluid Statistics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers.

10 Hours

UNIT – 2

Fluid Kinematics: Types of fluid flow, continuity equation in 2D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function.

Fluid Dynamics: Euler's equation of motion, Bernoulli's equation f rom first principles and also from Euler's equation, limitations of Bernoulli's e quation.

10Hours

UNIT - 3

Fluid Flow Measurements : Venturimeter, orificemeter, pitot-tube, vertical orifice, V-Notch and rectangular notches.

Dimensional Analysis : Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude, types of similitudes. **10 Hours**

UNIT – 4

Flow through pipes : Darcy's and Chezy's equation for loss of head due t o friction in pipes. **Laminar flow and viscous effects** : Reyonold's number, critical Reynold's number, la minar flow through circular pipes-Hagen Poiseille's equation, laminar flow between parallel and stationary plates.

10 Hours

UNIT – 5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems. **10 Hours**

Text Books:

1. James E.A., John and Haberm W.A., Introduction to Fluid Mechanics, Prentice Hall of India.
2. V. L. Streeter and E. B. Wylie, Fluid Mechanics, Tata McGraw Hill Pvt Ltd. New Delhi ,2nd Edition.
3. R. K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd. New Delhi.

Reference Books:

1. Y .A. Cengel, J. M. Cimbala, Fluid Mechanics –Funda mentals and Application, TMI.
2. S. K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, TMH.
3. R.K. Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand, and Company Ltd.

MACHINE TOOLS AND OPERATIONS

Subject Code	:17MA45	Exam Hours	:03
Hours/Week	:04 L, No. of Credits:04	CIE Marks	:40
Total Hours	:50	SEE Marks	:60

COMMON TO 17ME35B / 45B

MECHANICAL MEASUREMENTS AND METROLOGY

Subject Code	: 17MA46	Exam Hours	:03
Hours/Week	:03 L, No. of Credits:04	CIE Marks	:40
Total Hours	:40	SEE Marks	:60

Common to 17ME36B / 46B

Metrology & Machine Tool Laboratory

Subject Code	: 17MAL47	Exam Hours	:03
Hours/Week	:01L+02P, No. of Credits:02	CIE Marks	:40
Total Hours	:42	SEE Marks	:60

Course Objectives:

This course intended to equip the student with:

1. Knowledge of calibration and measurements
2. Understanding of procedures of calibration and principles of measurement
3. Practical exposure of calibration of machine tools, measuring instruments and measurement of profiles mechanical components.

Course Outcomes

At the end of this course, student will:

1. Have the knowledge of Calibration and measurements.
2. Implement the calibration of the machine tools and measuring instruments.
3. Carry out the calibrations of machine tools and measurement of profiles of mechanical components.

PART – A

1. Calibration of Micrometer using slip gauges
2. Calibration of LVDT
3. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer/Optical Projector
4. Measurement of Screw thread Parameters using Two wire or Three-wire method.
5. Measurements of Surface roughness, using Tally Surf/Mechanical Comparator

PART – B

1. Acceptance tests on a lathe/Drilling/Milling Machine
2. Cutting force measurement of turning /drilling/milling using Dynamo meters
3. Measurement of cutting tool temperature using thermo-couples
4. Determination of chip-reduction co-efficient during metal cutting on a lathe

WELDING PRACTICE

Subject Code	: 17MAL48	Exam Hours	:03
Hours/Week	:01L+02P, No. of Credits:02	CIE Marks	:40
Total Hours	:42	SEE Marks	:60

Course Objectives:

This course intended to equip the student with:

- Procedure of preparing jobs for welding.
- Knowledge of different welding techniques and equipment rating.
- Understanding of safety precautions to be followed while welding.
- Practical exposure of making joints using arc/ gas / TIG / MIG welding type
- Post weld testing, inspection and analysis

Course Outcomes

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

- Prepare jobs for welding
- Choose proper parameters for welding
- Make joints adopting safety measures
- Test, inspect and analyze welded joints

PART - A

1. Making of welded lap, butt, T & L joints using arc welding process
2. Making of two joints using gas welding.
3. Making of at least one joint using TIG welding technique
4. Making of at least one joint using MIG welding technique

PART - B

5. Testing of welded joints as per BIS
6. Microstructure study of welded joints
7. Inspection of welded joints by dye penetration and ultrasonic method

MANAGEMENT AND ENTREPRENEURSHIP
V Semester

Subject Code	**17MA51**	**CIE Marks**	**40**
Hours / Week	**2L+2T**	**SEE Marks**	**60**
Total Hours	**50**	**Exam Hours**	**03**
No. Of Credits:4			

Content	Hours/RBT levels
Module 1 **MANAGEMENT & ENTERPRENEURSHIP:** Introduction – Meaning – nature and characteristics of Management, Scope and Functional areas of management – Management as a science, art of profession – Management & Administration – Roles of Management, Levels of Management, Development of Management Thought – early management approaches – Modern management approaches. Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging Class. Concept of Entrepreneurship – Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.	**10 Hours** **L1, L2, L3**
Module 2 **PLANNING & ORGANIZING:** Nature, importance and purpose of planning process – Objectives – Types of plans (Meaning only) – Decision making – Importance of planning – steps in planning & planning premises – Hierarchy of plans. Nature and purpose of organization – Principles of organization – Types of organization – Departmentation – Committees- Centralization Vs Decentralization of authority and responsibility – Span of control.	**10 Hours** **L1, L2, L3**
Module 3 **STAFFING, DIRECTING & CONTROLLING:** MBO and MBE (Meaning Only) Nature and importance of staffing–Process of Selection & Recruitment (in brief). Meaning and nature of directing – Leadership styles, Motivation Theories, Communication – Meaning and importance – coordination, meaning and importance and Techniques of Co –Ordination. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).	**10 Hours** **L1, L2, L3**
Module 4 **SMALL SCALE INDUSTRIES & INSTITUTIONAL SUPPORT:** 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. Impact of Liberalization, Privatization, Globalization on SSI Effect of	**10 Hours** **L1, L2, L3**

WTO/GATT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only) Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.	
Module 5 **PREPARATION OF PROJECT:** Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.	**10 Hours** **L1, L2, L3, L4**

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Explain need, functions, roles, scope and evolution of Management, purpose of Planning and hierarchy of planning and also analyze its types.
CO2	Discuss Decision making, Organizing, Staffing, Directing and Controlling.
CO3	Understand and small scale industries and compare the different schemes in India for entrepreneurship.
CO4	Understand the market feasibility, technical feasibility, financial feasibility and social feasibility.

TEXT BOOKS:

4. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,

5. Dynamics of Entrepreneurial Development & Management – Vasant Desai – Himalaya Publishing House

6. Entrepreneurship Development – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).

REFERENCE BOOKS:

Management Fundamentals – Concepts, Application, Skill Development – Robers Lusier – Thomson

Entrepreneurship Development – S.S.Khanka – S.Chand & Co.

7. Management – Stephen Robbins – Pearson Education/PHI – 17th Edition, 2003.

Computer Aided Design and Manufacturing
Semester V

Subject Code	**17MA52**	**CIE Marks**	**40**
Number of Hours/Week	**4L**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION**: Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment. Introduction to CAD, Introduction to CAM. Advantages and disadvantages of CAD and CAM	**10 Hours** **L1, L2**
Module 2 **HARDWARE FOR CAD & COMPUTER GRAPHICS**: Basic Hardware structure. Working principles, usage and types of hardware for CAD – Input devices, output devices, memory, CPU, hardcopy and storage devices. Software configuration of graphic system, function of graphics package, construction of geometry, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities. Introduction to exchange of modeling data – Basic features of IGES, STEP, DXF, DMIS	**10 Hours** **L1,L2**
Module 3 **INTRODUCTION TO FINITE ELEMENT ANALYSIS:** Introduction, basic concepts, discretization, element types, nodes and degrees of freedom mesh generation, constraints, loads, preprocessing, application to static analysis NC. CNC, DNC Technologies NC, CNC, DNC, modes, NC elements, advantages and limitations of NC, CNC. Functions of computer in DNC. CNC TOOLING: Turning tool geometry, milling tooling system, tool presenting, ATC, work holding.	**10 Hours** **L1,L2,L3**

Module 4 **CAM PROGRAMMING:** Overview of different CNC machining centers, CNC turning centers, high speed machine tools, MCE. **CNC PROGRAMMING**: Part program fundamentals-steps involved in development of part program. Manual part programming, milling, turning, turning center programming. **CNC PROGRAMMING**: Manual part programming- milling & turning	**10 Hours** **L1,L2,L3**
Module 5 **INTRODUCTION TO ROBOTICS**: Introduction, robot configuration, robot motion, programming of robots, end effectors work cell, control and interlock, robot sensor, robot applications.	**10 Hours** **L1,L2,L3,L4**

Course Outcomes:

After studying this course, students will be able to:

CO1	To gain the knowledge of Role of computers in design and manufacturing, Product cycle and the different types Input devices, output devices
CO2	Understanding basic concepts of finite element analysis, concepts of robotics, Machining Cent
CO3	To Compare the NC and CNC tooling and NC, CAM and CNC programming

Text Books:

4. CAD/CAM Principles and Application - P.N. Rao, Tata McGraw Hill.
5. CAD/CAM - Groover& Zimmers, PHI, 2003

Reference Book:

4. NC Machine Programming and software Design – ChnoHwachang, Michel. A. Melkanoff, Prentice Hall, 1989.

5. CAD/CAM - Ibrahim Zeid, Tata McGraw Hill, 2014.

METAL FORMING
V Semester

Subject Code	**17MA53**	**CIE Marks**	**40**
Number of Hours/Week	**4L**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION:** Classification of metal working processes, characteristics of wrought products, Advantages and limitations of metal working processes. **CONCEPTS OF TRUE STRESS & TRUE STRAIN**: Triaxial & biaxial stresses. Determination of flow stress. Principal stresses, Tresca & vonmises yield criteria. **CONCEPTS OF PLANE STRESS & PLANE STRAIN**: Brief description of methods of metal deformation analysis. Effects of temperature, strain rate, friction and lubrication, hydrostatic pressure in metal working, Deformation zone geometry, workability of materials, Residual stresses in wrought products.	**10 Hours** **L1, L2**
Module 2 **FORGING:** Classification of forging processes. Forging machines and equipment. Expressions for forging pressures & load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it, Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. **ROLLING:** Classification of Rolling processes. Types of rolling mills, expression for Rolling load. Roll separating force. Frictional losses in bearing etc, power required rolling, Effects of front & back tensions, frictions, Roll diameter on rolling load, friction hill. Maximum possible reduction. Defects in rolled products.	**10 Hours** **L1,L2,L3**
Module 3 **DRAWING & EXTRUSION:** Drawing equipment & dies expression for drawing loads by slab analysis power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation. Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion, extrusion of seamless pipes & tube.	**10 Hours** **L1,L2,L3**

Module 4 **SHEET METAL FORMING & DEEP DRAWING**: Forming methods dies & punches progressive die, compound die, combination die. Rubber forming, Open back inclinable press (OBI press), piercing & blanking, bending, stretch forming, Roll bending & contouring. Principles, stresses & deformation in drawn up. Die & punch design parameters. Total punch load, limiting drawing ratio. Effect of anisotropy on LDR, forming limit criteria & diagrams. Defects in deep drawn products.	**10 Hours** **L1,L2,L3**
Module 5 **POWDER METALLURGY & HIGH ENERGY RATE FORMINGMETHODS**: Basic steps in powder metallurgy, Brief description of methods of production of metal powders, conditioning & blending of powders, compaction & sintering applications of powder metallurgy components. Principles, advantages & applications. Explosive forming, Electro hydraulic forming, electromagnetic forming.	**10 Hours** **L1,L2**

Course Outcomes:

After studying this course, students will be able to:

CO1	Classify the different processes in metal forming.
CO2	Describe the different types of metal forming process and its parameter.
CO3	Adapt to make use of suitable stresses to cause plastic deformation in different metal forming processes like forging, rolling, drawing, extrusion, sheet metal, PM & HERF.

