Rajasthan Technical University (RTU)
Production and Industrial Engineering

YEAR II / SEMESTER III

THEORY

S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	3PI1	Mech. of Solids	3	1	100	3
2.	3PI2	Material Science & Engg.	2	0	100	3
3.	3PI3	Engg. Thermodynamics	3	1	100	3
4.	3PI4	Manufacturing Processes	3	0	100	3
5.	3PI5	Object Oriented Programming in C ++	3	0	100	3
6.	3PI6	Advanced Engg. Mathematics	2	1	100	3
		Total	16	3	600	-

PRACTICALS AND SESSIONALS

S. No.	Code No.	Subject	T/S	P	MM
7.	3PI7	Strength of Material Lab	0	2	50
8.	3PI8	Material Science lab	0	2/2	50
9.	3PI9	Thermal Engg. lab – 1	0	2	50
10.	3PI10	Production Engg. Practice	0	3	75
11.	3PI11	Computer Programming lab.	0	2	50
12	3PI12	Machine Drawing	0	3	75
13.	3PIDC	Discipline & Extra Curricular Activities	0	0	50
		Total	0	13	400
				Grand Total	1000

Rajasthan Technical University (RTU)
Production and Industrial Engineering

YEAR II / SEMESTER IV

THEORY

S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	4PI1	Design of M/C Elements - I	3	0	100	3
2.	4PI2	Theory of Machines	3	1	100	3
3.	4PI3	Fluid Engineering	3	1	100	3
4.	4PI4	Machining & Machine Tools	3	0	100	3
5.	4PI5	Measurement and Metrology	3	0	100	3
6.	4PI6	Principles & Practices of Management	2	0	100	3
		Total	17	2	600	-

PRACTICALS AND SESSIONALS

S. No.	Code No.	Subject	T/S	P	MM
7.	4PI7	Machine Design	0	2	50
8.	4PI8	Theory of Machines lab	0	2	50
9.	4PI9	Fluid Mechanics lab	0	2	50
10.	4PI10	Production Practice –II	0	3	75
11.	4PI11	Computer Programming lab – II	0	2	75
12	4PI12	Communication Skill Workshop I	0	2	50
13.	4PIDC	Discipline & Extra Curricular Activities	0	0	50
		Total	0	13	400
				Grand Total	1000

Rajasthan Technical University (RTU)
Production and Industrial Engineering

YEAR III / SEMESTER V

THEORY

S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	5PI1	Welding Technology and Nondestructive testing	3	0	100	3
2.	5PI2	Work System design and Ergonomics	3	0	100	3
3.	5PI3	Operations Research	3	1	100	3
4.	5PI4	Tool Engineering	3	1	100	3
5.	5PI5	Thermal Engineering	3	1	100	3
6.	5PI6	Applied Probability and Statistics	3	1	100	3
		Total	18	4	600	-

PRACTICALS AND SESSIONALS

S. No.	Code No.	Subject	T/S	P	MM
7.	5PI7	Work System design and Ergonomics lab	0	3	100
8.	5PI8	Metrology Lab	0	2	75
9	5PI9	Computer Graphics Lab	0	2	75
10.	5PI10	Metal cutting Lab	0	3	100
11.	5PIDC	Discipline & Extra Curricular Activities	0	0	50
		Total	0	10	400
				Grand Total	1000

Total Hours	L	T	P
32	18	04	10

Rajasthan Technical University (RTU)
Production and Industrial Engineering

YEAR III / SEMESTER VI

THEORY

S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	6PI1	Design of machine Elements -II	3	1	100	3
2.	6PI2	Industrial Economics	3	0	100	3
3.	6PI3	Operation Management	3	1	100	3
4.	6PI4	Metal forming	3	0	100	3
5.	6PI5	Quality Control and Design of Experiments	3	1	100	3
6.	6PI6	IC Engines and Automobile Engineering	3	1	100	3
		Total	18	4	600	-

PRACTICALS AND SESSIONALS

S. No.	Code No.	Subject	T/S	P	MM
7.	6PI7	Quality control Lab.	0	3	100
8.	6PI8	Machine Design II	0	2	75
9.	6PI9	Metal forming and tool design Lab.	0	3	100
10.	6PI10	Mechanical Engineering Lab	0	2	75
9.	6PIDC	Discipline & Extra Curricular Activities	0	0	50
		Total	0	10	400
				Grand Total	1000

Total Hours	L	T	P
32	18	04	10

Rajasthan Technical University (RTU)
Production and Industrial Engineering

YEAR IV / SEMESTER VII

THEORY

S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	7PI1	Reliability and Maintenance Engineering	3	1	100	3
2.	7PI2	Total Quality Management	3	1	100	3
3.	7PI3	Project Management	3	1	100	3
4.	7PI4	Newer Machining Methods	4	0	100	3
5.	7PI5	Facilities Planning	3	0	100	3
6.	7PI6	Elective: i. Design and manufacturing of Plastic Products ii. Mechatronics iii. Computer Aided Design	3	0	100	3
		Total	19	3	600	-

PRACTICALS AND SESSIONALS

S. No.	Code No.	Subject	T/S	P	MM
7.	7PI7	Machine Tool Design Sessional	0	3	100
8.	7PI8	Industrial Engineering Lab	0	3	100
9.	7PI9	Practical Training and Industrial Visit*	0	2	100
10.	7PI10	Project stage-I	0	2	50
11.	7PIDC	Discipline & Extra Curricular Activities	0	0	50
		Total	0	10	400
				Grand Total	1000

Total Hours	L	T	P
32	19	03	10

* Industrial visit (20 marks) is for the duration of 10 days at the end of V semester and Practical Training (80 marks) is for the duration of 30 days at the end of VI semester. Both will be evaluated during the VII semester.

Rajasthan Technical University (RTU)
Production and Industrial Engineering

YEAR IV / SEMESTER VIII

THEORY

S. No.	Code No.	Subject	L	T	MM	Ex. Hrs.
1.	8PI1	Modeling and Simulation	3	1	100	3
2.	8PI2	Computer Integrated Manufacturing system	4	0	100	3
3.	8PI3	Industrial Automation and Robotics	4	0	100	3
4.	8PI4	Elective: i. Rapid Prototyping ii. Management Information Systems iii. Product Design and Launching	4	0	100	3
		Total	15	1	400	-

PRACTICALS AND SESSIONALS

S. No.	Code No.	Subject	T/S	P	MM
7.	8PI5	CAM Lab.	0	3	100
8.	8PI6	Simulation Lab	0	3	100
9.	8PI7	Automation & Robotics Lab	0	2	50
10.	8PI8	Seminar	0	2	100

11.	8PI9	Project stage- II	0	4	200
12.	8PIDC	Discipline & Extra Curricular Activities	0	0	50
		Total	0	14	600
				Grand Total	1000

Total Hours	L	T	P
30	15	01	14

Syllabus for 3rd Semester (II Year) B.tech. (Production and Industrial Engineering)

3PI1: MECHANICS OF SOLIDS

3L+1T MM: 100 Ex Hrs: 3

Unit – 1

Stress & strain: Tension, compression, shearing stress & strain; Poisson's ratio: Stress-strain relationship, Hooke's law; equations of static = w for 2D & 3D cars Elastic constants and their relations for a isotropic hookean material, anisotropy & orthotropy, thermal stresses, composite bars; simple elastic, plastic & visco-elastic behavior of common materials in tension and compression test, stress-strain curves. Concept of factor of safety & permissible stress. Conditions for equilibrium. Concept of free body diagram; Introduction to mechanics of deformable bodies.

Unit – 2

Members subjected to flexural loads: Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams. Bending stresses, Section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc.

Unit – 3

Principal planes, stresses & strains: Members subjected to combined axial, bending & Torsional loads, maximum normal & shear stresses; Concept of equivalent bending & equivalent twisting moments: Mohr's circle of stress & strain.
Theories of Elastic Failures: The necessity for a theory, different theories, significance and
comparison, applications.

Unit – 4

Torsion: Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity.
Stability of equilibrium: Instability & elastic stability. Long & short columns, ideal strut, Euler's formula for crippling load for columns of different ends, concept of equivalent length,

eccentric loading, Rankine formulae and other empirical relations.

Unit – 5

Transverse deflection of beams: Relation between deflection, bending moment, shear force and load, Transverse deflection of beams and shaft under static loading, area moment method, direct integration method: method of superposition and conjugate beam method. Variational approach to determine deflection and stresses in beam. Elastic strain energy: Strain energy due to axial, bending and Torsional loads; stresses due to suddenly applied loads; use of energy theorems to determine deflections of beams and twist of shafts. Castigliano's theorem. Maxwell's theorem of reciprocal deflections.

3PI2: MATERIAL SCIENCE AND ENGINEERING

2L+0T MM: 100 Ex Hrs: 3

UNIT 1

Atomic structure of Metals: Crystal structure, crystal lattice of (i) Body centred cubic (ii) Face centred cubic (iii) Closed packed hexagonal, crystallographic Notation of atomic planes and Directions (Miller Indices), polymorphism and allotropy, Crystal imperfection.

UNIT 2

Theories of plastic deformation. Phenomenon of slip, twinning and dislocation. Identification of crystallographic possible slip planes and direction in FCC, BCC, HCP. Recovery and recrystallization, preferred orientation causes and effects on the property of metals.

UNIT3

Classification of engineering materials. Solidification of metals and of some typical alloys: Mechanism of crystallisation (I) nuclear formation (ii) crystal growth. General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, Binary isomorphous alloy system, Hume-Rothery rule, Binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with a peritectic transformation. Equilibrium diagram of a system whose components are subject to allotropic change. Iron carbon

Equilibrium diagram, phase transformation in the iron carbon diagram (I) Formation of Austenite (ii) Transformation of Austenite into pearlite (iii) Martensite transformation in steel, TTT curves.

UNIT 4

Engineering properties and their measurements. Principles and applications of annealing, normalising, hardening, tempering. Recovery and recrystallization. Hardenability -its measures, variables, effecting Hardenability, methods, for determination of Hardenability. Over-heated and Burnt steel, its causes and remedies. Temper brittleness -its causes and remedies. Basic principles involved in heat treatment of plain carbon steel, alloy steels, cast iron and Non-ferrous metals and their alloys. Chemical Heat treatment of steels: Physical principles involved in chemical heat treatment procedure for carburizing, Nitriding, Cyaniding, carbo-nitriding of steel.

UNIT 5

Effects produced by Alloying element on the structures and properties of steel Distribution of alloying elements (Si, Mn, Ni, Cr, Mo, Co, W, Ti, Al) in steel, structural classes of steel. Classification of steels, BIS Standards. Fibre reinforced plastic composites**:** Various fibres and matrix materials, basic composite manufacturing methods, applications of composite materials.

3PI3: ENGINEERING THERMODYNAMICS

3L+1T MM: 100 Ex Hrs: 3

UNIT 1

Basic Concepts of Thermodynamics :Thermodynamics system, control volume, Properties, state, processes and cycle, equality of temperature, Zeroth Law of thermodynamics, temperature scale, laws of perfect gas, Pure substances, vapour-Liquid –solid-phase equibrium in a pure substances, thermodynamic surfaces

UNIT 2

Work and heat, Law of conservation of mass and energy, First law of thermodynamics, steady state Processes, Second law of thermodynamics, Heat engine, Carnot cycle, thermodynamic temperature scale, entropy, change of entropy for different processes, equivalence of Kelvin plank and clausius statements, clausius inequality.

UNIT 3

Available and unavailable energy, availability of a non flow and steady flow system, Helmbeltz and Gibb's functions, Thermodynamic Relations: Important mathematical relations, Maxwell relations, T-ds Relations, Joule-Thomson coefficient, Clayperon relation.

UNIT 4

Air – standard power cycle, Brayton cycle, Otto cycle, diesel cycle, Dual cycle, Stirling cycle, Ericssion cycle and Atkinson cycle, Mean effective pressure and efficiencies, Four stroke petrol and diesel engine, Two stroke Petrol and diesel engine.

UNIT 5

Properties of steam, phase change process, use of steam table & molier char. Rankine cycle, Reheat cycle, Regenerative cycle, cogeneration vapour compression refrigeration cycle.

3PI4: MANUFACUTRING PROCESSES

3L+0T MM: 100 Ex Hrs: 3

UNIT 1

Importance of manufacturing, economic and technological definition of manufacturing, survey of manufacturing processes. **Foundry Technology:** Patterns practices: Types of patterns, allowances and material used for patterns, moulding materials, moulding sands, Moulding sands; properties and sand testing; grain fineness; moisture content, clay content and permeability test, core materials and core making, core print; core boxes, chaplets, gating system design. Moulding practices**:** Green, dry and loam sand moulding, pit and floor moulding; shell moulding; permanent moulding; carbon dioxide moulding.

Casting practices: Fundamental of metal casting, sand casting, Shell-Mould casting, mold casting (plaster and ceramic), investment casting, vacuum casting, Permanent mould casting, slush casting, pressure casting, die casting, centrifugal casting, continuous casting, squeeze casting, casting alloys, casting defects, design of casting, gating system design, and riser design. Melting furnaces-rotary, pit electric, tilting and cupola.

UNIT 2 Metal Joining Processes: Principle of welding, soldering, brazing and adhesive bonding. Survey of welding and allied processes. Arc welding: power sources and consumables. Gas welding and cutting: Processes and equipments. Resistance welding: principle and equipments. Spot, projection and seam welding process. Atomic hydrogen, ultrasonic, plasma and laser beam welding, electron beam welding, and special welding processes
e.g. TIG, MIG, friction and explosive welding, welding of C.I. and Al, welding defects. Electrodes and Electrode Coatings

UNIT 3

Forming and Shaping Processes: Metal working, elastic and plastic deformation, concept of strain hardening, hot and cold working, rolling, principle and operations, roll pass sequence, forging, forging operations, extrusion, wire and tube drawing processes. Forging: Method of forging, forging hammers and presses, principle of forging tool design, cold working processes-Shearing, drawing, squeezing, blanking, piercing, deep

drawing, coining and embossing, metal working defects, cold heading, riveting, thread rolling bending and forming operation.

UNIT 4

Powder Metallurgy: Powder manufacturing, mechanical pulveriz ation, sintering, Electrolytic Process, chemical reduction, atomization, properties of metal powders, compacting of powders sintering, advantages and applications of P/M.

Rapid Prototyping Operations: Introduction, subtractive processes, additive processes, Virtual Prototyping and applications

UNIT 5 Plastic Technology: Introduction, Classification of Plastics, Ingredients of Moulding compounds, General Properties of Plastics, Plastic part manufacturing processes such as compression moulding, transfer moulding, injection moulding, extrusion moulding, blow moulding, calendaring, thermoforming, slush moulding, laminating

3PI5: OBJECT ORIENTED PROGRAMMING IN C++

3L+0T MM: 100 Ex Hrs: 3

UNIT 1

Introduction to Object Oriented Programming: Basic concepts: Class, Object, Method, Message passing, Inheritance, Encapsulation, Abstraction, Polymorphism.

UNIT 2

Basics of C++ Environment: Variables; Operators; Functions; user defined, passing by reference, passing an array to the function, inline function, scope, overloading; Pointers: objects and lvalue, arrays and pointers, the new and delete operators, dynamic arrays, arrays of pointers and pointers to arrays, pointers to pointers and functions; Strings: String I/O, character functions in ctype.h, string functions in string.h.

UNIT3

Object oriented concepts using C++: Classes: Member functions, Friend functions, Constructors, Access functions, Private member functions, class destructor, static data and function members; Overloading: inline functions, this operator, overloading various types of operators, conversion operators; the String Class; Composition and Inheritance: Hierarchy and types of inheritance, protected class members, private versus protected access, virtual functions and polymorphism, virtual destructors, abstract base classes.

UNIT 4

Templates and Iterators: function and class templates, container classes, subclass templates, iterator classes; Libraries: standard C++ library, contents of a standard C

headers, string streams, file processing: Files and streams classes, text files, binary files, classification of files, the standard template library.

UNIT 5

Data Structures Using C++: Linked lists – Singly linked list, Doubly linked lists, Circular lists, Stacks and Queues priority Queues, Stacks, Queues.

3PI6: ADVANCED ENGINEERING MATHEMATICS

2L+1T MM: 100 Ex Hrs: 3

Unit- 1 Fourier Series and method of separation of variables (Boundary value problems)

Expansion of simple functions in Fourier series, half range series, change of interval, Harmonic analysis.
Application to the solution of wave equation and diffusion equation in one dimension and Laplace's equation in two dimensions by method of separation of variable

Unit-2 Laplace Transform

Laplace Transform with its simple properties . Inverse Laplace transform convolution Theorem (without proof) solution of ordinary differential equation with constant coefficient .

Unit-3 Special functions.

Bessel's function of first kind, simple recurrence relations, orthogonal property. Legendre's function of first kind simple recurrence relations, orthogonal property , Rodrigue's formula.

Unit – 4 Numerical Analysis

Finite differences , Difference operators , forward, Backward, central & average operators. Newton's forward and backward interpolation formula, Stirling's central difference formula Lagrange's interpolation formula for unequal interval. Solution of non linear equations in one variable by Newton Raphson's and Regula falsi's method .

Unit-5 Numerical Analysis

Numerical solution of simultaneous algebric equation by Gauss elimination and Gauss seidel method.
Numerical differentiation , Numerical integration trapezoidal rule , Simpson's one third and three eight rule. Numerical solution of ordinary differential equation of first order:

Picards method, Euler's , and modified Euler's ,method, Milne's methods and Runga Kutta fourth order method..

3PI7: STRENGTH OF MATERIALS LAB

2 Periods

MM: 50

. Izod Impact testing.
. Rockwell Hardness Testing.
. Spring Testing
. Column Testing for buckling
. Torsion Testing
. Tensile Testing
. Compression Testing
. Shear Testing
. Brinell Hardness Testing

1. 10. Bending Test on UTM.
2. 11. Study of Fatigue Testing Machine.

3PI8: MATERIAL SCIENCE AND HEAT TREATMENT LAB

2/2 Periods
MM: 50

1. 1. Study of Engineering Materials and crystals structures. Study of models BCC, FCC, HCP and stacking sequence, tetrahedral and octahedral voids.
2. 2. To calculate the effective number of atoms, co-ordination number, packing factors, c/a ratio for HCP structure.
3. 3. Study of brittle and ductile fracture.
4. 4. To prepare metallic samples for metallographic examination and to study the principle and construction of the Metallurgical Microscope.
5. 5. Study of the following Micro structures: Hypo, Hyper and Eutectoid Steel, Grey, White, Nodular and Malleable Cast Iron.
6. 6. Annealing of Steel -Effect of annealing temperatures and time on hardness.
7. 7. Study of Microstructure and hardness of steel at different rates of cooling. Microstructure examination of white cast iron.
8. 8. Hardening of steel, effect of quenching medium on hardness.
9. 9. Effect of Carbon percentage on the hardness of Steel.
10. 10. Study of various crystal structures and dislocations through models.
11. 11. Study of Iron-Carbon Equilibrium Diagram and sketch the various structures present at room temperature.

3

PI9:
THERMAL
ENGINEERIN
G LAB 1
2 Periods
MM: 50

1. 1. Comparative study of four stroke diesel and petrol engines.
2. 2. Comparative study of two stroke petrol and diesel engines.
3. 3. Studies of fuel supply systems of diesel and petrol engines.
4. 4. Study of cooling, lubrication and ignition system in diesel and petrol engines.
5. 5. To study various types of Boilers and to study Boiler mounting and accessories.
6. 6. To study various types of Dynamometers.
7. 7. To study Multi Stage Air Compressors.
8. 8. To find the BHP, Thermal efficiency of four stroke diesel engine.
9. 9. Study of Brakes, Clutches, and Transmission System.
10. 10. To prepare a comparison sheet of various automobiles (4 Wheeler and 2 Wheeler).

3PI10: PRODUCTION PRACTICE I

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3 Periods

MM: 75

. Study of lathe machine, lathe tools cutting speed, feed and depth of cut.
. To perform step turning, knurling and chamfering on lathe machine as per drawing.
. Taper turning by tailstock offset method as per drawing.
. To cut metric thread as per drawing.
. To perform square threading, drilling and taper turning by compound rest as per drawing.
. To study shaper machine, its mechanism and calculate quick return ratio.