TEXT BOOKS:

4. Materials and Processes in Manufacturing - E.Paul, Degramo, J.T.Black, Ronald, A.K.Prentice-Hall of India 2002

5. Manufacturing Engg., & Technology - Serope Kalpakjain and Stevan.R.Schmid, Pearson Education Asia, 4th Edi. 2002.

REFERENCE BOOKS:

1 Deformation processing - W.A.Backofen, Addissen Weslay, 1973

2. Principles of Industrial Metal working process – G.W.Rowe, CBS Pub 2002.

ELEMENTS OF MACHINE DESIGN
V Semester

Subject Code	**17MA54**	**CIE Marks**	**40**
Number of Hours/Week	**3L+2T**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **DESIGN FOR STATIC STRENGTH & IMPACT LOADING:** Design consideration: codes and Standards, 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. Combined Stress concentration factor. Derivation of instantaneous stress due to axial, bending loading, effect of inertia.	**10 Hours** **L1, L2, L3**
Module 2 **DESIGN FOR FATIGUE STRENGTH & DESIGN OF SHAFTS** Introduction, S – N diagram, Low cycle fatigue, High cycle fatigue, Endurance limit. Modifying factors –size effect, surface effect, Stress concentration effects; fluctuating stresses, Fatigue Strength under fluctuating stresses, Goodman and Soderberg relationship; Stress due to combined loading, cumulative fatigue damage. Torsion of shafts, design for strength & rigidity, with steady loading, ASME & BIS codes for design of transmission shafting, shafts under fluctuating loads and combined loads.	**10 Hours** **L1,L2,L3,L4**
Module 3 **DESIGN OF GEARS:** Spur Gears: Definitions, stresses in gear tooth, Lewis equation, form factor, Design for strength, dynamic and wear load. Bevel Gears: Definitions, formative number of teeth, design for strength, dynamic and wear load.	**10 Hours** **L1,L2,L3,L4**

Module 4	10 Hours
COTTER JOINT & KNUCKLE JOINTS, KEYS AND COUPLINGS: Design for cotter and knuckle joints, Keys: types of keys, design of keys. Design of coupling: Design of rigid flange coupling & bushed pin type flexible coupling Rigid and Flexible couplings: Flange coupling, Bush and pin type coupling.	**L1,L2,L3,L4**
Module 5	**10 Hours**
LUBRICATION AND BEARINGS: Mechanisms of Lubrication – Viscosity, bearing modulus, coefficient of friction, minimum oil film thickness-Heat Generated, Heat dissipated, bearing materials, lubricants and properties. Examples of journal bearing and thrust bearing design, Ball and Roller Bearings: Bearing life, equivalent bearing load, selection of bearings of different types.	**L1,L2,L3,L4**

Course Outcomes:

After studying this course, students will be able to:

CO1	Understand basic of Mechanical Design procedure, material properties and selection of material, codes and standards, able to understand theories of failure, able to understand stress concentration factor, study about lubrication and bearings
CO2	Design machine components with and without geometric discontinuities subjected to static, impact and fatigue load, a component having.
CO3	Analyze the stress level and deformation in the different parts of the machine components.
CO4	Determine the life of components subjected to various loads.

Text Books:

4. Mechanical Engineering design-Joseph Edward Shigley, Tata McGraw Hill, New Delhi 1986
5. Design of Machine Elements – V.B. Bhandri, - Tata McGraw Hill Publishing Co. Ltd., New-Delhi.

Reference Book:

6. Machine Design – R. K. Jain, Khanna Publications, New Delhi.
7. Elements of Machine Design, H G Patil et. al, IK International, 2019.

PRODUCT DESIGN
V Semester

Subject Code	**17MA551**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**3**	**Exam. Hours**	**03**
Number of Credits: 3			

Contents	**Hours/ RBT level**
Module 1 **INTRODUCTION:** Asimow's Model: definition of Product Design, Design by Evolution, Design by Innovation, Essential Factors of Product Design, Production-Consumption Cycle, Flow and Value Addition in the Production – Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and flowcharting, Product Strategies, Time to Market, Analysis of the Product, The Three S's, Standardization, Renard Series (Preferred Numbers), Role of Aesthetics in Product Design, Functional Design Practice.	**08 Hours** **LI, L2**
Module 2 **IDENTIFYING CUSTOMER NEEDS:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications. Concept Generation: The activity of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process.	**08 Hours** **L2, L3**
Module 3 **CONCEPT SELECTION:** Overview of methodology, concept screening, and concept scoring, Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process. Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.	**08 Hours** **L2,L3**

Module4	08 Hours
INDUSTRIAL DESIGN: Assessing the need for industrial design, industrial design process, managing the industrial design process, assesses the quality of industrial design. Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes. Legal factors and social issues. Engineering ethics and issues of society related to design of products.	**L2,L3**
Module 5	**08 Hours**
HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESIGN: Introduction, Human being as Applicator of Forces, Anthropometry: man as Occupant of Space, The Design of Controls, The Design of Displays, Man/Machine Information Exchange. **APPROACHES TO PRODUCT DESIGN:** Concurrent Design, Quality Function Deployment (QFD).	**L2,L3,L4**

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Select an appropriate product design and development process for a given application
CO2	Understand the need analysis, defining the need and its specifications.
CO3	Apply the produce design techniques to establish the product architecture.
CO4	Apply techniques in product design development in industrial environment.
CO5	Design the work space considering ergonomic factors.

Text Books:

5. Product Design and Manufacturing - A.C. Chitale and R.C.Gupt,. PH1, 3rd Edition, 2003.
6. Product Design & Development- Karl T. Ulrich & Steven D.,Epinger, , Tata Mc Graw Hill, 3red Edition, 2003

Reference Books:

· Tim Jones, Butterworth Heinmann, New Product Development -, Oxford, UIC1997.
· Kevin otto and Kristini wood, Product Design - Pearson Education, 2000

Machine Tool Design

V Semester

Subject Code	**17MA552**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/ RBT level
Module1 **PRINCIPLES OF MACHINE TOOL DESIGN, DRIVES and MECHANISMS:** General requirements of machine tool design - design process machine tool layout, Drives: Electric drives, Hydraulic drives structure, Regulation of speed and feeds, stepped regulation, standardization of speed and feed, step less regulation of speeds and feeds.	**10Hrs** **L1,L2,L3**
Module 2 **CUTTING FORCE ANALYSIS AND POWER REQUIREMENT:** In Turning, Milling, Drilling, Shaping and Broaching operation with simple problems. General requirements of machine tools - Centre lathe, Milling machine.	**06Hrs** **L1,L2**
Module 3 **DESIGN OF MACHINE TOOL STRUCTURES, GUIDE WAYS AND POWER SCREWS:** Functions-Requirements-Design criteria Material used – static and dynamic stiffness – Profile and basic design procedure for machine tool structures. Design of beds, columns, housing, bases, tables cross-rails, arms saddle, carriages.	**08Hrs** **L2,L3**
Module 4 **DESIGN OF SPINDLE AND SPINDLE BEARINGS:** Functions-Requirements and materials for spindle compliance and machining accuracy. Design of spindles, antifriction bearing, Hydrodynamic and Hydrostatic bearing, Air lubricated bearing.	**08Hrs** **L2,L3**
Module 5 **DYNAMICS OF MACHINE TOOLS:** Concept of dynamic cutting process, Physical causes of chatter and vibrations, Types of Chatter. Stability chart, chatter vibration in Lathe, Drilling machine, Grinding machine and Milling machine. Different methods for avoiding machine tool chatter and vibration.	**08Hrs.** **L2,L3**

Course Outcomes:

The student on completion of the course will be able to:

CO1	Understand the structure of machine tools, and drives therein.
CO2	Estimate the cutting forces in machining.
CO3	Design the static structure of the machine tool.
CO4	Design the spindles and choose supporting elements.
CO5	Identify the dynamic signature of the machine tool in operation.

Text Books:

· Machine Tool Design, N.K. Mehta, 2nd Ed., Tata McGraw Hill 2001.

· Principles of Machine Tools, Sen and Bhattacharaya Oxford IBM, Publishing 2000

Reference Books:

5. Machine Tool Design Volume – II and III, N. Acharkan MIR Publications 2000.

6. Design of Machine Tools, S. K. Basu and D. K. Pal 2000.

7. Principles of Machine Tool Design, Koensberger 1993.

MAINTENANCE ENGINEERING
VSemester

Subject Code	**17MA553**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION TO MAINTENANCE SYSTEM:** Definition, Scope, Objective, functions and Importance of maintenance system, Type of maintenance system, Break down maintenance system, Preventive maintenance, Predictive maintenance, design out maintenance, corrective maintenance, planned maintenance, total productive maintenance, condition monitoring. Problems on selection of methods like preventive or breakdown maintenance.	**8 Hours** **L1, L2**
Module 2 **ECONOMICS IN MAINTENANCE:** Repair, replacement, Repair complexity, Finding out most optimal preventive maintenance frequency. Numerical treatment required.	**8 Hours** **L1,L2,L3**
Module 3 **MAINTENANCE OF MACHINERY:** Causes of machine failure, performance evaluation, complete overhauling of Machines tools. Maintenance planning and scheduling. Repair order control manpower requirement, Maintenance job analysis spare parts control. **MAINTENANCE PLANNING:** Planning of maintenance junctures manpower allocation, Long range planning, short range planning. Planning techniques and procedures. Estimation of maintenance work. Maintenance control.	**8 Hours** **L1,L2,L3**
Module 4 **INDUSTRIAL SAFETY:** Economic importance of accidents, Types of safety organizations, Analysis of accident records, accident investigations, Analysis of accident Safety standards for Mechanical equipment. **SAFETY STANDARDS:** Safety standards for Electrical equipment and systems. Chemical hazards, material handling, exhaust systems, welding, Plant housekeeping-building, Aisles, passages, floors, tool cribs, washrooms, canteens.	**8 Hours** **L1,L2,**

Module 5	8 Hours
COMPUTERS IN MAINTENANCE: Features and benefits of Computer aided maintenance. Application of computers to maintenance work. **INDUSTRIAL POLLUTION CONTROL:** Dust control –Fiber collectors, mechanical dust collectors, wet type collectors, Electro static precipitators, Noise pollution Control – Noise measurement and control. Industrial vibration and its control	**L1,L2,**

Course Outcomes:
After studying this course, students will be able to:

CO1	Understand the concept s and types of maintenance engineering.
CO2	Analyze the economics of maintenance activities.
CO3	Identify the causes of machine failure and estimate the maintenance work.
CO4	Outline the industrial safety, safety standards and pollution control.
CO5	Make use of computers in maintenance.

Text Books:
8. Maintenance Engineering and Management - R.C.Mishra and K.Pathak, Prentice Hall of India, 2002
9. Maintenance Engineering Hand book - Morrow.