Foundry Shop

1. 1. To prepare mould of a given pattern requiring core and to cast it in aluminium.
2. 2. Moisture test and clay content test.
3. 3. Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core).
4. 4. Permeability Test.
5. 5. A.F.S. Sieve analysis Test.

3

PI11:
COMPUTER
PROGRAMMIN
G LAB I
2 Periods
MM: 75

List of programs in C:

1. 1. Program for revising control statements, arrays and functions.
2. 2. Program using string handling and various functions described in string.h, ctype.h.
3. 3. Program using structures and sorting algorithm (Insertion, Selection, Quick, Heap sort) and functions described in math.h.
4. 4. Program using file handling and related functions defined in stdio.h, io.h.
5. 5. Program using pointers, array and pointers, pointers to structures, dynamic memory allocation.

List of Programs in C++

1. 6. Program using basic I/O and control statements.
2. 7. Program using class, objects, objects as function parameters.
3. 8. Program using functions and passing reference to a function, inline functions. Program using Inheritance and virtual base class.
4. 9. Program using pointers, arrays, dynamic arrays. Program using functions defined in ctype.h and stringh.
   10. Program using constructors, destructors. Program using function and operator over loading

   List of program in C++ implementing Data Structures
5. 11. Creating and managing (add, delete, print, insert) nodes of a Linked list.
6. 12. Creating and managing (create, pop, push etc.) stacks and queues.

Note: Students should submit and present a minor project at the end of the lab.

3

PI12:
MACHINE
DRAWING
3 Periods
MM: 50

Detail drawings:
Couplings: Pin-type flexible coupling etc,
IC. Engine parts: connecting rod, crank shaft, etc,
Boiler Mountings: Steam stop valve/ feed check-valve/ safety valve /three way stop valve blow off-cock.
Bearings: Swivel bearing
Machine Tool Parts: Shaper tool head, Lathe Tail Stock, Turret Tool Post, Turret Bar feeding Mechanism / Universal Dividing Head, Swivel machine vice.
Miscellaneous: Screw jack and drill-press vice.
Free Hand Sketches: Pipes and Pipe fittings, clutches, bearings, bearing puller, valve gear mechanisms, machine arbor and cutter, universal dividing head, jigs and fixtures, Step less drive , sliding gear box.

Syllabus for 4th Semester (II Year) B.Tech. (Production and Industrial Engineering)

4PI1: DESIGN OF MACHINE ELEMENTS-I

3L+0T MM: 100 Ex Hrs: 3

UNIT -1
Materials: Properties and IS coding of various materials, Selection of material from properties and economic aspects.

Manufacturing aspects in Design : Selection of manufacturing processes on the basis of design and economy, Influence of rate of production, standard size, Influence of limits, fits tolerances and surface finish. Change in the shape of the designed element to facilitate its production, Design of castings, working drawing.

UNIT -2
Design for strength: Allowable stresses, detailed discussion on factor of safety (factor of ignorance):
Stress concentration. Causes & mitigation. Introduction of various design considerations like strength, stiffness, weight, cost, space etc. Concept of fatigue failures.
Design of machine elements subjected to direct stress, Pin, cotter and keyed joints, Design of screw
fastening.

UNIT -3
Design of members in Bending: Beams, levers and laminated springs.

UNIT -4
Design of members in torsion : Shafts and shaft couplings.

UNIT -5
Design of shafts, brackets under combined stresses, Calculation of transverse & torsional deflections. Screw fasteners subjected to eccentric loading.

4PI2: THEORY OF MACHINES

3L+1T MM: 100 Ex Hrs: 3

UNIT 1
Introduction to mechanism: Basic concept of machines, links, kinematic pair, kinematic chain and mechanism.

Inversions of kinematic chains: four bar chain mechanisms, quick return mechanisms, inversions of double slider crank mechanisms.
Velocity and acceleration in mechanism: Velocity and acceleration polygons, Coriolis component, relative velocity and instantaneous centre method.

UNIT 2
Automotive vehicle mechanisms: law of correct steering, Davis and Ackerman steering mechanism, Hooke's joint.
Pantograph and straight line mechanism: Scott-Russel, Tchebicheff, Peaucellier and Watt mechanism.
Friction devices: Types and laws of friction. Pivots and collars. Power screws such as lead screw of the lathe, Single and multi-plate and cone clutches.
Brakes: Band, block and band and block brakes.
Power transmission: Belts and ropes, effect of centrifugal force and creep.

UNIT 3
Gears: Laws of gearing, gears terminology; tooth form; interference, undercutting and minimum number of teeth on pinion in contact with gear. Spur, helical, bevel, worm and worm gears, rack and pinion.
Gear Trains: Simple, compound and epicyclic gear trains.
Gear boxes-sliding and constant mesh gear box for automobile.

UNIT 4
Cams: Type of cams; displacement, velocity and acceleration curves for different followers; consideration of pressure angle and wear; Analysis of motion of follower for cams with specified contour.
Flywheel: Turning moment diagram, calculations for flywheel.
Governors: Simple, Porter, Proell, Hartnell and spring controlled governors, Governor effort, sensitivity and power stability, inertia effects.

UNIT 5
Balancing: Balancing of rotating masses in same and different planes, balancing of reciprocating masses, swaying couple, hammer blow and tractive effort, balancing of machines.
Gyroscope: Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicles taking a turn, stabilization of ship.

4PI3: FLUID ENGINEERING

3L+1T MM: 100 Ex Hrs: 3

UNIT 1
Basic concept relating to fluids: Definitions -incompressible and compressible fluids. Density, Relative density, viscosity, Kinematic viscosity. Newtonian and Non Newtonian fluids, effect of temperature and pressure on viscosity. Ideal fluid, Compressibility and Elasticity of fluids and surface tension.

UNIT 2
Static pressure and its Measurement: Pascals law, Manometers. Fluid Statics: Total

pressure, centre of pressure, Problems on plane and Curved surface. Definition of Buoyancy, Centre of buoyancy. Metacentre and Metacentric height.
Fluid Kinematics: Definitions, steady and unsteady flow, uniform and non uniform flow, one,
two and three dimensional flow, Rotational and Irrorational flow, Streamline, path line and
streak line. Continuity equation in Cartesian and polar coordinates, Circulation and vorticity,
stream function, velocity potential, vortex flow.

UNIT 3

Fluid Dynamics: Euler's equation of motion -Bernoullis equation, application of Bernoulli's equation -Verturimeter, Orifice meter, pitot tube, orifices, mouthpiece and time of emptying tanks. Momentum equation -application of the momentum equation, Pipe bends curves vanes. Compressible Flow

UNIT 4

Flow through pipes: Reynolds experiment Critical velocities, Pipes in series and parallel. Dimensional Analysis: Bukingham -π theorem, Dimensionless numbers, Model similitude, Types of model, scale effect and model testing.

UNIT 5

Hydraulic Turbine: Euler's Fundamental equation. Classification of turbine, Pelton wheel, Francis turbine Kaplan turbine, Velocity Triangles, Power and efficiency calculation, draft tube and cavitation, Specific speed.
Centrifugal Pump : Classification of centrifugal pumps, velocity diagram, specific speed, head, power and efficiency. Reciprocating Pump : Indicator diagram, slip, effect of friction
and acceleration, theory of air vessels. Hydraulic accumulator, intensifier, Hydraulic ram.

4PI4: MACHINING AND MACHINE TOOLS

3L+0T MM: 100 Ex Hrs: 3

UNIT 1

Classification of metal removal process and machines Mechanics of metal cutting: Geometry of single point cutting tool and tool angles. Tool nomenclature in ASA, ORS, NRS and interrelationship. Mechanism of chip formation and types of chips, chip

breakers. Orthogonal and oblique cutting, cutting forces and power required, theories of metal cutting. Thermal aspects of machining and measurement of chip tool interface temperature. Friction in metal cutting.

UNIT 2

Machinability: Concept and evaluation of machinability, tool life, mechanisms of tool failure,
tool life and cutting parameters, machinability index, factors affecting machinability. Cutting
fluids: Types, properties, selection and application methods
General Purpose Machine Tools: Classification and constructional details of lathe, drilling,
milling, shaping and planning machines. Tooling, attachments and operations performed, selection of cutting parameters, calculation of forces and time for machining. Broaching operation.

UNIT 3

Special Purpose Machine Tools: Automatic lathes, capstan and turret lathe machines. Swiss automatic, operational planning and turret tool layout, sequence of operations. Tracer
attachment in Machine Tools: mechanical-copying machines; Hydraulic Tracing Devices; Electric Tracing systems; Automatic tracing.

Abrasive processes: Abrasives; natural and synthetic, manufacturing, nomenclature. Selection of grinding wheels, wheel mounting and dressing, characteristic terms used in grinding. Machines for surface and cylindrical grinding, their constructional details and processes.
Surface finishing: Honing, lapping, superfinishing, polishing and buffing processes.

UNIT 4

Thread Manufacturing: casting; thread chasing; thread cutting on lathe; thread rolling, die
threading and tapping; thread milling; thread grinding.
Gear Manufacturing Processes: hot rolling; stamping; powder metallurgy; extruding etc. Gear generating processes: gear hobbling, gear shaping. Gear finishing processes: shaving, grinding, lapping, shot blasting, phosphate coating, Gear testing.

UNIT 5

High Velocity Forming Methods: (High-energy rate forming processes) Definition; Hydraulic forming, Explosive forming, Electro-hydraulic forming, Magnetic pulse forming.
Industrial Safety: Human factor in machine equipment safety; reducing industrial noise; precautions to be taken by operators for safe working on different machine tools.

4PI5: MEASUREMENT AND METROLOGY

3L+0T MM: 100 Ex Hrs: 3

UNIT 1
An Overview of the process of Measurement, Significance of mechanical measurement, Fundamental methods of measurement, Generalized measuring system, Type of input quantities, Measurement standards. Response of measuring systems: Introduction, Amplitude, Frequency and Phase response. Sensors: Transducer, strain gauge, Thermister, thermocouple, Piezoelectric sensors, Semiconductor sensors, light-detecting transducers, Hall-Effect sensors. Amplifiers: Vacuum-Tube, Solid-state, Integrated, Operational amplifiers. Digitizing Mechanical Inputs, Fundamental digital circuit elements, Analog-to-Digital and Digital-to-Analog conversion. Cathode-ray Oscilloscope (CRO), Oscillographs, XY Plotters, Spectrum analyzer, data logger, errors in measurements.

UNIT 2
Strain and Stress Measurement using strain gauge. Force and Torque Measurement : Mechanical weighing systems, Elastic transducers, Strain-gauge and Piezoelectric load cells, Hydraulic and Pneumatic systems. Mechanical, hydraulic, Electric and Transmission dynamometers. Pressure Measurement: Static and dynamic pressures, Pressure-measuring systems, pressure-measuring transducers – Gravitational and elastic type, Elastic diaphragms-Flat metal and corrugated Bourdon gauges. Fluid Flow Measurement: Obstruction meters, Additional flow meters, Thermal Anemometry

UNIT 3
Temperature Measurement: Use of bimaterials, pressure thermometers, Thermo resistive elements, semiconductor-Junction temperature sensors, pyrometer. Motion Measurement: Vibrometers and Accelerometers, seismic instrument. Velocity Measurement: Tachometers, stroboscope and Laser velocity transducer. Acoustic Measurement: Microphones, Sound level meter, Frequency spectrum analysis, Discrete Fourier transform

UNIT 4
Definition and concept of metrology, Concept of precision, accuracy, interchangeability and repeatability, Tolerance and fits, Dimensioning and dimensional chains, Process and errors in measurement. Concept of flatness, straightness, parallelism, squareness, roundness, circularity, runout and concentricity, Measurement of surface finish: Definition of terms, Relation among the various Indices of surface roughness, Ideal and final roughness in machining, Influences of machining parameters on surface roughness,

Correlation of $R$with h. The concept of form factor, $F$and Bearing area curves, Bearing area curves,

$amax$

Surface texture – Primary and secondary, Some observations on surface texture measurement, texture measurement with stylus type instruments, Tomlinson surface meter, Talysurf and profilograph, cut-off length, Magnitude of roughness from various machining processes.

UNIT 5
Linear measuring instruments: Vernier, micrometers, Limit gauges, height and depth gauge as per Indian standards. Comparators, Projectors and Microscopes, Angle measuring instruments: sine bar, bevel

protractor, angle blocks, autocollimators. Screw thread metrology: Elements of Screw thread metrology, measurement of external and internal screw thread. Gear metrology: element of gear teeth metrology, Vernier gear tooth caliper, Parkinson gear tester, Interferometry, Co-ordinate measuring machine (CMM)

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4PI6: PRINCIPLES AND PRACTICES OF MANAGEMENT

2L+0T MM: 100 Ex Hrs: 3

UNIT 1

Management: Definition including conceptual analysis, functions. Evolution of management thought, scientific management, contributions of Taylor, Gilbert, Gantt, Elton Mayo, Henry Fayol and others. Management process and systems approach to Management, functions of managers. Levels of management, Administration and Management. Decision making.

UNIT 2

Forms of ownership:

Proprietorship, partnership, joint stock company, private and public limited companies. Formation of Joint Stock Companies: Registration, Issue of Prospectus and commencement certificate. Co -operative Society, choice of business forms and state undertakings. Multinational corporations and International management

Planning: Managerial planning, Type of plans, steps in planning; mission, objectives, strategies, policies, procedures, rules and programmes. Managing by objectives, strategic planning process, SWOT analysis.

UNIT 3

Organizing: Meaning of organizing and organization, formal and informal organization, span of management, process of organizing. Organizational structure: Line organization, functional organization, matrix organization, strategic business units. Line/Staff concepts, empowerment, and decentralization, delegation of authority. Effective organizing and organizational culture.

Staffing: overview, factors affecting staffing, systems approach, job design, selection, skills of manager. Performance appraisal, rewards. Career strategy, managerial training. Managing change.

UNIT 4

Human factors in managing Motivation : Theory X, Theory Y, Maslow's hierarchy of needs, Hertzberg's hygiene theory, expectancy, porter and Lawler model, equity theory, Reinforcement theory, McClelland's theory behavioral model. Motivational techniques, job enrichment.

Leadership : traits, approaches situational, contingency, path goal approach, transactional and transformational leadership.

UNIT 5

Group decision making: Reasons for using Committees and groups, successful operation of committees and groups, working in teams.

Communication: purpose, process of communication, communication flow in the organization, barriers to communication, Improvement of communication; role of electronic media in communication.

Controlling: Basic control process, feed forward and feedback control, performance measures and control, requirement of effective control, use of Information Technology for control

4

PI7:
MACHINE
DESIGN
2 Periods
MM: 50

1. 1. Selection of material IS Coding
2. 2. Selecting fit and assigning tolerances
3. 3. Problems on

- .(a) Knuckle and Cotter joints
- .(b) Torque : Key and shaft couplings
- .(c) Bending: Beams, Levers etc.
- .(d) Combined stresses: Shafts, Brackets, eccentric loading bolts etc.

4

PI8: THEORY
OF
MACHINES
LAB
2 Periods
MM: 50

1. 1. To verify the relation $T = I.\omega.\ \omega p$ on a Gyroscope and to find Ifor given gyroscope disc.
2. 2. To plot pressure distribution curve for Journal bearing along its length as well as along circumference at any section. (Towers Experiment)

3. 3. To draw displacement Vs angle of rotation for Cam follower Mechanism.
4. 4. To plot F vs. R curves for various governors.
5. 5. Study of quick return mechanisms and inversions of double slider mechanism.
6. 6. To determine natural frequency of spring mass system.
7. 7. To determine natural frequency of Equivalent spring mass system.
8. 8. To conduct experiment of trifler suspension.
9. 9. To determine natural frequency of Free torsional vibrations of single rotor system Horizontal rotor and Vertical rotor
10. 10. Study of free damped torsional vibration: performing the experiment to find out damping co-efficient.
11. 11. To determine natural frequency of (a) simple pendulum (b) compound pendulum.

4

PI9: FLUID MECHANIC S LAB
2 Periods
MM: 50

1. 1. Find the metacentric height of a given body.
2. 2. Find the coefficient of discharge, coefficient of velocity and coefficient of contraction, of given orifice.
3. 3. Determine the coefficient of discharge of V-Notch
4. 4. Determine the flow rate of water by V-Notch for given value of coefficient of discharge.
5. 5. Find the velocity of fluid by Pitot tube.
6. 6. Find the flow rate of fluid by Venturimeter.
7. 7. Find the efficiency of Hydraulic ram.
8. 8. Find the head loss in pipe for given length.
9. 9. Find the flow rate by orifice meter.
10. 10. Find the Reynolds number experimentally of laminar, transient and turbulent flow.

4

PI10: PRODUCTIO N PRACTICE II
3 Periods
MM: 75

Machine Shop
1. 1. To study single point cutting tool geometry and to grind the tool to the given tool geometry.
2. 2. To study milling machine, milling cutters, indexing methods and various indexing heads.
3. 3. To prepare a gear on milling machine as per drawing.
4. 4. Prepare a hexagonal / octagonal nut using indexing head on milling machine and to cut BSW / Metric internal threads on lathe.

5. 5. To cut multi-start square / metric threads.
6. 6. To cut external metric threads and to match it with the nut.
7. 7. To prepare the job by eccentric turning on lathe machine.
8. 8. To prepare a job on shaper from given MS rod.

Welding Shop
Study of the effects of process parameters in welding

1. 1. TIG Welding
2. 2. MIG welding

4

PI11:
COMPUTER
PROGRAMMIN
G LAB II
2 Periods
MM: 75

1. 1. Write a program in C to generate all the possible permutations of a given character string of length less than or equal to 8. The string can have duplicate characters.
2. 2. Write a program in C++ to generate given number of unique random alphanumeric strings of given length.
3. 3. Write a program in C++ to search a string within a given string.
4. 4. Write a program in C++ to plot chart for the data given in a file. The chart can be bar graph, run chart, plot etc.
- .5. Write program in C++ for following numerical techniques
- .a. Numerical integration by trapezoidal and Simpson's rule.
- .b. Gauss – Seidel iteration method.
- .c. Various matrix operations and their use as sub routines.

1. 6. Write a program in C++ to implement queue using two stacks.
2. 7. Write a program in JAVA demonstrating exception handling.
3. 8. Write a program in JAVA demonstrating threads
4. 9. Write a program in JAVA demonstrating applets.
5. 10. Minor Project utilizing concepts of C/C++/JAVA. It should be an application solving a type of technical problem.

4

PI12:
COMMUNICATIO
NS SKILL
WORKSHOP I
2 Periods
MM: 50

The objective of this workshop is to improve the communication skills of the students

using case studies, practice sessions and exercises on the under mentioned topics.

1. 1. Ice Breaker Session -Introductions of the participants to each other
2. 2. Communicating Theory -one way and, two way, barrier, filters in communication.
3. 3. Body Language, Non Verbal interpretations
4. 4. Listening, Active Listening, Feed Back
5. 5. The hidden data of communication : Dealing with feelings; Assertiveness; Self confidence
6. 6. Working in teams : Team concept; Elements of team work; Formation of a team; Stages of the team of formation; Effective team; Team Player styles
7. 7. Discussions and Decision: Characteristics of good GD; Structured GD; Strategies for making Group Decisions
8. 8. Presentations: Public Presentation Techniques and practice.
9. 9. Ethics and etiquette: Ethics; dealing with ethical dilemma; Dress, Dining etiquette; Email, communicating etiquettes
10. 10. Report making and presentation

III B.E. (Production and Industrial Engineering)
V Semester

5PIE1: WELDING TECHNOLOGY AND NONDESTRUCTIVE TESTING

3L+0T MM: 100 EX. HRS. 3

UNIT 1:-

Types of joints, welding joint, safety feature in welding, classification of welding, metallurgy of welding, weldability and weldability testing, welding symbols, Gas welding, soldering and brazing, welding joint design, V- formation in butt joint, Pre-heating of welding surface and its temperature measurements.