Reference Book:

1. Industrial Pollution Control Handbook - LUND
2. Industrial Maintenance - H P Garg
3. Maintenance Engineering Hand book - Lindrey Higgins, McGraw Hill, 6th edition, 2003

OPTIMIZATION TECHNIQUES

V Semester

Subject Code	**17MA561**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **Introduction:** Statement of optimisation problem, Design vector, Design constraints, Objective function, Classification of optimisation problems based on: constraints, nature of design variables, nature of the equations involved. **Single variable optimisaton:** Necessary and sufficient conditions, Multivariable optimisation with no constraints: Necessary and sufficient conditions, Semidefinite case, Saddle point, Multivariable optimisation with equality constraints, Solution by direct substitution, Lagrange Multipliers, Interpretation of Lagrange multipliers, Multivariableoptimisationwithinequalityconstraints:Khun Tucker conditions(concept only)	**10 Hours** **L1, L2, L3**
Module 2 **Nonlinear Programming: One-Dimensional Minimization Methods** Introduction, Unimodal Function, Elimination methods: unrestricted search, fixed step size, accelerated step size, Exhaustive search: dichotomous search, interval halving method, Fibonacci method, golden section method, Interpolation methods: Quadratic and cubic interpolation method, direct root method, Newton method, Quasi-Newton method, secant method	**12 Hours** **L1, L2, L3**
Module 3 **Nonlinear Programming: Direct search methods:** Classification of unconstrained minimization methods, rate of convergence, scaling of design variables, random search methods , univariate method, pattern directions, Powell's method, Simplex method.	**06 Hours** **L2,L3**
Module 4 **Nonlinear Programming: Indirect Search (Descent) Methods: Gradient of a function,** Steepest decent method, Fletcher Reeves method, Newtons method, Davidon-Fletcher-Powell method.	**06 Hours** **L2,L3**

Module V: Integer Programming: Introduction, Graphical representation, Gomory's cutting plane method: concept of a cutting plane, Gomory's method for all-integer programming problems, Balas' algorithm for zero–one programming, Branch-and- Bound Method.	**6 Hours** **L2,L3**

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Understand optimisation terminology and concepts, and classification of optimization problems.
CO2	Apply optimisation methods to engineering problems, including developing a model, defining an optimisation problem, applying optimisation methods, exploring the solution, and interpreting results.
CO3	Apply unconstrained optimisation theory for continuous problems, including the necessary and sufficient optimality conditions and algorithms
CO4	Apply constrained optimisation theory for continuous problems and algorithms
CO5	Apply integer programming technique to optimize the allocations.

Text Books:

1. Engineering Optimisation Theory and Practice S. S. Rao , , Fourth Edition, John Wiley & Sons, 2009.

Reference Books:

1. Optimisation Concepts and Applications in Engineering, A. D. Belegundu, T.R. Chanrupatla, Cambrige UniversityPress,2011

2. Engineering Optimisation: Methods and Applications Ravindran, K. M. Ragsdell, and G. V. Reklaitis, , 2nd ed., Wiley, New York,2006.

Knowledge Management

V Semester

Subject Code	**17MA562**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits:3			

Content	Hours/RBTLevel
Module 1 **KNOWLEDGE INFLUENCES: INTRODUCTION:** External influences on organizations, Changing nature of management, Types of organizations, Strategic management in organizations, Knowledge management, Knowledge management an emerging concept, Model of strategic knowledge management. **INTRODUCTION TO KEY CONCEPTS:** What is Management? Knowledge Management and business strategies, Knowledge intensive firms and Knowledge workers, Learning and Knowledge Management.	**9Hrs** **L1,L2**
Module 2 **KNOWLEDGE CREATION AND LOSS:** Innovation dynamics and knowledge processes, characterizing innovation processes, innovation as an interactive process, knowledge creation and Nonaka, the social dynamics of innovation networking processes, forgetting and unlearning knowledge. **DEVELOPING AND MANAGING KNOWLEDGE REPOSITORIES:** Effective knowledge repositories, mapping the content structure, repository quality control, case studies (not for examination)	**10Hrs** **L1,L2,L3**
Module 3 **DESIGN KNOWLEDGE MANAGEMENT SYSTEM:** Introduction, Structure preserving design, Step 1: design system architecture, Step 2: identify target implementation platform, Step 3: specify architectural components, Step 4: specify application within architecture, design of prototypes, distributed architecture. **SOCIO-CULTURAL ISSUES:** Introduction, significance of cross community knowledge processes, characterizing cross community knowledge processes, identity, knowledge, trust and social relations, classification of boundary types,	**10Hrs** **L2,L3**

facilitating/managing knowledge between communities	
Module 4 **KNOWLEDGE LEADERSHIP:** Introduction, contributions of disciplines to Knowledge Leadership, the generic attributes of knowledge leader, specific knowledge leadership roles, leading knowledge teams, leading a knowledge network, recruiting and selecting knowledge leaders.	**06Hrs** **L2,L3**
Module 5 **INFORMATION AND COMMUNICATION TECHNOLOGIES AND** **KNOWLEDGE MANAGEMENT:** Introduction, linking knowledge management and ICTs, objectivist perspectives on ICT – enabled knowledge management, practice based perspectives on ICT enabled KM, the importance of accounting for socio cultural factors in ICT enabled KM, debates regarding the role of ICTs in KM processes.	**07Hrs.** **L2**

Course Outcomes: The student on completion of the course will be able to:

CO1	Understand the links between Knowledge Management, organizational learning, innovation and creativity.
CO2	Analyse the fundamental elements of Knowledge Management.
CO3	Examine and evaluate how leadership can be used to facilitate a human infrastructure to diffuse knowledge and enable best practice.
CO4	Apply Knowledge Management objectives in projects across diverse fields.
CO5	Identify the drivers and inhibitors of effective Knowledge Management practices to promote innovation.

Text Books:

1. Knowledge Management, Shelda Debowski, Wiley India, 2007.

2. Knowledge Management in Organizations, Donald Hislop, 2nd Ed., Oxford Universities Press, 2009

Reference Books:

1. Knowledge Engineering and Management, Guus Schreiber, et al, Universities Press India Pvt. Ltd., 2003

2. Knowledge Management - Classic and contemporary works, Daryl Morey, et. al., 2007

COMPUTER AIDED DESIGN AND MANUFACTURING LAB
V Semester

Course Code	**17MAL57**	**CIE Marks**	**40**
Number of Hours/Week	**3**	**SEE Marks**	**60**
Total hours/Week	**40**	**Exam Hours**	**03**
No. of Credits: 2			

Content	Hours/RBTLevel
PART – A Modelling and simulation of Machining process of simple machine parts using CAM packages – minimum six models.	**20** **L1, L2 ,L3**
PART – B Using finite element package analyse bar, tapered bar, truss, beams with concentrated and distributed loads for deformation strains and stresses.	**20** **L1, L2 ,L3**

COURSE OUTCOMES:

On completion of this subject students will be able to:

CO1	Understand the codes for CAM packages, and FEM package for analysis
C02	Simulate the machining operation using CAM package
CO3	Analyse the structural members for deformations, strains and stresses

Text Books:

1. CAD/CAM Principles and Application - P.N. Rao, Tata McGraw Hill.
2. CAD/CAM - Groover& Zimmers, PHI, 2003

Reference Book:

1. CAD/CAM Ibrahim Zeid, Tata McGraw Hill, 2014.
2. NC Machine Programming and software Design – ChnoHwachang, Michel. A. Melkanoff, Prentice Hall, 1989.
3. Numetical control and CAM - Pressman RS and Williams JE, Johnwiley.

Scheme of Examination:

One Model from Part – A : 40 Marks
One Model from Part – B : 40 Marks
Viva – Voce :20 Marks
Total : 100 Mark

MACHINE SHOP LAB

V SEMESTER

Course Code	**17MAL58**	**CIE Marks**	**40**
Number of Hours / Week	**03**	**SEE Marks**	**60**
Total Number of hours	**42**	**Exam Hours**	**03**
No. of Credits: 2			

Content	**No. of Hours/RBT**
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.	**32 Hours** **L1, L2, L3**
Part B Cutting of V Groove/ dovetail / Rectangular groove using a shaper Cutting of Gear Teeth using Milling Machine	**7 Hours** **L1, L2, L3**
Part C **For demonstration** Demonstration of formation of cutting parameters of single point cutting tool using bench grinder / tool & cutter grinder. Demonstration of surface milling /slot milling	**3 Hours** **L1, L2, L3**

COURSE OUTCOMES:

On completion of this subject students will be able to:

CO1	Understand the formation of cutting tool parameters of single point cutting tool using bench grinder / tool and cutter grinder, Surface Milling/Slot Milling.
C02	Demonstrate precautions and safety norms followed in Machine Shop.
CO3	Exhibit interpersonal skills towards working in a team.
CO4	Perform turning, facing, knurling , thread cutting, tapering , eccentric turning and allied operations, keyways / slots , grooves etc using shaper.
CO5	Perform gear tooth cutting using milling machine.

REFERENCE TEXT BOOKS:

1. Strength of Materials, Rajput R. K., 2007 Edition.
2. Callister's Materials Science and Engineering, R. Balasubhramanaim, 2 Edition, 2014.

Scheme of Examination:

One Model from Part-A	50 Marks
One Model from Part-B	30 Marks
Viva – Voce	20 Marks
TOTAL	100 Marks

ENGINEERING ECONOMICS

Semester VI

Subject Code	**17MA61**	**CIE Marks**	**40**
Number of Hours/Week	**4L**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBT Level
Module 1 **INTRODUCTION**: Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making, Intuition and analysis, Tactics and Strategy. Engineering Economics Decision maze. Law of demand and supply, Law of returns.	**10 Hours** **L1, L2**
Module 2 **INTEREST AND INTEREST FACTORS:** Interest rate, Simple interest, compound interest, Cast-flow diagrams, Exercises and Discussion.	**10 Hours** **L1, L2, L3**
Module 3 **PRESENT & EQUIVALENT ANNUAL 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, Discussions and Problems. 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, Problems.	**10 Hours** **L1, L2, L3**
Module 4 **RATE OF RETURN CALCULATIONS:** Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Cost of capital concepts. BRIEF DISCUSSION ON DEPRECIATION AND TAX CONSIDERATIONS: Causes of Depreciation, Basic methods of computing depreciation charges, Tax concepts, Corporate income tax. **ESTIMATING AND COSTING:** Components of cost 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.	**10 Hours** **L1, L2, L3**

Module 5	10 Hours
INTRODUCTION, SCOPE OF FINANCE, FINANCE FUNCTIONS & FINANCIAL RATIO ANALYSIS: 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. Introduction, Financial Planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting.	**L1, L2, L3**

Course Outcomes:

After studying this course, students will be able to:

CO1	Knowledge on the importance of Economics and time value of money for an Engineer.
CO2	Understand and classify the costs/revenue associated with projects/components under different heads.
CO3	Compute , Develop and Interpret Financial Statement of Organizations
CO4	Compare the merit of a project or health of organizations based cost / revenue

TEXT BOOKS:

1. Engineering economy - RIGGS J.L.,, McGraw Hill, 2002

2. Engineering economy - THUESEN J.G., , PHI, 2002

REFERENCE BOOK:

1. Engineering economy – TARACHAND.
2. Industrial Engineering and Management - OP KHANNA, Dhanpat Rai & Sons.
3. Financial Management - I M PANDAY, Vikas Publishing House

COMPUTER INTEGRATED MANUFACTURING

Semester VI

Subject Code	17MA62	CIE Marks	40
Hours / Week	2L+2T	SEE Marks	60
Total Hours	50	Exam Hours	03
No. Of Credits:4			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION:** brief introduction to CAD and CAM – manufacturing planning, manufacturing control- introduction to CAD/CAM – concurrent engineering- CIM concepts – computerized elements of CIM system –types of production – manufacturing models and metrics – mathematical models of production performance – simple problems – manufacturing control – simple problems – basic elements of an automated system – levels of automation – lean production and just-in-time production.	**10 Hours** **L1, L2, L3**
Module 2 **PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING:** Process planning – computer aided process planning (CAPP) – logical steps in computer aided process planning – aggregate production planning and the master production schedule – material requirement planning – capacity planning-control systems-shop floor control-inventory control – brief on manufacturing resource planning-ii (MRP2) & enterprise resource planning (ERP) – simple problems.	**10 Hours** **L2, L3, L4**
Module 3 **CELLULAR MANUFACTURING:** Group technology(GT), part families – parts classification and coding – simple problems in Opitz part coding system – production flow analysis – cellular manufacturing – composite part concept – machine cell design and layout – quantitative analysis in cellular manufacturing – rank order clustering method – arranging machines in a GT cell – Hollier method – simple problems.	**10 Hours** **L1, L2, L3, L4**
Module 4 **FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS):** Types of flexibility – FMS – FMS components – FMS application & benefits – FMS planning and control– quantitative analysis in FMS – simple problems. Automated guided vehicle system (AGVs) – AGVs application – vehicle guidance technology – vehicle management & safety.	**10 Hours** **L2, L3, L4**
Module 5 **INDUSTRIAL ROBOTICS:** Robot anatomy and related attributes – classification of robots- robot control systems – end effectors – sensors in robotics – robot accuracy and repeatability – industrial robot applications – robot part programming – robot accuracy and repeatability	**10 Hours** **L2, L3, L4**

COURSE OUTCOMES:

After studying this course, students will be able to:

CO1	Define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen.
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines.
CO3	Able to apply mathematical models and metrics for automated manufacturing industries.

TEXT BOOKS:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
3. "Introduction to Robotics: Mechanics And Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.

REFERENCE BOOKS:

1. "CAD/CAM" by Ibrahim Zeid, Tata McGraw Hill, 2014.
2. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
3. CAD/CAM/CIM, Dr. P. Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

ADDITIVE MANUFACTURING
Semester VI

Subject Code	**17MA63**	**CIE Marks**	**20**
Number of Hours/Week	**4L**	**SEE Marks**	**80**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION TO ADDITIVE MANUFACTURING & CLASSIFICATION OF AM PROCESSES**: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM. Liquid polymer system, discrete particle system, molten material systems, solid sheet system	**10 Hours** **L1, L2**
Module 2 **AM PROCESS CHAIN:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.	**10 Hours** **L1,L2**
Module 3 **DESIGN FOR AM:** Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.	**10 Hours** **L1,L2**

Module 4 **GUIDELINES FOR PROCESS SELECTION**& Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control. **POST PROCESSING OF AM PARTS:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.	**10 Hours** **L1,L2,L3**
Module 5 **AM APPLICATIONS**: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Remanufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.	**10 Hours** **L1,L2,L3,L4**

Course Outcomes:

After studying this course, students will be able to:

CO1	Identify the additive manufacturing techniques and processes.
CO2	Summarize the AM process chain and guidelines for process selection.
CO3	Describe the post processing of AM parts, design for AM and AM applications.

Text Books:

1. Stereo lithography and other RP & M Technologies - Paul F. Jacobs - SME, NY 1996.
2. Rapid Manufacturing - Flham D.T & Dinjoy S.S - Verlog London 2001.
3. Rapid automated - Lament wood - Indus press New York.

Reference Book:

1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000.

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NON DESTRUCTIVE TESTING
Semester VI

Subject Code	17MA64	CIE Marks	40
Number of Hours/Week	4L	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03
Number of Credits:4			

Content	Hours/RBTLevel
Module 1 **OVERVIEW OF NDT:** NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.	**10 Hours** **L1, L2, L3**
Module 2 **SURFACE NDE METHODS:** Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing-Theory of magnetism, inspection materials, magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.	**10 Hours** **L1,L2,L3**
Module 3 **THERMOGRAPHY AND EDDY CURRENT TESTING (ET):** Thermography-Principles, Contact and non -contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.	**10 Hours** **L1,L2,L3**
Module 4 **ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE):** Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications.	**10 Hours** **L1,L2,L3**
Module 5 **RADIOGRAPHY (RT):** Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.	**10 Hours** **L1,L2,L3**

Course Outcomes:

After studying this course, students will be able to:

CO1	Classify various nondestructive testing methods.
CO2	Check different metals and alloys by visual inspection method.
CO3	Explain and perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test, X-ray and Gamma ray radiography, Leak Test, Eddy current test.
CO4	Identify defects using relevant NDT methods.
CO5	Differentiate various defect types and select the appropriate NDT methods for better evaluation.
CO6	Document the testing and evaluation of the results.

Text Books:

1. "Practical Non-Destructive Testing", Baldev Raj, T.Jayakumar, M.Thavasimuthu Narosa Publishing House, 2009.
2. "Non-Destructive Testing Techniques", Ravi Prakash, 1st revised edition, New Age International Publishers,2010

Reference Book:

1. ,"Non-Destructive Evaluation and Quality Control", ASM Metals Handbook American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. "Introduction to Non-destructive testing: a training guide", Paul E Mix, Wiley, 2nd Edition New Jersey, 2005
3. ," Handbook of Nondestructive evaluation", Charles, J. Hellier McGraw Hill, New York 2001
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

QUALITY ASSURANCE

VI SEMESTER

Subject Code	**17MA651**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40L**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	**Hours/RBTLevel**
Module 1 **INTRODUCTION TO QUALITY:** Definition of Quality, Quality function, Dimensions of quality, Quality engineering terminology, Brief history of quality methodology, Statistical methods for quality improvement, Quality Costs – Four categories costs and hidden cost. Introduction to Quality Function Deployment. **QUALITY ASSURANCE:** Definition and concept of quality assurance, departmental assurance activities. Quality audit concept, audit approach etc.	**08Hours** **L1, L2,**
Module 2 **STATISTICAL PROCESS CONTROL** – Chance and Assignable causes of variation. Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational subgroups. Analysis of patterns of control charts Frequency distribution and Histogram. **PROCESS CAPABILITY:** Basic definitions, standardized formula, relation to product tolerance and Six-Sigma concept of process capability.	**08 Hours** **L1,L2,L3,**
Module 3 **Control charts for X- bar and Range(R)**, Statistical basis of the charts, development and sue of X- bar and r charts, interpretation of charts Control charts for X-bar and standard deviation (S), development and use of X-bar and S Charts.	**08 Hours** **L1,L2,L3**

Module 4 **Control chart for fraction non – conforming (defectives)** – development of control chart, brief discussion on variable sample size. Control chart for non-conformities (defects) – development and operation of control chart for constant sample size and variable sample size. Choice between variables and attributes control charts.	**08 Hours** **L1,L2,L3**
Module 5 **OPERATING CHARACTERISTIC CURVES:** Construction and use. Acceptance plans – single, double and multiple sampling. Determinations of average outgoing quality, average outgoing quality level, average total inspection, production risk and consumer risk. **ISO QUALITY SYSTEM:** ISO/QS9000 Quality Systems – History of ISO9000 standards, QS9000 quality standards, goals and their standards.	**08 Hours** **L1,L2,L3,**

Course Outcomes:

After studying this course, students will be able to:

CO1	CO Explains the basic concept of Quality, Control Charts and Acceptance Sampling
CO2	Construct control charts and evaluate revised control limits
CO3	CO Analyze process capability and operating characteristic curves

Text Books:

1. Douglas C Montgomery, Introduction to Statistical Quality Control, John Wiley, Seventh Edition, 2012.

Reference Book:

1. Grant E.L. and Leavenworth, Statistical Quality Control, TMH, 2000.

2. IS 2500 Standard sampling plan.

JIGS AND FIXTURES
VI Semester

Subject Code	**17MA652**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	**Hours/RBTLevel**
Module 1 **LOCATING AND CLAMPING PRINCIPLES:** Introduction, function and advantages of jigs and fixtures – basic elements – principles of location – locating methods and devices – redundant location – principles of clamping – types of clamp, mechanical actuation – pneumatic and hydraulic actuation standard parts – drill bushes and special types of bushes– tolerances and materials used**.**	**8 Hours** **L1, L2**
Module 2 **JIGS AND FIXTURES:** Elements of jig, Design consideration in jigs and fixtures, selection of materials, types of jigs – post, turnover, channel, latch, box, pot, angular post jigs – indexing jigs, jig feet and legs, chip control. Fixtures: general principles of milling, lathe, boring, broaching and grinding fixtures, inspection and welding fixtures.	**8 Hours** **L1,L2,L3**
Module 3 **PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES:** Press working terminologies, operations, types of presses, shearing action, clearances, press work materials, Principles of die design: screws and dowels, components of dies, die block, Punch and types of punch, punch support, punch shedders. Pilots, strippers, guiding stock, stops.	**8 Hours** **L1,L2,L3**

Module 4 **BENDING AND DRAWING DIES:** Introduction, Difference between bending and drawing, progressive die, compound die, combination die. Special methods of bending and drawing, types of bending dies, – spring back – knockouts – direct and indirect – pressure pads – ejectors – variables affecting metal flow in drawing operations – draw die inserts – draw beads- ironing, single and double action dies.	**10 Hours** **L1,L2,L3**
Module 5 **OTHER FORMING TECHNIQUES:** Bulging, swaging, embossing, coining, curling, hole flanging, shaving and sizing, assembly, recent trends in forming , computer aids for sheet metal forming analysis. Single minute exchange of dies: introduction, stages, implementation and effects, reducing set-up cost and time. Poka yoke: objective, system for mistake proofing, 5 whys, six mistake proofing techniques, some examples of poke-yoke.	**10 Hours** **L1,L2,L3**

Course Outcomes:

After studying this course, students will be able to:

CO1	Able to outline and define, classify of different clamp locating methods and devices, jigs, fixtures, press tools, dies and forming techniques.
CO2	Ability to describe the different types of metal forming process and its parameter with an example.
CO3	Adapt to make use of suitable variables of metal flow in forming technique and dies, principles of location and clamping, design and development of dies, jigs, fixtures and press tools.

Text books:

1. “Jigs and Fixtures”, Joshi, P.H. Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.

2. “Press tools – Design and Construction Joshi P.H”, wheels publishing, 1996

Reference books:

1.“Design of Jigs Fixtures & Press Tools”, Venkataraman. K., Tata McGraw Hill, New Delhi, 2005.

2. “Tool Design”, Donaldson, Lecain and Goold 3rd Edition, Tata McGraw Hill, 2000.

4. “Jigs and Fixture Design”, Hoffman Thomson Delmar Learning, Singapore, 2004.

5. ASTME Fundamentals of Tool Design Prentice Hall of India.

6. Design Data Hand Book, PSG College of Technology, Coimbatore

MATERIAL HANDLING EQUIPMENTS
VI Semester

Subject Code	**17MA653**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION**: Objectives of material handling system, Principal groups of materials handling equipment and classification, Scope of Material Handling, Criteria for selection of Material Handling Equipment's, Basic kind of material handling problems, Various methods to analyze material Handling problems	**08 Hours / L1,L2,L3**
Module 2 **CONVEYOR DESIGN:** Introduction to apron conveyors , Pneumatic conveyors, Belt Conveyors, Screw conveyors and vibratory conveyors and their applications, Design of Belt conveyor- Belt selection procedure and calculation of drop energy, Idler design	**08 Hours / L1,L2,L3,L4**
Module 3 **DESIGN OF HOISTS**: Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.	**08 Hours / L1,L2,L3,L4**
Module 4 **DESIGN OF CRANES**: Hand-propelled and electrically driven E.O.T overhead Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes.	**08 Hours / L1,L2,L3,L4**
Module 5 **DESIGN OF BUCKET ELEVATOR:** Introduction, Types of Bucket Elevator, Design of Bucket Elevator- loading and bucket arrangements, Cage elevators, shaft way, guides, counter weights.	**08 Hours / L1,L2,L3,L4**

Course Outcomes

After studying this course, students will be able to:

CO1: Understand the working of various material handling equipment's.
CO2: Design the conveyer equipment's.
CO3: Design hoisting equipment for materials lifting.