UNIT 2:-

Arc welding, welding electrodes, selection of welding electrodes, flux, carbon arc welding, SMAW, TIG (GTAW), MIG (GMAW), CO_2 welding, flux cored arc welding (FCAW), electro slag welding and electro gas welding, plasma arc welding, spot welding, stud welding, resistance welding, seam welding, percussion welding, Arc cutting.

UNIT 3:-

Ultrasonic welding, friction welding and inertia welding, friction stir welding, forge welding, Thermit welding, electron beam welding, laser beam welding, under water welding, adhesive bonding, welding of different materials like wrought iron, cast iron, carbon steel, tool steel, stainless steel, aluminum, magnesium, copper, plastic, metal spraying, pipe welding.

UNIT 4:-

Defects in welding, causes of welding defects, distortion, stress relief and heat treatment of weldments, welding jigs and fixtures, inspection and testing of welds, destructive testing method, tensile test, compression test, bend test, impact test, hardness test, allowable stresses, estimation of welding cost, codes used in welding.

UNIT 5:-

Non destructive testing methods : visual inspection, leak test, x-ray and γ-ray radiography, magnetic particle test, liquid penetration test, fluorescent penetration test, ultrasonic test, eddy-current test, allowable defects & quality control of welding as per ASME standard..

5PIE2: WORK SYSTEM DESIGN AND ERGONOMICS

3L MM: 100 EX. HRS : 3

UNIT 1:-

Work Study: Objectives of work study - work study procedure human factors in the application of work study-relationship between method study and work measurement.

UNIT 2:-

Method Study: General principles - basic steps-criteria for selecting work-samples and techniques - data collection-critical evaluation-brain storming and creativity-development of new methods and installation-principles of layout of material handling-principles of motion economy-work placed layout-examples of method study in plants and offices.

UNIT 3:-

Work Measurement: Introduction to work measurement, purpose-use of work measurement-basic procedure-time study equipment's-selection of jobs to be studied-approach to workers-steps in making a time study-number of cycles to be studied-Rating-use of rating factor-allowances-personal allowance, fatigue allowance-compiling allowed time for a job - examples of time study-synthesis from standard data. Use of work measurement techniques. Work sampling, Theory; determination of homogenous groups and number of observations-confidence limits-area of application limitations-systematic work sampling and random work sampling.

UNIT 4:-

Ancillary techniques: Pre-determined Motion standards, MTM and work factor-design of work place, design of fixtures and equipment's, standard data, TMU formula, job evaluation & merit rating.

UNIT 5:-

Ergonomics: The nature of Ergonomics; Ergonomics practice Systems concepts. Human body measurement (Anthropometry). Joints, bones, muscles. Layout of equipment. Seat design. Design of controls and compatibility.

5PIE3: OPERATIONS RESEARCH

3L + 1T MM: 100 EX. HRS. 3

UNIT 1:-

Overview of Operations Research: Linear Programming: LP formulation, graphical method, simplex method, duality and Sensitivity analysis, Transportation Model, Assignment Model..

UNIT 2:-

Integer Linear Programming, Branch & Bound Algorithms zero one Implicit Enumeration cutting Plane Algorithms. Replacement Models: Capital equipment replacement with time, group replacement of items subjected to total failure.

UNIT 3:-

Queuing Theory: Analysis of the following queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population, Single channel queue with finite customer population, Multichannel queue with finite customer population, Analysis of the queue with unlimited and limited system capacity.

UNIT 4:-

Simulation: Need of simulation, advantages and disadvantages of simulation method of simulation. Generation of Random numbers, Generation of Normal Random numbers, Generation of random numbers with any given distribution. Use of random numbers for system simulation, Application of simulation for solving queuing Inventory Maintenance, Scheduling and other industrial problems.

UNIT 5:-

Competitive Situations and Solutions: Game theory, two person zero sum game, approximate solution, simplified analysis for other competitive situations. Theory of Decision-Making: Decision making under certainty, risk and uncertainty, decision trees.

5PIE4: TOOL ENGINEERING

3L + 1T MM: 100 EX. HRS. 3

UNIT 1:-

Introduction, properties of tool material, types of tool material, basic requirement of tool material and general consideration in tool design.

UNIT 2:-

Design of material-cutting tool: Single point tools, basic principles of multiple point tools, Linear-Travel tools (Broach), Axial Feed Rotary Tools (Drill), Milling Cutters.

UNIT 3:-

Introduction to press, Press accessories, Die design fundamentals, Strip layout, Blanking and piercing Dies, Combination Dies (compound & progressive die).

UNIT 4:-

Bending Dies, Drawing and Deep drawing dies.

UNIT 5:-

Introduction to Jig & Fixtures, usefulness, Principles of Jig & Fixtures design, Principle of location, Locating and Clamping device, Basic construction principle, Drilling jigs, Brief introduction about Milling fixtures, Grinding fixtures, Broaching and Lathe fixtures.

5PIE5: THERMAL ENGINEERING

3L + 1T MM: 100 Ex. Hrs. 3

UNIT 1:-

HEAT TRANSFER: Introduction: Fourier's law of conduction, Newton Rikhman equation, Stefan Boltzman law, Overall head transfer coefficient. Conduction: Three dimensional heat flow equation- cartesian co-ordinates. One dimensional steady state conduction without heat generation, One dimensional flow through a plane wall, composite wall & tube, thick spherical shell, Critical insulation, Heat flow through fins.

UNIT 2:-

Convection: Dimensional analysis of forced and free convection, empirical relations.

Radiation: Introduction, Absorption, reflection and transmission, Monochromatic and total emissive power.

UNIT 3:-

Heat exchanger: Types of Heat Exchanger, LMTD equation for parallel and counter flow Heat Exchanger and its applications. Effectiveness - NTU Method

UNIT 4:-

Reciprocating Air Compressor, Refrigeration & Air Conditioning: Air refrigeration system, vapour compression & vapour absorption system, steam refrigeration, refrigerants, Refrigeration equipments.

UNIT 5:-

Psychrometrics: Properties of moist air, Psychrometric chart & its use, Elementary psychrometric processes. Comfort Air Conditioning.

5PIE6: APPLIED PROBABILITY AND STATISTICS

3L + 1T MM: 100 EX. HRS: 3

UNIT 1:-

Basic Concepts of probability, Conditional Probability, Baye's Theorem, Random variable, Distribution functions and density functions, Expected value and summary measures, discrete probability distributions: binomial, negative binomial, hypergeometric, Poisson etc, Continuous probability distributions; uniform, exponential, normal etc.

UNIT 2:-

Descriptive statistics: collection, presentation of data, measures of central tendency, measures of variation and skewness.

UNIT 3:-

Sampling methods, sampling distributions, sampling distributions of means, central limit theorem, sampling distributions of variance, the student's t distribution, sampling distributions of the proportion.

UNIT 4:-

Theory of Estimation: estimation, interval estimation, confidence level, confidence interval form population mean, sample size for estimating population mean and proportion.

UNIT 5:-

Theory of Statistical inference: Testing of Hypothesis, Type I and Type II errors, significance level, power curve of a test, testing of population mean, proportion, testing of difference between means, and proportion, Chi square tests, testing of population variance, Analysis of Variance. Method of least squares, Correlation and regression analysis.

5PIE7: WORK SYSTEM DESIGN AND ERGONOMICS LAB

3P **MM: 100** **Ex. Hrs: 3**

1. 1. Rating: To obtain practice in rating operators performance in Card Dealing & Walking.

- .2. Man Machine Chart
- .(a) Prepare man machine chart for drilling two holes in a plate 10 mm. thick on a radial drilling machine.
- .(b) To determine standard time for drilling a hole in MS workpiece by stopwatch method.
- .3. Two handed Process Chart
- .(a) To draw two handed process chart for bulb holder assembly and to suggest a satisfactory layout. (a) To find out standard time for assembly.
- .4. Left - Hand And Right - Hand Operation Chart
- .(a) To make left - hand and right - hand operation chart for bolts and washer assembly and
- .(b) Draw work place layout using principles of motion economy.

2. 5. Pin Board Experiment:-

A. To find out time requirement to fill the 30 holes with pins : by only right hand. (five cycles each), by only left hand (five cycles each) and. By using simultaneously both hands in a symmetrical motion. (five cycles each).

B. Determine the time required to fill 30 holes in board with pins when two boards are : together (Condition A) , 30 cm apart (Condition B) and 60 cm apart (Condition C).

C. Determine the no. of pin boards that could be filled in a 8 hour day under each of these three conditions. Assume that an operator could maintain the pace in the experiment and that no fatigue or delay Allowances are made.

D. Calculate in % how much more time was required to fill the pin board under condition B than A under condition C than A.

E. Compute the total distance in feet through which the two hands would move in

filling 1000 pin board under each of these conditions.

F. Calculate in % how much further the hands would move under condition B than A, under condition C than A.

1. 6. Process Chart and Flow Diagram To prepare a process - chart and flow diagram for filling petrol in a scooter at a petrol pump.
2. 7. To study with reference to the bulb holder assembly operation the following aspects : Learning effect, Sequence of operation, Preparation of 2-H process chart, Computing cycle time.
3. 8. To determine the normal working area, max. working area, height for a normal man (i) for the assy. of pins in a box (ii) For the assembly of Nuts, bolts and washers.
4. 9. To study the operator's performance under different working conditions (light, temp., sound, atmosphere etc.)
5. 10. Verification of Brouha's cycle

5PIE8: METOROLOGY LAB

2P MM: 75 Ex. Hrs: 2 Perform any twelve experiments :

1. 1. Study of various measuring tools like dial gauge, micrometer, vernier caliper and telescopic gauges.
2. 2. Measurement of angle and width of a V-groove by using bevel protector.
3. 3. To measure a gap by using slip gauges.
4. 4. Measurement of angle by using sine bar.
5. 5. Study and use of surface roughness instrument (Taylor Hobson make)
6. 6. Inspection of various elements of screw thread by Tool makers microscope and optical projector.
7. 7. Measurement of gear tooth thickness by using gear tooth vernier caliper.
8. 8. To check accuracy of gear profile with the help of profile projector.
9. 9. To determine the effective diameter of external thread by using three-wire method.
10. 10. To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.
11. 11. To plot the composite errors of a given set of gears using composite gear tester.
12. 12. Measurement of coating thickness on electroplated part and paint coating on steel and non-ferrous material using coating thickness gauge.
13. 13. Study and use of hardness tester for rubber and plastics.
14. 14. To check the accuracy of a ground, machined and lapped surface - (a) Flat surface (b) Cylindrical surface.
15. 15. To compare & access the method of small-bore measurement with the aid of spheres.