Text Books:

1. "Materials handling equipment", Rudenko N., Elnvee Publishers, 1970

2."Engineering Science and application design for belt conveyor", Ishwar G Mulani and Mrs. Madhu I Mulani, Madhu I. Mulani, 2002.

Reference Books:

1. "Belt conveyors for bulk materials"Conveyor Equipment Manufacturer's Association, 6th edition, The New CEMA Book

2. "Conveying Machines, Vol. I and II", Spivakovsy A.O. and Dyachkov V.K., MIR Publishers, 1985.

3. "Materials Handling Equipments", Alexandrov, M., MIR Publishers, 1981.

AUTOMATION AND ROBOTICS
VI SEMESTER

Subject Code	**17MA661**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40L**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	**Hours/RBTLevel**
Module 1 **Automation:** History of automation, Advantages and disadvantages of automation. Types of automation – fixed, programmable and flexible automation, Automation strategies, Automated production lines and its applications. Automatic identification – barcode technology and radio frequency identification. **Automated manufacturing systems:** Components, Classification and overview of manufacturing systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS.	**8 Hours** **(L1, L2, L3)**
Module 2 **INTRODUCTION TO ROBOTICS:** Definition of robot, History of robotics, Robot anatomy, Robot configurations: polar, cartesian, cylindrical and jointed-arm configuration, Robot motions, joints, and work volume, Robot drive systems, Precision of movement – spatial resolution, accuracy, repeatability, end effectors – tools and grippers, Asimov's laws of robotics. **Spatial descriptions:** Positions, orientations and frames, Changing descriptions from frame to frame, Operators: translations, rotations and transformations.	**8 Hours** **(L1, L2, L3, L4)**
Module 3 **Controllers:** Basic control system concepts and models, Transfer functions, Block diagrams, Characteristic equation, Types of controllers: on-off, proportional, integral, differential, P-I, P-D, P-I-D controllers. **Robot actuation and feedback components:** Position sensors – potentiometers, resolvers, encoders, and velocity sensors, Actuators – pneumatic and hydraulic actuators, electric motors, stepper motors, servomotors, power transmission systems.	**8 Hours** **(L1, L2, L3, L4)**
Module 4 **Sensors:** Tactile sensors, Proximity and range sensors, Use of sensors in robotics. **Machine vision system:** Introduction to machine vision, Sensing and digitizing function in machine vision, Image processing and analysis, Training and vision systems.	**8 Hours** **(L1, L2, L3, L4)**
Module 5 **Robotic technology of the future:** Robot Intelligence, Advanced sensor capabilities, Telepresence, Mechanical design features, Mobility, Locomotion and navigation, Universal hand **Artificial Intelligence:** Goals of AI research, AI techniques – Knowledge representation, problem representation and problem solving, Levels of robot programming, Requirements of robot programming language, LISP programming.	**8 Hours** **(L1, L2, L3, L4)**

Course outcomes:

After studying this course, students will be able to:

CO1	Understand the role of automation and Flexible Manufacturing Systems (FMS) in manufacturing.
CO2	Explain robotic configurations and controllers and actuation systems for robotic drive systems.
CO3	Explain different sensors and control systems.
CO4	Understand robotic technologies and robotic programming using AI.

Textbooks:

1. Robotics for Engineers –Yoram Koren, McGraw Hill International, 1st Edition, 1985.
2. Introduction to Robotics Mechanics and Control – John J. Craig, 3rd Edition, Pearson, 2009.

Reference books:

1. Industrial Robotics – Groover, Weiss, Nagel, McGraw Hill International, 2nd Edition, 2012.
2. Robotic Engineering – An Integrated Approach, Klafter, Chmielewski and Negin, Phi, 1st Edition, 2009.

SUPPLY CHAIN MANAGEMENT
VI Semester

Subject Code	**17MA662**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **Introduction**: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.	**08 Hours** **L1,L2**
Module 2 **Strategic Sourcing Outsourcing** – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing	**08 Hours** **L1,L2,L3**
Module 3 **Warehouse Management Stores management**-stores systems and procedures incoming materials control-stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling-transportation and traffic management - operational efficiency-productivity-cost effectiveness-performance measurement. Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.	**08 Hours** **L1,L2,L3**
Module 4 **Supply Chain Network optimisation models.** Impact of uncertainty on Network Design - Network Design decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.	**08 Hours** **L2,L3**

Module 5	08 Hours L1,L2,L3
Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain- E- Business in supply chain.	

Course Outcomes:

After studying this course, students will be able to:

CO1	Understand the framework and scope of supply chain management.
CO2	Build and manage a competitive supply chain using strategies, models, techniques and information technology.
CO3	Plan the demand, inventory and supply and optimise supply chain network.
CO4	Understand the emerging trends and impact of IT on Supply chain.

Text Books:

1.Supply Chain Management – Janat Shah, Text and Cases, Pearson Education, 2009.

2.Supply Chain Management-Strategy Planning and Operation Sunil Chopra and Peter Meindl, , PHI Learning / Pearson Education, 2007.

Reference Book:

1.Business Logistics and Supply Chain Management, Ballou Ronald H, Pearson Education, 5 th Edition, 2007.

2. Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Tata McGraw-Hill, 2005.

3. Supply Chain Management-Concept and Cases, Altekar Rahul V, PHI, 2005.

ADDITIVE MANUFACTURING LABORATORY

VI Semester

Course Code	**17MAL67**	**CIE Marks**	**40**
Number of Hours/Week	**1L + 2P**	**SEE Marks**	**60**
Total hours	**40**	**Exam Hours**	**03**
No. of Credits: 2			

Content	Hours/RBTLevel
PART – A Create part models using CAD packages and then export the models onto the 3D Printing machine and create the prototype. For example model individual parts of a Plummer block and assemble it once the all parts are completed. Create following parts: 1. Block Base 2. Hexagonal Nut 3. Bolts 4. Cap 5. Bearing top half 6. Bearing bottom half. Creation of Screw jack all part drawings Creation of Bench vice with all part drawings Creation of their own Product from requirement gathering to final product involves Creation of 3D Part Drawings	**15** **L1, L2 ,L3**
PARTB Conversion of 3D Part drawings to steriolithograhy (.stl) format.	**15** **L1, L2 ,L3**
PARTC Generation of Additive Manufacturing Machine specific Code. Fabrication of model using Rapid Prototyping Machine.	**10** **L1, L2 ,L3**

Course Outcomes

After studying this course, students will be able to:

CO1	gain knowledge about the all Rapid Prototyping Process.
CO2	understand the Material choice according to the application.
CO3	fabricate the final physical model using Rapid Prototyping Machine.

Reference Text Books:

1. "Rapid Prototyping: Principles & Applications",Chua Chee Kai, Leong Kah Fai, World Scientific, 2003.
2. Computer Aided Manufacturing - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999.

Scheme of Examination:

One Model from Part – A : 50 Marks
One Model from Part – B : 30 Marks
Viva – Voce :20 Marks
Total : 100 Marks

NON DESTRUCTIVE TESTING LABORATORY

VI Semester

Course Code	17MAL68	CIE Marks	40
Number of Hours/Week	1L + 2P	SEE Marks	60
Total hours	40	Exam Hours	03
No. of Credits: 2			

Objective:

To provide the knowledge on types, working principles and advantages of NDT. To enable the students to choose the NDT procedure for a given part.

Content	Hours/RBTLevel
1. Visual inspection. 2. Radiography. 3. Liquid (Dye) penetrant method. 4. Magnetic particles. 5. Eddy current testing. 6. Ultrasonic Inspection. 7. Acoustic Method.	**40** **L1, L2 ,L3**

Course Outcomes

After studying this course, students will be able to:

CO1	Understand the non-destructive testing method to be used based on testing material
C02	Conduct the NDT by various methods
CO3	Identify the defects on the surface and core.

Text Books:

1. "Practical Non-Destructive Testing", Baldev Raj, T.Jayakumar, M.Thavasimuthu Narosa Publishing House, 2009.
2. "Non-Destructive Testing Techniques", Ravi Prakash, 1st revised edition, New Age International Publishers,2010

Reference Book:

1. " Handbook of Nondestructive evaluation Charles, J. Hellier,", McGraw Hill, New York 2001
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

CONTROL ENGINEERING

VII Semester

Subject Code	**17MA71**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**3L+2T**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBT Level
Module 1 **Introduction:** Components of a control system, Open loop and closed loop systems. **Types of controllers:** Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers. **Modeling of Physical Systems :** Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems.	**10Hrs** **L1,L2,L3**
Module 2 **Time domain performance of control systems:** Typical test signal , Unit step response and time domain specifications of first order, second order system. steady state error, error constants.	**10Hrs** **L1,L2**
Module 3 Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.	**10Hrs** **L2,L3**
Module 4 **Stability of linear control systems:** Rouths criterion, Root locus, Determination of phase margin and gain margin using root locus.	**08Hrs** **L2,L3**
Module 5 **Frequency domain analysis:** Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.	**10 Hrs.** **L2,L3**

Course Outcomes:

The student on completion of the course will be able to:

CO1	Identify the type of control and control actions.
CO2	Develop the mathematical model of the physical systems.
CO3	Estimate the response and error in response of first and second order systems subjected to standard input signals.
CO4	Represent the complex physical system using block diagram and signal flow graph and obtain transfer function.
CO5	Analyse a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain.
CO6	Analyse the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.

Text Books:

1. Automatic Control Systems, Farid G., Kuo B. C., McGraw Hill Education, 10thEdition,2018
2. Modern control Engineering, K. Ogeta, Pearson, 5th Edition,2010.

Reference Books:

1. Control Systems Engineering, Norman S Nice, Fourth Edition, Wiley StudentEdition,2007.
2. Control systems, Manik D. N., Cengage,2017,

HYDRAULIC CIRCUITS AND PROGRAMMABLE LOGIC CONTROLLERS (PLC)

VII SEMESTER

Subject Code	**17MA72**	**CIE Marks**	**40**
Number of Hours/Week	**4**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	**Hours/RBT Level**
Module 1 **INTRODUCTION TO FLUID POWER:** Components, advantages and applications, Pascal's law and its applications, Fluids for hydraulic system: types, properties, and selection, Additives, effect of temperature and pressure on hydraulic fluid, Seals, sealing materials, compatibility of seal with fluids, Types of pipes, hoses, and quick acting couplings, Pressure drop in hoses/pipes, Fluid conditioning through filters, strainers, Sources of contamination and contamination control.	**10 Hours** **(L1, L2, L3)**
Module 2 **PUMPS AND ACTUATORS:** Classification of hydraulic pumps, Pumping theory Construction and working of gear, vane, piston, fixed and variable displacement pumps., Pump performance, Selection factors, Numerical problems on pumps, Classification of cylinders – single and double acting cylinder, Symbolic representation of hydraulic actuators, Mounting arrangements, cushioning, special types of cylinders, problems on cylinders, Classification of hydraulic motors, Construction and working of gear, vane, and piston motors, Theoretical torque, power, flow rate, and hydraulic motor performance, Numerical problems on motors.	**10 Hours** **(L1, L2, L3)**
Module 3 **CONTROL COMPONENTS AND CIRCUIT DESIGN OF HYDRAULIC SYSTEMS**: Classification of control valves, Directional Control Valves (DCV): symbolic representation, constructional features of poppet, sliding spool, rotary type valves, solenoid and pilot operated DCV, shuttle valve, and check valves, Pressure Control Valves (PCV): types, direct operated types and pilot operated types, Flow Control Valves: compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, Symbolic representation of DCV, PCV, and FCV. Hydraulic circuit design: Control of single-acting hydraulic cylinder, Control of double-acting hydraulic cylinder, Regenerative circuit, Pump unloading circuit, Counterbalance valve application, Metering-in, metering-out and bleed-off circuits, Hydraulic cylinder sequencing circuits, Cylinder synchronizing circuit.	**10 Hours** **(L1, L2, L3)**
Module 4	

INTRODUCTION TO PNEUMATIC SYSTEMS: Advantages and limitations, Applications, Choice of working medium, Characteristics of compressed air, Structure of pneumatic control system, Fluid conditioners - dryers and FRL unit, Pneumatic actuators: Linear cylinder – types, working, construction and applications, Rotary cylinders – types, working, construction and applications, End position cushioning, seals, and mounting arrangements, symbols, Pneumatic Control Valves: DCV (poppet, spool), PCV, FCV, Use of memory valve, Quick exhaust valve, Time delay valve, Shuttle valve.

10 Hours

(L1, L2, L3)

Module 5

FUNDAMENTALS OF PROGRAMMABLE LOGIC CONTROLLER (PLC): Definition, Advantages, Functions of PLC, Evolution of the modern PLC, Types of PLC, Block diagram of PLC, PLC timers and counters, Data handling, Communication in PLCs, Introduction to logic, ladder design, and switches, Industrial automation vs. Information technology, Supervisory Control and Data Acquisition (SCADA) System.

10 Hours

(L1, L2, L3, L4)

Course outcomes:

After studying this course, students will be able to:

CO1	Explain fluid power systems.
CO2	Understand hydraulic pumps and motors.
CO3	Apply hydraulics concept to design hydraulic circuits using different valves.
CO4	Understand PLC and automation based on different applications.

Textbooks:

1. "Fluid Power with Applications", Anthony Esposito, Pearson Edition, 2000.
2. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.
3. "PLC and Industrial Automation", Madhuchhanda Gupta and Samarjit Sen Gupta, Penram International Pub. (Indian) Pvt. Ltd., 2011.

Reference books:

1. Majumdar S.R., "Oil Hydraulics", Tata McGraw Hill, 2002.
2. John W Webb, Ronald A Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition

STATISTICAL QUALITY CONTROL
VII SEMESTER

Subject Code	**17MA73**	**CIE Marks**	**40**
Number of Hours/Week	**3L+2L**	**SEE Marks**	**60**
Total Number of Hours	**50L**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION:** Definition of Quality, Quality Dimensions, Inspection and Quality control, Quality Assurance – Quality planning, Quality costs – Economics of quality, Quality loss function.	**10 Hours L1, L2**
Module 2 Introduction to Control charts, Construction and application. Chance and assignable causes of process variation, Statistical basis of the control chart for variable, Attribute control charts - p, n np,c and u charts.	**10 Hours L1,L2,L3**
Module 3 Warning and Modified Control Limits. Control Chart for Individual Measurements, Multi- Variable Chart, X – Chart with a Linear Trend, Charts for moving average and ranges, Cumulative-Sum and Exponentially, Weighted Moving Average Control Charts.	**10 Hours L1,L2,L3**
Module 4 Process Stability. Analysis using a Histogram, Probability Plots and control Chart, Gauge capability studies, Process Capability.	**10 Hours L1,L2,L3**
Module 5 Acceptance Sampling Fundamental, OC Curves, Sampling Plans for Attributes, Signal and double sampling plans, Multiple and Sequential sampling plans, Sampling plans for variables- MIL-STD-105D standards.	**10 Hours L1,L2,L3**

Course Outcomes:

After studying this course, students will be able to:

CO1	CO Explains the basic concept of Quality, Control Charts and Acceptance Sampling
CO2	Construct control charts and evaluate revised control limits
CO3	CO Analyze process capability and operating characteristic curves

Text Books:

1. Introduction to Statistical Quality Control, Douglas C Montgomery, John Wiley, Seventh Edition, 2012.

2.Quality Planning and Analysis, J.M . Juran, Frank M Gryna, Tata-McGraw Hill 3rd Edition, 1995.

Reference Book:

1.Statistical Quality Control, Grant E.L. and Leavenworth, TMH, 2000.

2. IS 2500 Standard sampling plan

FACILITY PLANNING AND DESIGN
VII SEMESTER

Subject Code	**17MA741**	**CIE Marks**	**40**
Number of Hours/Week	**3**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	**Hours/RBTLevel**
Module 1 **PLANT LOCATION AND LAYOUT:** Factors influencing plant location, Theories of plant location and location economics. PLANT LAYOUT: Objectives of plant layout, Principles of plant layout, types of plant layout, their merits and demerits. **MATERIAL HANDLING:** Definition, principles, system design and selection of equipment, UNIT load concepts, basic layout types – immer, Nadler, Muther, Apple James and Ree's approaches to plant layout, Modular design concept, Production Line balancing.	**8 Hours** **L1, L2**
Module 2 **COMPUTER AIDED LAYOUT: CRAFT, COFAD, PLANET, CORELAP, ALDEP. CONSTRUCTION OF THE LAYOUT:** Methods of constructing the layout, evaluation of layout, efficiency indices, presenting layout to management, implementing layout.	**8Hours** **L1,L2,L3**
Module 3 **SPACE DETERMINATION AND AREA ALLOCATION:** Factors for consideration in space planning, receiving, storage, production, shipping, other auxiliary service actions, Establishing total space requirement, area allocation factors to be considered, expansion, flexibility, aisles column and area allocation procedure. Design of layout using Travel chart, plot plan, block plan, Sequence demand straight line method and non-directional method.	**8 Hours** **L1,L2,L3**

Module 4 **QUANTITATIVE APPROACHES TO FACILITIES PLANNING:** Deterministic models – Single and multi facility location models, Location allocation problems. **QUANTITATIVE APPROACHES TO FACILITIES PLANNING:** Quadratic assignment problem, Warehouse layout models, plant location problems. Conveyor models. Storage models.	**8 Hours** **L2,L3**
Module 5 **PROBABILISTIC MODELS:** Conveyor models, waiting line models and simulation models. Evaluation, selection, implementation and maintenance of the facilities plan.	**8 Hours** **L2,L3**

Course Outcomes:

After studying this course, students will be able to:

CO1	Explain objectives, principles, merits , demerits and efficiency of plant layout
CO2	Understand the design procedure, establishment of facilities and models and maintenance of plant layout
CO3	Analyze the plant location and space allocations for layout

TextBooks:

1. Facilities Planning -Thompkins. J A and White, J. A.
2. Facility layout and Location -Francies, R.L. and White, J.A..
3. Plant Layout and Material handling -James M Apple, 2nd Edition, John, Wiely and Sail.

Reference Books:

1. Practical plant layout -Muther Richard, - McGraw Hill-1955.
2. Facilities Design -Sunderesh Heragu, , PWS Publishing Company, ISBN- 0-534-95183.
3. Plant Layout Design -James M Moore., Mac Millon Co. 1962 LCCCN : 61-5204.

PROCESS PLANNING
VII SEMESTER

Subject Code	**17MA742**	**CIE Marks**	**40**
Number of Hours/Week	**3**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **INTRODUCTION TO PROCESS PLANNING** Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection. Production equipment and tooling selection	**8 Hours** **L1, L2, L3**
Module 2 **PROCESS PLANNING ACTIVITIES** Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies	**8Hours** **L1,L2,L3**
Module 3 **INTRODUCTION TO COST ESTIMATION** Importance of costing and estimation –methods of costing-elements of cost estimation – Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost	**8 Hours** **L1,L2,L3**
Module 4 **PRODUCTION COST ESTIMATION** Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop	**8 Hours** **L1,L2,L3**
Module 5 **MACHINING TIME CALCULATION** Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding	**8 Hours** **L1,L2,L3**

Course Outcomes:

After studying this course, students will be able to:

CO1	Explain process planning, quality assurance and costing & estimation
CO2	Explain the location of jobs on machine tools
CO3	Select tools for operations on turning, milling and shaping operations
CO4	Estimate the cutting time and cost for turning, milling and shaping operations

Text Books:

1. "Process planning, Design/Manufacture Interface", Peter scalon, Elsevier science technology Books, Dec 2002.

Reference Books:

6. "Manufacturing Processes and systems", Ostwalal P.F. and Munez J., 9th Edition, John Wiley, 1998.
7. "Operations Management", Russell R.S and Tailor B.W, 4th Edition, PHI, 2003.
8. "Product Design and Manufacturing", Chitale A.V. and Gupta R.C., 2nd Edition, PHI, 2002.

PRECISION ENGINEERING
Semester VII

Subject Code	**17MA743**	**CIE Marks**	**40**
Number of Hours/Week	**3**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **CONCEPTS OF ACCURACY AND MACHINE TOOLS:** Part Accuracy – errors, accuracy of machine tools – spindle accuracy – displacement accuracy – errors due to numerical interpolation	**8 Hours** **L1, L2, L3**
Module 2 **STIFFNESS, THERMAL EFFECTS AND FINISH MACHINING:** Overall stiffness of Lathe – compliance of work piece – errors caused by cutting forces – deformation in turning – heat sources – thermal effects – Finish Turning, Surface roughness.	**8 Hours** **L1,L2,L3**
Module 3 **DIMENSIONING:** Definition of terms – Key dimension – Superfluous dimension – dimensional stepped shaft – assigning tolerances in the constituent dimensions – dimensional chains.	**8 Hours** **L1,L2,L3**
Module4 **MICRO-MACHINING MICRO-FABRICATION:** Micro Machining – Photo resist process – Lithography – LIGA Process – Optical, processing of materials –micro forming, diamond turning – micro positioning devices – etching – physical vapour deposition – Chemical vapour deposition	**8 Hours** **L1,L2,L3**
Module 5 **SMART STRUCTURES AND MICRO ACTUATORS:** Smart structures and applications – smart sensors – micro valves – MEMS – Micro motors – Micro pumps – micro dynamometer– micro optics – micro nozzles.	**8 Hours** **L1,L2,L3,**

Course Outcomes:
After studying this course, students will be able to:

CO1	Understand the technology and variables involved in precision engineering
CO2	Be able to select the type of microfabrication technique required for any specific product
CO3	Have the basic knowledge for selecting the type of dimensioning and machine tools for the fabrication process.
CO4	Know about the special microfabrication and gauging when their use is warranted.
CO5	Have a broad knowledge of micromachining and smart materials

Text Books:

6. "Precision Engineering in Manufacturing", Murthy R.L., New Age International Pvt, 2005.
7. "Micro sensors, MEMS and Smart Devices", Juliar W.Gardner. Vijay K. Varadan, John Wiley and sons, 2001.