5PIE9: COMPUTER GRAPHICS LAB

2P MM: 75 Ex. Hrs: 2

Turbo C Graphics: To make C programs to animate different mechanisms and system: Such as Slider Crank Mechanism, Quick Return Mechanism, Cam Follower, Solar system, ball motion in billiard, Rolling of wheel from inclined plane, Seesaw motion, Projectile motion of a wheel, etc.

5PIE10: METAL CUTTING LAB

3P MM: 100 Ex. Hrs: 3

Perform any twelve experiments :

1. 1. Find out Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.
2. 2. Forces measurements during orthogonal turning.
3. 3. Estimation of Power required during orthogonal turning.
4. 4. Torque and Thrust measurement during drilling.
5. 5. Forces measurement during plain milling operation.
6. 6. Measurement of Chip tool Interface temperature during turning using thermocouple technique.

7. 7. Exercise involving cylindrical grinding on surface grinding machine.
8. 8. Study the variation of surface roughness with different speed and feed during plain milling operation on flat surface.
9. 9. Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
10. 10. Engrave a profile on given workpiece using EDM machine.
11. 11. Exercises for boring of cylindrical bores and machining of external surfaces coincident with internal bores on boring machine.
12. 12. To prepare metallic samples for metallographic examination and to study the principle & construction of the Metallurgical Microscope.
13. 13. Study of Microstructure and Hardening of steel in different medium and cooling rates.
14. 14. Effect of Carbon percentage on the hardness of Steel.
15. 15. To study the various crystal structures and dislocations through models.
16. 16. To study the Iron-Iron Carbide Equilibrium Diagram and sketch the various structures present at room temps.

5PIE11 : Discipline & Extra curricular activities

MM: 50

Rajasthan Technical University (RTU)
Production and Industrial Engineering

P& I syllabus sixth semester

6PI1 & 6ME1: DESIGN OF MACHINE ELEMENTS- II

3L+1T MM 100 Ex. Hrs: 3

Unit 1
Fatigue Considerations in Design: Variable load, loading pattern, Endurance stresses, influence of size, surface finish, notch sensitivity & stress concentration. Goodman line, Soderberg, Design of machine members subjected to combined, steady and alternating stresses. Design for finite life. Design of Shafts under Variable Stresses.

Unit 2
Pre loading of bolts; effect of initial tension & applied loads, Bolts subjected to variable stresses. Design of members which are curved like crane hook, body of C-clamp, machine frame etc. Power screws like lead screw, screw jack.

Unit 3
Design of helical compression, tension, torsional springs. Springs under variable stresses. Design of belt, rope and pulley drive system, selection of chain & sprocket drive systems.

Unit 4
Design of gear teeth, Lewis and Buckingham equations; wear and dynamic load considerations, Design and force analysis of spur, helical, bevel and worm gears. Bearing reactions due to gear tooth forces.

Unit 5
Design of sliding & journal bearing; method of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium.
Selection of anti-friction bearings for different loads and load cycles. Mounting of the bearings. Method of lubrication, selection of oil seals.

Rajasthan Technical University (RTU)
Production and Industrial Engineering

6 PI 2: INDUSTRIAL ECONOMICS

3L+0T MM 100 Ex. Hrs: 3

UNIT1
Concept and scope of Engineering Economics. Problem Solving and decision making. Time Value of Money: Interest formulae and their applications, Cash Flow Diagrams. Single and multiple payment cash flows.

UNIT 2
Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

UNIT 3
Replacement studies: current salvage value of defender, replacement due to deterioration and obsolescence. Depreciation meaning and methods of computing depreciation-Straight line method of depreciation, declining balance method of depreciation, Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation.

UNIT 4
Cost and Costs Control: Costs and Cost Accountancy: Meaning of cost and cost Accountancy (C.A.) Financial Accountancy (F.A.) comparison between C.A. and F.A. Elements of cost Direct cost and indirect cost, variable costs and fixed cost calculation of Product cost, Cost control-Techniques of cost control. Budgets- Meaning Kinds, Advantages, Budgetary control. Inflation - Causes of inflation, consequences of inflation, measuring inflation, leasing/buying decisions. Break-Even analysis, linear break-even analysis, Break-Even charts and relationships, Non-linear break-even analysis.

UNIT 5
Finance & Financial Statements: Introduction Needs of Finance, Kinds of Capital Sources of fixed capital shares -ordinary and Preference Shares. Borrow capital. Surplus

profits: Sources of Working capital, Management of working capital, Financial Institutions. Financial Statement (i) Profit & Loss Statement (ii) Balance Sheet (B.S.) Financial ratios-current ratio, Liquidity ratio, Profits investment ratio, equity ratio and Inventory turn-over ratio. Management and Financial ratio, Money conversion cycle in the Business.

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6PI3: OPERATIONS MANAGEMENT

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1
Introduction: Scope of Operations Management, operations manager and the management process. Operations Strategy, Competitiveness and Productivity.
Demand Forecasting: components of forecasting demand, Approaches to forecasting: Qualitative methods, Time series methods, Regression methods, Accuracy and control of forecasts, Selection of forecasting technique.

Unit 2
Products and Services, Process, Types of Production Systems: Mass, Batch, Job shop production. Product and process matrix. Process planning and Process analysis. Capacity Planning: Defining and measuring capacity, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives- Cost- Volume analysis etc.

Unit 3
Production Planning: Production planning objective and functions, Bill of material, Capacity and man power requirement planning, Planning levels: long range, Intermediate range and Short range planning, aggregate planning; Objective, Strategies, graphical and mathematical techniques of aggregate planning, master production scheduling, MRP and MRPII Systems

Unit 4
Production Control: Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up. Techniques of production control in job shop production, batch production and mass production systems,

Unit 5
Material Management: Objectives, scope and functions of material management, planning, procurement, storing, ending and inventory control. Purpose of inventory, inventory cost, inventory control systems, Selective inventory control systems, Determination of EOQ, Lead

time and reorder point. Methods of physical stock control

Rajasthan Technical University (RTU)
Production and Industrial Engineering

6 PI 4: METAL FORMING

3L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Theoritical basis for metal forming: Engineering stress and strain curve for tension test on a ductile material, Meaning of salient points on the cuve, True stress and strain curve, Equation of flow curve, relative between true stress and conventional stress, true stress and conventional strain, ideal or hypothetical stress strain curves for various types of plastic materials. Mohr's circle for two & three dimensional stress (without derivation). Yielding theories : Tresca (maximum shear stress criterion) and Von-Mises (maximum distortion energy criterion). Relation between tensile & shear yield stress.

Unit 2
Classification of metal forming processes, cold forming, hot forming and warm or semi hot forming. Materials of cold forming. Factors for the selection of temperatures for semi hot forming. Effect of variables on metal forming processes, effect of temperature, strain rate and friction.

Unit 3
Analysis of manufacturing process. Total work per unit volume done on the metal, ideal work of deformation, work to overcome friction at the metal tool interface and redundant work. Analysis of open die forging for sliding friction and sticking friction. Emperical methods to compute forging loads in open die forging and close die forging.

Unit 4
Rolling: Rolling of flat slaps & strip, geometry of rolling process, backward slip and forward slip, angle of bite, ragging and specific roll pressure. Analysis of rolling, maximum draft, rolling load, roll torque and power, powder rolling.

Unit 5
Drawing: Drawing of wire, rod and tube. Geometry of drawing, analysis of wire/rod drawing. Maximum reduction or draft per pass and optimum die angle for wire drawing. Tube of pipe drawing. Analysis of tube drawing. Extrusion: Direct and indirect extrusion. Analysis of extrusion process.

Rajasthan Technical University (RTU)
Production and Industrial Engineering

6 PI 5: QUALITY CONTROL AND DESIGN OF EXPERIMENTS

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1

The meaning of Quality and quality improvement, dimensions of quality, history of quality methodology, quality control, Quality of design and quality of conformance, Quality policy and objectives, Economics of quality.

Modeling process quality: Describing variation, frequency distribution, continuous and discrete, probability distributions, pattern of variation, Inferences about process quality: sampling distributions and estimation of process parameters. Analysis of variance, statistical aids in limits and tolerances.

Unit 2

Statistical Quality Control: Concept of SQC, Chance and assignable causes of variation, statistical basis of control chart, basic principles, choice of control limits, sample size and sampling frequency, analysis of patterns on control charts. The magnificent seven. Control chart for variables,: X-bar and R charts, x-bar and S charts, control chart for individual measurement. Application of variable control charts.

Unit 3

Control chart for attributes: control chart for fraction non conforming P-chart, np-chart, c-chart and u-chart. Demerit systems, choice between attribute and variable control chart. SPC for short production runs.

Process capability analysis using histogram and probability plot, capability ratios and concept of six sigma.

Unit 4

Quality Assurance; Concept, advantages, field complaints, quality rating, quality audit, vendor quality rating (VQR), vendor rating (VR), manufacturing planning for quality, Quality function deployment (QFD). Acceptance Sampling: Fundamental concepts in acceptance sampling, operating characteristics curve. Acceptance sampling plans, single, double and multiple sampling plans, LTPD, AOQL, AOQ. Introduction to Quality systems like ISO 9000 and ISO 14000

Unit 5

Design of experiments: Strategy of experimentation; Basic principles, Guidelines for designing experiments. Simple Comparative Experiments: Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Paired comparison Designs, Inferences about the Variances of Normal Distributions. Introduction to Taguchi Method of Design Of Experiments, Quality loss function, Signal-to-Noise ratio, Orthogonal array experiments.

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6 PI 6: INTERNAL COMBUSTION ENGINES AND AUTOMOBILE ENGINEERING

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1 Introduction
Introduction of Internal and external combustion engine and their comparison, four stroke cycle S.I. and C.I. engine, two stroke engine, comparison of four stroke and two stroke engines, comparison of S.I. and C.I. engine, classification of I.C. Engine, Valve timing diagram for S.I. and C.I. engines, effect of valve timing and engine speed on volumetric efficiency, reasons for ignition and injection advance, dual fuel.