Reference Book:

4. "The Science and Engineering of Microelectronic Fabrication", Stephen A. Campbell, Oxford University Press, 1996.
5. "Understanding Smart Sensors", Raady Frank, Artech. House, Boston, 1996.
6. MEMS Hand Book, CRC Press, 2001

OPERATIONS MANAGEMENT
Semester VII

Subject Code	**17MA751**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
MODULE 1 **OPERATIONMANAGEMENTCONCEPTS:**Introduction,Historical development, The trend: information and Non- manufacturing systems, Operations management, Factors affecting productivity; International dimensions of productivity, the environment of operations, Production systems decisions – a look ahead. OPERATION DECISION MAKING: Introduction, Management as a science, Characteristics of decisions, Framework for decision making, Decision methodology, Decision support systems, Economic Models, Statistical models.	**08 Hours** **L1,L2,L3**
MODULE 2 **SYSTEMS DESIGN AND CAPACITY:** Introduction, Manufacturing and service systems, Design and systems capacity, Capacity planning. FORECASTING DEMAND: Forecasting objectives and use, Forecasting variables, Opinion and Judgemental methods, Time series methods, Exponential smoothing, Regression and correlation method, application and control of forecasts.	**08 Hours** **L1,L2,L3**
MODULE 3 **AGGREGATE PLANNING AND MASTER SCHEDULING:** Introduction – Planning and scheduling, Objectives of aggregate planning, aggregate planning methods, Master scheduling objectives, Master scheduling methods.	**08 Hours** **L1,L2,L3,L4**
MODULE 4 **MATERIAL AND CAPACITY REQUIREMENTS PLANNING:** Overview: MRP and CRP, MRP: Underlying concepts, System parameters**,** MRP logic, System refinements, Capacity management, CRP activities.	**08 Hours** **L2,L3,L4**
MODULE 5 **SCHEDULING AND CONTROLLING PRODUCTION ACTIVITIES:** Introduction, PAC objectives and data requirements, Scheduling strategy and guidelines, Scheduling methodology, Priority control, Capacity control. **SINGLE MACHINE SCHEDULING:** Concept, measures of performance, SPT rule, Weighted SPT rule, EDD rule, Minimizing the number of tardy jobs**.** **FLOW – SHOP SCHEDULING:** Introduction, Johnson's rule for 'n' jobs on 2 and 3 machines, CDS heuristic. **JOB-SHOP SCHEDULING:** Types of schedules, Heuristic procedure, scheduling 2 jobs on 'm' machines.	**08 Hours** **L1,L2,L3,L4**

Course Outcomes:
After studying this course, students will be able to :

CO1	Explain the concept and scope of operations management in a business context.
CO2	Recognize the role of Operations management among various business functions and its role 2 in the organizations' strategic planning and gaining competitive advantage.
CO3	Analyze the appropriateness and applicability of a range of operations management 3 systems/models in decision making.
CO4	Assess a range of strategies for improving the efficiency and effectiveness of organizational 4 operations.
CO5	Evaluate a selection of frameworks used in the design and delivery of operations.

Text Books:
5. Operation Management - Monks, J.G., t, McGraw-Hill International Editions, 1987.
6. Production and Operations Management - Pannerselvam. R., PHI.
7. Operations management - Productions & by Adam & Ebert.

Reference Book:
3. Operations Management - Buffa, Modern Production/, Wiely Eastern Ltd.
4. Production and Operations Management - Chary, S.N., Tata-McGraw Hill
5. Operations management - James Dilworth.

RELIABILITY ENGINEERING
VII Semester

Subject Code	**17MA752**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module1 **CONCEPTS OF RELIABILITY, SYSTEM AND MODELS:** Definition of reliability – reliability Vs quality-reliability function-MTTF – hazard rate function-bathtub curve – derivation of the reliability function-constant failure rate model – time dependent failure models. Weibull distribution – normal distribution – the lognormal distribution. Serial configuration – parallel configuration – combined series parallel systems – system structure function, minimal cuts and minimal paths – Markov analysis – load sharing systems, standby system, degraded systems, three state devices – covariate models, static models, dynamic models, physics of failure models.	**10 Hours** **L1, L2, L3**
Module 2 **DESIGN FOR RELIABILITY AND MAINTAINABILITY:** Reliability design process – system effectiveness – economic analysis and life cycle cost – reliability allocation – optimal, Arinc, Agree, – Design methods – parts and material selection, derating, stress- strength analysis – failure analysis – identification of failure mode – determination of causes –assessment of effects – classification of seventy – computation of critically index – corrective action – system safety and FTA. Analysis of downtime – the repair time distribution – stochastic point processes – system repair time – reliability under preventive maintenance – state dependent systems with repair – MTTR-mean system downtime – MTR – MH/OH – cost model – fault isolation and self diagnostics – repair Vs replacement – replacement model – proactive, preventive, predictive maintenance – maintenance and spares provisioning – maintainability prediction and demonstration – concepts and definition of availability.	**10 Hours** **L1, L2,L3**
Module 3 **OPTIMIZATION OF SYSTEM RELIABILITY:** Optimization techniques for system reliability with redundancy – heuristic methods applied to optimal system reliability- redundancy allocation by dynamic programming – reliability optimization by non linear programming	**6 Hours** **L1,L2,L3**

Module 4 **THE ANALYSIS OF FAILURE DATA AND RELIABILITY TESTING:** Data collection – empirical methods – ungrouped and grouped complete, censored data – static life estimation – test time calculation – burn in testing, acceptance, sequential, binomial testing – accelerated life testing – their acceleration models – experimental design – reliability growth process – idealized growth curve – various growth models – identifying failure and repair distributions.	**6 Hours** **L1,L2,L3**
Module 5 **PACKAGING AND TRANSPORTATION FOR RELIABILITY** Objectives – preservation-packaging – transportation and subsequent storage – reliability and the customer – Purchase of equipment – installation – commissioning a new system – reliability prediction and control – reliability management – the people concerned with reliability, coordination, training.	**10 Hours** **L1,L2,L3**

Course Outcomes:
After studying this course, students will be able to:

C01	Understand the reliability concepts and their use in design
C02	Apply distribution models to components and systems to estimate their reliability
C03	Analyse their reliability of systems and estimate the life of systems/components
C04	Estimate the redundancy of components/systems
C05	Apply the reliability models to packaging and transportation models

TEXT BOOKS:

6. "An introduction to Reliability and Maintainability Engg", Charles E. Ebling, Tata McGrawHill, 2000.

REFERENCES:

6. "Practical Reliability Engineering Patrick D T o'connor,", John-Wiley and Sons inc, 2002.
7. "Reliability, Maintainability and Risk: Practical Methods for Engineers", David J Smith, Butterworth, 2002
8. "Optimal Reliability Design and Applications", Way kuo, Rajendra Prasad V, Frank A and Tillman, ching- lai Hwang Cambridge University Press P ltd., 2001.
9. Engineering Design and Reliability, Srinath I.S, ISTE, 1999.
10. "Introduction to Mechanical Reliability: A Designers Approach, Hemisphere Oleg Vinogradov, Publications, 1991.

MATERIALS MANAGEMENT
VII Semester

Subject Code	**17MA753**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	**Hours/RBTLevel**
Module 1 **Introduction:** Dynamics of Materials Management - Materials Management at Micro-level, Materials Management at Macro-level. Definition of Material Management Systems Approach to Materials Management: Systems Approach - The Process of Management and the Materials Function, The Materials Function, Interfaces. Benefits of the Integrated Systems Approach.	**8 Hours** **L1, L2**
Module 2 **Forecasting, Objectives and the Materials Organization**: Systems Design, Integral Control of the Flow of Materials, Forecasting and Planning, Forecasting Methods, Objectives of Materials Management - Organization of Materials Management, Functional Organization Model for Materials Management. Materials Planning: Making the Materials Plan Work, The Materials Cycle and Flow Control System. **Purchasing:** Purchasing Principles, Procedures and Practices, Fundamental Objectives of Purchasing - Scope, Responsibility and Limitations, Sources of Supply and Supplier Selection, Purchasing Policy and Procedures.	**8 Hours** **L1, L2**
Module3 **Purchasing in Materials Management System Concept:** Price Determination, Price Forecasting, Price-Cost Analysis, Negotiation, Reciprocity, Cost-Plus Contracts, Hedging, Forward Buying, Buying Ethics, Principles and Standards of Purchasing, Make-or Buy, Information, Documentation and Purchasing Library, Legal Aspects of Purchasing, Law of Agency, Law of Contract, Legal Status of the Buyer, Warranties and Conditions, Right of Inspection, Right of Rejection, Vendor-Vendee Relations, Vendor Development, Vendor Rating, Purchasing and Procurement Activities under Materials Management: Supplier Quality Assurance Programme, Buyer-Supplier Relationship. Incoming Material Quality Control: Significance of Inspection, Metrology or Engineering Measurement, Purchase Inspection, Sampling Inspection, Sampling Technique, Different Types of Population, Different Types of Sampling.	**8 Hours** **L1,L2,L3**
Module 4 **Purchasing Capital Equipment, Plant and Machinery:** Responsibility and Decision, Purchasing v/s Leasing, International Buying, Import Purchasing, and Governmental **Purchasing**: Industrial Needs, Import Procedure and Documents, Basis of Licensing, Import Purchasing Procedures, Letter of Credit, Income-Tax Clearance, Customs Tariff-Registration of Licenses at Port. Governmental Purchasing: Policy and Procedures, Tenders. Registration of Firms, Procedure for Registration, Terms of Registration, Removal of the Firms from the List, Blacklisting of Firms, Banning of Firms, Suspension of Firms.	**8 Hours** **L1,L2,L3**

Inventory Management and Control Systems: Definition of Inventories, The Need for Inventory Audits Control, Types of Inventories, Inventory Control, Max-Min System, Inventories and Demand Uncertainty, Determining Safety Stock.	
Module 5 **Q-system or Quantity Control System or Re-order Point System**-Effect of Quantity Discounts, P-system or Periodic Review or Periodic Count System or Replenishment System, Optional Replenishment System or "S, s" Policy. Discussion on ABC Analysis, advantages and disadvantages. MRP system and MPS system Stores Management and Operation: Storage System, Stores Location and Layout, Materials Management Information System and Computer: MIS - Management and MM, Computer System for MIS and MM, In-process Materials and Management Control.	**8 Hours** **L1,L2, L3**

Course Outcomes:
After studying this course, students will be able to:

CO1	Ability to perform the role of material manager in purchase, inventory and storage in an organization
CO2	Able to analyse due date performance using MRP
CO3	Able to practice material planning through the use of ICT tools.

Text Books:

1. Materials Management, A.K. Datta., PHI Pvt. Ltd, New Delhi, 2001.

Reference Book:

1. Handbook of Materials Management, P. Gopala krishnan, PHI Pvt. Ltd, New Delhi, 2002.

HYDRAULIC CIRCUITS AND PROGRAMMABLE LOGIC CONTROLLERS (PLC) LABORATORY
VII Semester

Subject Code	17MAL76	CIE Marks	40
Hours / Week	1L+2P	SEE Marks	60
Total Hours	40	Exam Hours	03
No. Of Credits:2			

Content	Hours/RBT Level
Part A 1. Meter-in and Meter-out in designing of Hydraulic Circuits using Single-rod cylinder & 4/2 DCV/Manual lever operated valve. 2. Application of 4/3 position tandem centre configuration, DCV/Manually operated Valve to demonstrate application in forklifts. 3. Operation of Hydraulic motor using 4/3-way valve. 4. Application of Hydraulic accumulator as stand by hydraulic energy source during power failures. 5. Design a hydraulic circuit and verify its operation over a hydraulic press.	**16 Hours** **(L2, L3)**
Part B **LOGIC GATES** 1. To draw the ladder program for various logic gates using STEP 7 software and to verify the correctness of the same using the PLC. **DEMORGAN LAW** 2. To draw the ladder diagrams for De Morgan's laws and to verify the truth tables of the same using the PLC. **ARITHMETIC OPERATIONS** 3. To draw and verify the ladder diagram for arithmetic operations using the PLC. **TWO MOTOR SYSTEM (USE OF OFF DELAY TIMER)** 4. To draw and verify the ladder diagram for the given problem using the PLC. **TWO MOTOR SYSTEM (USE OF ON DELAY TIMER)** 5. To draw and verify the ladder diagram for the given problem using the PLC. **SELECTION COMMITTEE** 6. To draw and verify the ladder diagram for the given problem using the PLC. **RAILWAY PLATFORM SIGNALLING** 7. To draw and verify the ladder diagram for the given problem using the PLC.	**24 Hours** **(L2, L3)**

Course Outcomes:
On completion of the course, students will be able to:

CO1	Understand the working of hydraulic valves, hydraulic motors, hydraulic packs and PLC circuits.
CO2	Design and verify the hydraulic circuits.
CO3	Analyze PLC circuit diagrams by using basic electronic circuits.

Books:

3. "Fluid Power with applications", Anthony Esposito, Pearson edition, 2000.
4. "PLC and Industrial application", Madhuchhandan Gupta and SamarjitSen Gupta, Penram International Pub. (Indian) Pvt. Ltd., 2011.
5. FESTO, Fundamentals of Pneumatics, Vol I, II and III.

Scheme of examination:

One Question from Part A = 40 Marks (10 marks for write up + 30 for conduction)

One Question from Part B = 40 Marks (10 marks for write up + 30 for conduction)

Viva-voce = 20 Marks

COMPUTER INTEGRATED MANUFACTURING LAB
VII Semester

Subject Code	17MAL77	CIE Marks	40
Hours / Week	1L+2P	SEE Marks	60
Total Hours	40	Exam Hours	03
No. Of Credits:2			

Content	Hours/RBT Level
Part-A Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software. CNC part programming using CAM packages. Simulation of Turning, Drilling, Milling operations. 3 typical simulations to be carried out using simulation packages like: Cadem CAM Lab-Pro, Master- CAM. Program generation using software. Optimize spindle power, torque utilization, and cycle time. Generation and printing of shop documents like process and cycle time sheets, tool list, and tool layouts. Cut the part in single block and auto mode and measure the virtual part on screen. Post processing of CNC programs for standard CNC control systems like FANUC, SINUMERIC and MISTUBISHI.	30 HOURS L2, L3, L4
PartB (Only for Demo/Viva voce) FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components. (Only for Demo/Viva voce) Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs). Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.	10 HOURS L1, L2, L3

Corse Outcomes:

After studying this course, students will be able to:

CO1	Generate CNC Mill Part programming for Point to point motions, Line motions, Circular interpolation, Contour motion, Pocket milling- circular, rectangular, Mirror commands etc
CO2	Apply Canned Cycles for Drilling, Peck drilling, Boring, Tapping, Turning, Facing, Taper turning Thread cutting etc.
CO3	Apply simulation techniques for Tool Path generation for different machining operations of small components using CNC Lathe & CNC Milling Machine

TEXT BOOKS:

4. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
5. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.

REFERENCE BOOKS:

5. "Computer Automation in Manufacturing", Boucher, T. O., Chapman & Hall, London, UK, 1996.
6. CAD/CAM/CIM, Dr. P. Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

Scheme for Examination:

Two Questions to be set; one question from manual part programming and one from part programming using CAM package. (40 marks each)

Viva-Voce - 20 Marks

Total: 100

Marks Software Requirement: Cadem CAMLab-Pro, Master- CAM, and/or any other related software.

OPERATIONS RESEARCH

VIII Semester

Subject Code	17MA81	CIE Marks	40
Number of Hours/Week	3L:2T	SEE Marks	60
Total Number of Hours	50	Exam. Hours	03
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **Introduction:** Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).	**10 Hours** **L1, L2, L3**
Module 2 **LPP:** Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.	**10 Hours** **L1,L2,L3,L4**
Module 3 **Transportation Problem:** Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem. **Assignment Problem**: Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Numerical Problems.	**10 Hours** **L1,L2,L3,L4**
Module 4 **Network analysis:** Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems. **Sequencing**: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.	**10 Hours** **L1, L2, L3, L4**

Module 5	
Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games. **Queuing Theory:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.	**5. Hours** **L1, L2, L3, L4**

Course Outcomes:
After studying this course, students will be able to:

CO1	Describe the algorithms used in operation research in various applications.
CO2	Apply OR techniques to solve the resource allocation optimally
CO3	Carry out analysis using assignment and game theory concepts.
CO4	Allocate the resources for services optimally.
CO5	Analyze the project duration and Critical path.

Text Books:

3. Operations Research, P K Gupta and D S Hira, S. Chand and Company LTD. Publications, New Delhi – 2007
4. Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006.

Reference Books:

3. Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications
   Pvt. Ltd. 2016.
4. Operations Research, Paneer Selvan, PHI.
5. Introduction to Operations Research, Hillier and Lieberman,8thEd., McGraw Hill.

TOTAL QUALITY MANAGEMENT
VIII Semester

Subject Code	**17MA82**	**CIE Marks**	**40**
Number of Hours/Week	**4L**	**SEE Marks**	**60**
Total Number of Hours	**50**	**Exam. Hours**	**03**
Number of Credits: 4			

Content	Hours/RBTLevel
Module 1 **Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	**10 Hours** **L1,L2**
Module 2 **Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.	**10 Hours** **L1,L2**
Module 3 **Customer Satisfaction and Customer Involvement: Customer Satisfaction**: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	**10 Hours** **L1,L2,L3**
Module 4 **Continuous Process Improvement:** process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control : Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	**10 Hours** **L1,L2,L3**
Module 5 **Tools and Techniques:** Bench marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.	**10 Hours** **L1,L2,L3**

Course Outcomes:
After studying this course, students will be able to:

CO1	Understand the various approaches of TQM.
CO2	Infer the customer perception of quality
CO3	Analyze customer needs and perceptions to design a feedback system.
CO4	Apply statistical tools for implementation and continuous improvement of systems

Text Books:

6. Total Quality Management: Dale H. Besterfield, Publisher -Pearson Education India, ISBN: 8129702606, Edition 03.
7. Total Quality Management for Engineers: M. Zairi, ISBN:1855730243, Publisher: Wood head Publishing

Reference Books:

6. 1.Managing for Quality and Performance Excellence by James R. Evans and William M Lindsay,9th edition, Publisher Cengage Learning.
7. A New American TQM, four revolutions in management, Shoji Shiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
8. Organizational Excellence through TQM, H. Lal, New age Publications, 2008.

PRODUCT LIFECYCLE MANAGEMENT

VIII Semester

Course Code	**17MA831**	**CIE Marks**	**40**
Number of Hours / Week	**03**	**SEE Marks**	**60**
Total Number of hours	**40**	**Exam Hours**	**03**
No. of Credits: 3			

Content	Hours/RBTLevel
Module - 1 **INTRODUCTION TO PLM AND PDM** Introduction to PLM, Need for PLM, Opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.	**8 Hours** **L1, L2**
Module – 2 **PRODUCT DESIGN** Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product.	**8 Hours** **L1, L2, L3, L4**
Module – 3 **PRODUCT DEVELOPMENT** New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	**8 Hours** **L1, L2, L3, L4**
Module – 4 **TECHNOLOGY FORECASTING** Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.	**8 Hours** **L1, L2, L3, L4**

Module – 5	
PRODUCT BUILDING AND STRUCTURES	**8 Hours**
Virtual product development tools for components, machines, and manufacturing plants: **L1, L2, L3,** 3D CAD systems, digital mock-up, model building, model analysis, production (process) **L4** planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.	

COURSE OUTCOMES:

On completion of this subject students will be able to:

CO1	Explain the various strategies of PLM and Product Data Management.
CO2	Describe decomposition of product design and model simulation.
CO3	Apply the concept of New Product Development and its structuring.
C04	Analyze the technological forecasting and the tools in the innovation.
CO5	Apply the virtual product development and model analysis.

Text Books:

3. Product Lifecycle Management: Paradigm for 21st Century Product RealizationStark, John., Springer-Verlag, 2004. ISBN 1852338105

4.Product Design for the environment-A life cycle approach, Fabio Giudice, Guido La Rosa, Taylor & Francis 2006

Reference Books:

7. Product Life Cycle Management,SaaksvuoriAntti/ ImmonenAnselmie, Springer, Dreamtech, 3-540-25731-4

8. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

PROJECT MANAGEMENT
VIII Semester

Subject Code	**17MA832**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module 1 **Introduction:** Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.	**08 Hours** **L1,L2,L3**
Module 2 **Planning Projects:** Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organization, coding the WBS for the information system. **Scheduling Projects:** Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.	**08 Hours** **L1,L2,L3**
Module 3 **Resourcing Projects:** Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. **Project Risk Planning:** Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines.	**08 Hours** **L1,L2,L3**

Module 4 **Performing Projects:** Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. 28 Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.	**08 Hours** **L1,L2,L3**
Module 5 **Network Analysis Introduction, network construction** - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	**08 Hours** **L1,L2,L3,L4**

Course Outcomes:

After studying this course, students will be able to:

CO1	Understand the selection, prioritization and initiation of individual projects and strategic role of project management, work breakdown structure.
CO2	Understand the scheduling and uncertainty in projects and risk management planning.
CO3	Understand the activities: purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
CO4	Determine project progress through balanced scorecard approach
CO5	Draw the network diagram to calculate the duration of the project and reduce it using crashing.

Text Books:

7. Project Management, Timothy J Kloppenborg, Cengage Learning, Edition 2009.

8. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.

9. Project Management by S Choudhury, Mc Graw Hill Education (India) Pvt. Ltd. New Delhi, 2016

Reference Book:

8. Project Management, Pennington Lawrence, Mc Graw hill

9. Project Management, A Moder Joseph and Phillips New Yark Van Nostrand, Reinhold.

10. Project Management, Bhavesh M. Patal, Vikas publishing House,

FLEXIBLE MANUFACTURING SYSTEMS

VIII Semester

Subject Code	**17MA832**	**CIE Marks**	**40**
Number of Hours/Week	**3L**	**SEE Marks**	**60**
Total Number of Hours	**40**	**Exam. Hours**	**03**
Number of Credits: 3			

Content	Hours/RBTLevel
Module1 **PLANNING,SCHEDULING,ANDCONTROLOFFLEXIBLE MANUFACTURING:** Introduction – development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility – single product, single batch, n – batch scheduling problem – knowledge-based scheduling system	**8 Hours** **L1, L2, L3**
Module2 **COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS:** Introduction – composition of FMS – hierarchy of computer control – computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends	**8 Hours** **L1, L2, L3, L4**
Module3 **FMS SIMULATION AND DATABASE:**Application of simulation – model of FMS – simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database	**8 Hours** **L1, L2, L3, L4**
Module4 **GROUP TECHNOLOGY AND JUSTIFICATION OF FMS:** Introduction – matrix formulation – mathematical programming formulation – graph formulation – knowledge-based system for group technology – economic justification of FMS – application of possibility distributions in FMS systems justification.	**8 Hours** **L1, L2, L3, L4**
Module5 **APPLICATIONS OF FMS AND FACTORY OF THE FUTURE**: FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.	**8 Hours** **L1, L2, L3, L4**

Course outcomes:

After studying this course, students will be able to:

CO1	Understand the role of Flexible Manufacturing Systems (FMS) in manufacturing.
CO2	Analyze FMS using simulation and analytical techniques.
CO3	Explain the processes in group technologies.
CO4	Understand various applications using AI and expert systems using FMS technology.

Textbooks:

1. "Handbook of flexible manufacturing systems", Jha, N.K. Academic Press Inc., 1991.

Reference books:

6. "CAD/CAM/CIM", Radhakrishnan P. and Subramanyan S., Wiley Eastern Ltd., New Age International Ltd., 1994.
7. "Automation, Production Systems and Computer Integrated Manufacturing", Groover M.P., Prentice Hall of India Pvt., New Delhi, 1996.
8. "Manufacturing Engineering and Technology", Kalpakjian, Addison-Wesley Publishing Co., 1995.