Unit 2 Combustion
Determination of stoichiometric air fuel ratio, fuel-air and exhaust gas analysis for a given combustion process. Combustion in S.I. and C.I. engines, Detonation, Pre-ignition , Knocking, Antiknock rating of fuels Octane number, critical compression ratio, HUCR, performance number, Cetane number.

Unit 3 Carburetor
Properties of air-petrol mixtures, mixture requirement, simple carburetor, limitation of simple carburetor, modern carburetor, Main metering system, Idling system, Economizer system, acceleration pump and cold starting system. Nozzle lip, venturi depression, calculation of fuel jet and venturi throat dia for given air fuel ratio. Petrol Injection system, electronic fuel injection, advantage and disadvantage of petrol injection.
Injection System
Requirement, type, fuel pump, type of fuel injector, type of nozzle, atomization, spray penetration and spray direction, multiple point fuel injection system.

Unit 4 Ignition System
Battery and magneto ignition system and their comparative study, spark plug heat range, electronic ignition system, firing order, Ignition timing, centrifugal and vacuum ignition advance.
Introduction to Cooling System and Lubrication System
Testing and Performance
Performance parameters, measurements of brake power, indicated power, friction power, fuel and air consumption, exhaust gas calorimeter, calculation of various performance

parameter, heat balance sheet. Performance characteristics for S.I. and C.I. Engine with load and speed.

Unit 5

Gear boxes, Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, Automatic transmission sytem; Hydraulic torque converter; overdrive, propeller shaft, universal joints, front wheel drive, differential; Rear axle drives.

Steering system, steering gear boxes, Steering linkages, steering mechanism, under and over steering. Steering Geometry, effect of camber, caster, king pin inclination, toe in and toe out; suspension spring, front and rear suspension systems.

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6 PI 7: QUALITY CONTROL LAB

3 P **MM 100**

1. 1. Case study on X bar charts and process capability analysis.
2. .2. P – Chart:
3. .(a) Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective.
4. .(b) Plot a P-chart by taking a sample of n=20 and establish control limits.
2. 3. Plot C-chart using given experimental setup.
3. 4. Operating Characteristics Curve:

(a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 , 4 . Designate the red ball to defective.

(b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution.

 .5. Distribution Verification:
 .(a) Verification of Normal Distribution
 .(b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations.
2. 6. Verification of Poisson distribution.
 .7. Central Limit Theorem:
 .(a) To show that a sample means for a normal universe follow a normal distribution.
 .(b) To show that the sample means for a non normal universe also follow a normal Distribution.
3. 8. Study of Universe Distribution and comparison with – (i) Uniform (ii) Poisson
4. 9. Solve problems using available SPC software in lab.
5. 10. Testing of hypothesis for small samples based on students' 't' test and paired 't' test.
6. 11. Testing of hypothesis for small samples based on F test and chi square test.

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6 PI 8: MACHINE DESIGN – II SESSIONAL

2 P MM 75

Problems on

1. 1. Fatigue loading
2. 2. Helical compression, tension and torsional springs design
3. 3. Curved Beams
4. 4. Preloaded bolts and bolts subjected to variable stresses
5. 5. Belt, Rope and Chain drive system
6. 6. Gear Design
7. 7. Sliding contact bearing design
8. 8. Anti-friction bearing selection

6PI9: METAL FORMING AND TOOL DESIGN LAB

3 P MM 100

1. 1. Study of the effect of clearance and shear angle on the blanking and piercing

operations

2. 2. To determine the effect of percentage of reduction and the semicone angle of the die on the drawing load.

3. 3. Tofind the effect of percentage of reduction and the die geometry on extruding force.

4. 4. Experimental determination of wire drawing force for wire drawing operation.

5. 5. Study of the drop forging operation (flowability, forging load etc by plasticine model.

6. 6. To determine roll load in the sheet rolling process.

7. 7. Students will be given at least one practical problem regarding the design and fabrication of Jigs & Fixture or Press tool.

8. 8. Working drawings of the following:- Drilling Jigs (Box type, Leaf type, Indexing type, Trunion type etc.), Milling Fixtures, Grinding fixtures, Assembly and welding fixtures (for automobile components and frames etc.), Drawing Dies, Bending Dies, Compound Dies, Combination Dies & Progressive Dies.

9. 9. Detremination of true stress true strain relationship.

10. 10. To mount die assembly on power press and produce the desired blanks.

11. 11. To mount forming die assembly and to form a cup of M S Sheet.

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1. 12. Study of sheet gauges and sheet metal working machines and preparing a funnel using shear, circle cutting machine, ending rollers and spot wring machine.

2. 13. Determine the drawing force component during wire drawing operation using wire drawing dynamometer.

6PI10: MECHANICAL ENGINEERING LAB.

2 P **MM 75**

1. 1. Disassembling and assembling of multi-cylinder petrol and diesel engines and study of their parts.

2. 2. To disassemble and assemble a 2-stroke petrol engine.

3. 3. To disassemble and assemble a 4-stroke motor cycle engine and study of various engine parts.

4. 4. Study of carburettors and MPFI system and disassembling and assembling of their parts.

5. 5. To calculate valve timing of a multi-cylinder petrol engine and valve tappets adjustment.

6. 6. Disassemble all the parts of a fuel injection pump and its parts study.

7. 7. To disassemble the governor and study its various parts.

8. 8. Study of parallel flow and counter flow heat exchanger.
9. 9. Load test and performance Characteristics on Petrol Engine
10. 10. Load test and performance Characteristics on Diesel Engine

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P & I syllabus seventh semester

7PI1: RELIABILITY AND MAINTENANCE ENGINEERING

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1
Introduction: Maintenance Objectives and Functions; Maintenance Organisation and Administration of Maintenance Systems. Need of planned maintenance. Maintenance policies; Breakdown, time based maintenance: Block replacement, age replacement and periodic replacement policy. Corrective and preventive maintenance. Maintenance planning, Scheduled maintenance. Cost of maintenance versus Cost of equipment and production delays. Inspection: Inspection intervals, Inspection reports, card history system.

Unit 2
Predictive maintenance. Equipment wear records, standards. Equipment used in predictive maintenance. Computerized maintenance, Total Productive Maintenance. Methods of condition monitoring, Non-destructive testing, Liquid Penetrate, Magnetic particles, Ultrasonic testing, and Vibration analysis. Oil analysis, Radiographic testing.

Unit 3
Reliability: Definition, failure data analysis, Mean failure rate, mean time to failure (MTTF), mean time between failures (MTBF) , hazard rate, Bathtub curve. Use of Weibull

probability chart foe assessing characteristics life, guarantee period etc.

Unit 4
System reliability: Series, parallel and mixed configuration; Simple problems. Reliability improvement: Techniques, use of Pareto analysis-Design for reliability, redundancy unit and stand by redundancy, Optimization of reliability.

Unit 5
Spare Parts Management: Spare parts, features and categorization of spares, cost considerations, Techniques of cost reduction; Selective controls used in spare parts control; ABC analysis, FSN, XYZ, VED and other approaches. Inventory control of spares.

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7PI2: TOTAL QUALITY MANAGEMENT

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1
Quality and Total Quality Management; Excellence in manufacturing/service, factors of excellence, relevance of TQM. Concept and definition of quality; total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality Management Models, benefits of TQM.

Unit 2
Just-in-time (JIT): Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation. Customer: Satisfaction, data collection and complaint, redressal mechanism. Planning Process: Policy development and implementation; plan formulation and implementation.

Unit 3
Process Management: Factors affecting process management, Quality function development (QFD), and quality assurance system. Total Employees Involvement (TEI): Empowering employees: team building; quality circles; reward and Recognition; education and training, Suggestion schemes. Problems solving, Defining problem; Problem identification and solving process; QC tools. Benchmarking definition, concept, process and types of benchmarking.

Unit 4
Quality Systems: Concept of quality system standards: relevance and origin of ISO 9000; Benefits; Elements of ISO 9001, ISO 9002, ISO 9003.

Unit 5
Advanced techniques of TQM: Design of experiments: failure mode effect analysis: Taguchi methods.

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7PI3: PROJECT MANAGEMENT

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1 Project Management Concepts
Introduction, project characteristics, taxonomy of projects, project identification and formulation. Establishing the project and goals. Nature & context of project management; phases of PM, A framework for PM issues, PM as a conversion process, project environment & complexity. Organizing human resources, organizing systems & procedures for implementation. Project direction.

Unit 2 Project Organization & Project Contracts
Introduction, functional organization, project organization, matrix organization, modified matrix organization, pure project organization, selection of project organization structure, project breakdown structures, project contracts, types of contracts, types of payments to contractors.

Unit 3 Project Appraisal & Cost Estimation
Introduction, technical appraisal, commercial appraisal, economic appraisal, financial appraisal, management appraisal, social cost/benefit analysis, project risk analysis. Cost analysis of the project, components of capital cost of a project, modern approach to project performance analysis.

Unit4 Project Planning & Scheduling
Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, event slacks & floats, PERT model, expected time for activities, expected length of critical path, calculating the project length and variance, PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique.

Unit 5 Modification & Extensions of Network Models
Complexity of project scheduling with limited resources, resource leveling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking- examples with algorithm, decision networks, probabilistic networks, computer aided project management- essential requirements of PM software, software packages for

CPM. Enterprisewide PM, using spread sheets for financial projections.

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7PI4: NEWER MACHINING METHODS

4L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Introduction and classification of advanced machining process, consideration in process selection, difference between traditional and non-traditional process, Hybrid process.
Unit 2
Mechanical advanced machining process: Introduction, Mechanics of metal removal, process pricnciple, Advantages, disadvantages and applications of AJM,USM,WJC.
Unit 3
Thermo electric advanced machining process: Introduction, Principle, process parameters, advantages, disadvantages and applications about EDM, EDG, LBM, PAM, EBM
Unit 4
Electrochemical and chemical advanced machining process: ECM, ECG, ESD, Chemical machining, anode shape prediction and tool design for ECM process. Tool (cathode) design for ECM Process.
Unit 5
Abrasive finishing processes: AFM, MAF (for Plain and cylindrical surfaces).

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7PI5: FACILITIES PLANNING

3L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Definition of facilities planning, significance and objectives of facilities planning. Process of facilities planning. Strategic facilities planning. Product selection, Review of various types of manufacturing processes and Process selection.

Unit 2
Facility Location: Need for location decisions, location factors, location analysis: Qualitative methods: subjective, equal weight, variable weight, factor point rating and composite measure method. Quantitative methods: location breakeven analysis, median model, gravity model, Brown and Gibson method, single facility location models, minmax location problem, Location allocation models, Bridgeman's Dimensional Analysis. Industrial buildings, influence of building on layout.

Unit 3
Facility Layout: Importance and function, objectives and advantages of good layout, types of plant layout problems. Basic layout types: Product, Process, Group and fixed position layout. Plant layout factors, Layout procedure, Systematic layout planning procedure, Flow and activity analysis, Process charts, flow diagram, Travel chart, activity relationship chart, and Relationship diagram. Evaluation and implementation of layout.

Unit 4
Computer aided layout: CRAFT, CORELAP, COFAD, ALDEP, PLANET. Production and assembly line balancing - various operational research techniques for balancing of assembly line and fabrication line.

Unit 5
Material Handling: Principles of material handling, materials handling system design. Systematic handling analysis, Unit loads, Material Handling Equipment: Conveyors, monorail, hoists and Cranes; automated storage and retrieval systems (AS/RS) , Industrial trucks, Containers and supports, Auxiliary and other equipments

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7PI6.1: DESIGN AND MANUFACTURING OF PLASTIC PRODUCTS

3L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Glossary of Terms Associated with Plastic Engineering. Thermoplastics and thermo sets, their properties. Mechanical & physical properties of plastics. Selection of plastics for different uses and their limitations.

Unit 2
Polymer processing techniques such as extrusion, compression and transfer moulding. Injection moulding, blow moulding, thermoforming, rotational moulding, calendaring, Bag moulding reaction moulding. Joining and assembling of plastics: Processes.

Unit 3
Design of moulds for thermo sets: Compression moulds, transfer moulds, injection moulds, runner and gate design, vents. Design of moulded products, wall thickness, fillets and radii, ribs, under, cuts, drafts, holes, threads, inserts parting lines, surface treatment mould design for avoiding warpage.

Unit 4
Standards for Tolerances on moulded articles: Design consideration.
Casting of acrylics, phenolics and epoxies, polyesters and nylons.

Unit 5
Ceramics and non-ceramic phases: Common ceramics, Crystal structures. Binary and ternary ceramics. Silicates, clays, graphite and carbides, General Properties of ceramics. Deformation and creep. Toughening, Mechanics. Ceramic processing techniques, material selection for general applications and industrial application, limitations of ceramics.

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7PI6.2 & 7 ME 6.2: MECHATRONICS

3L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Introduction about Mechatronics, scope of Mechatronics, application, process control automation and N/c Machines.

Unit 2 Sensors and Transducers
Introduction, classification, specification, characteristics of transducers, type of transducers displacement, strain, vibration pressure, flow, temperature, force & torque, tactile.

Unit 3 Hydraulic Pneumatic & Electrical actuators
Pumps & Compressors, control valves & accessories, actuators, fluid power symbols, fluid power systems, switching devices, solenoids, motors.

Unit 4 Data Acquisition and Control System
Introduction, Quantitizing theory, Analog to Digital Conversion, Digital to Analog (D/A) conversation, transfer function, transient response & frequency response & frequency response, stability criteria.

Unit 5 Design of Mechatronic systems
Introduction, Automatic front and book and cutting in steel rolling mill, lift control system, CNC lathe, temperature control of a heat treatment furnace, EOT crane control panel, Grey

grain separators, electrode arm control in electric arc furnace.

7 PI 6.3 & 7 ME 1: COMPUTER AIDED DESIGN

3L+0T 100 Marks Ex. Hrs: 3

UNIT I.

Overview of Computer Graphics, Picture representation, Coordinate Systems, Output Graphcis Display devices. Raster Scan Graphics : DDA for line generation and Bresenham's algorithm for line and circle generation**.**

UNIT II

Wire frame models, Parametric representation of curves, Plane curves : line, circle, ellipse, parabola and hyperbola. Space curves : Cubic spline curve, Bezier Curve and B Spline Curves. Blending of Curves.

UNIT III

Surface models and entities Parametric representation of Hermite Bicubic surfaces, Bezier surfaces and B-spline surfaces. Solid Models and entities, Solid Representation : B-rep. and CSG. Comparison between three types of models.

UNIT IV

Two and three dimensional transformation of Geometric models: Translation, Scaling Reflection, Rotation and Shearing. Homogeneous Representation, Combined Transformation. Projection of Geometric models: Parallel and Perspective Projection.

UNIT V

Clipping : Point clipping, Line clipping, Cohen-Sutherland algorithm etc. Viewing Transformation, Hidden Line and surface Removal : Techniques and Algorithms.

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7PI7: MACHINE TOOL DESIGN SESSIONAL

3 P **MM 100**

Problems/study on

1. **1.** Functional requirements of machine tools.
2. 2. Working and auxiliary motions in machine tools.
3. 3. Design criterion for machine tool structure, Static & dynamic stiffness.
4. 4. Function & important requirements of spindle unit.
5. 5. Importance of machine tool compliance with respect to machine tool accuracy.
6. 6. Application and sketching of Slider-crank mechanism, Cam mechanism, Rack & pinion mechanism, Nut & screw mechanism, Ratchet gear mechanism, Geneva mechanism, Reversing mechanism, Differential mechanism, Norton mechanism, Mender's mechanism.
7. 7. Aim of speed & feed rate regulation, stepped regulation of speed.
8. 8. G.P. series is used in steeped regulation of speed.
9. **9.** Design a four / six speed Gear Box.
10. 10. Design of Lathe bed. (including Torque analysis of lathe bed, bending of lathe bed, designing for torsional rigidity, use of reinforcing stiffener in lathe bed)
11. 11. Analysis of force under headstock, tail stock and saddle.
12. **12.** Design of Guide ways / Slide ways.
13. **13.** Estimation of power requirements and selection of motor for metal cutting machine tool spindles.

7PI8: INDUSTRIAL ENGINEERING LAB

3 P **MM 100**

1. 1. Determination of time standard for a given job using stopwatch time- study.
2. 2. Preparation of flow process chart, operation process chart and man-machine charts for an existing setup and development of an improved process.
3. 3. Study of existing layout of a workstation with respect to controls and displays and suggesting improved design from ergonomic viewpoint.
4. 4. To carryout a work sampling study.
5. 5. Toconduct process capability study for a machine in the workshop.
6. 6. To design a sampling scheme based on OC curve.
7. 7. To conduct Shewart's experiments on known population
8. 8. Generation of random numbers for system simulation such as facility planning, job shop scheduling etc.

P&I syllabus eighth semester

8PI1: MODELING AND SIMULATION

3L+ 1T 100 Marks Ex. Hrs: 3

Unit 1 Physical modeling
Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling, Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling

Unit 2 Computer system simulation
Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems, Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems

Unit 3 Probability concepts in simulation
Stochastic variables, discrete and continuous probability functions, random numbers, generation of random numbers, variance reduction techniques, Determination of the length of simulation runs, Output analysis.

Unit 4 System dynamics modeling
Identification of problem situation, preparation of causal loop diagrams and flow diagrams, equation writing, level and rate relationship. Simulation of system dynamics model.

Unit 5 Verification and validation
Design of simulation experiments, validation of experimental models, testing and analysis. Simulation languages comparison and selection, study of SIMULA, DYNAMO, STELLA, POWERSIM. Simulation softwares.

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8PI2: COMPUTER INTEGRATED MANUFACTURING SYSTEM

4L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Introduction: Overview of manufacturing processes, types of manufacturing systems, the product cycle, computer's role in manufacturing, sources and types of data used in

manufacturing.

The Beginning of CAM: Historical Background, Basic components of NC systems, NC Procedure, NC coordinate system and machine motions, applications and economics of NC.

Unit 2
Part programming- manual and computer assisted such as APT Language. Computer Controls In NC Systems: Problems with conventional NC computer numerical control, Direct numerical control, combined CNC/ DNC systems, adaptive control machining system computer process interfacing, New development and latest trends.

Unit 3
Computer Aided Process Planning: Traditional Process Planning, Retrieval process planning system, Generative Process Planning, Machinability data system, computer generated time standards. Group Technology: Introduction, part families, part classification and coding, coding system and machining cells.

Unit 4
Compuer Aided Production Management Systems: Introduction to computer aided PPC, Introduction to computer aided inventory management, manufacturing resource planning (MRPII), computer process monitoring and shop floor control, computer process control. Computer Aided Quality Control: Computer in quality control, contact inspection methods, Non contact inspection methods, optical and non optical computer aided testing. Computer Aided Material Handling: Computer control on material handling, conveying, picking. Ware house control, computerized material handling for automated inspection and assembly.

Unit 5
Computer Integrated Manufacturing Systems: Introduction, types special manufacturing systems, flexible manufacturing systems (FMS). Collabarative Engineering**:** Introduction, Faster Design throughput, Web based design, Changing design approaches, extended enterprises, concurrent engineering, Agile and lean manufacturing.

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8PI3: INDUSTRIAL AUTOMATION AND ROBOTICS

4L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Introduction: Concept and scope of automation: Socio economic consideration: Low cost automation. Fluid Power Control: Fluid power control elements and standard graphical symbols. Construction and performance of fluid power generators; Hydraulic and pneumatic

cylinders - construction, design and mounting; Hydraulic and pneumatic valves for pressure, flow and direction control: Servo valves and simple servo systems with mechanical feedback.

Unit 2
Pneumatic Logic Circuits: Design of pneumatic logic circuits for a given time displacement diagram or sequence of operations.
Fluidics: Boolean algebra; Truth tables; Conda effect; Fluidic elements.

Unit 3
Transfer Devices and Feeders: Classification: Construction details and application of transfer devices and feeders used for job orienting and picking operations. Electrical and Electronic Controls: Introduction to electrical and electronic controls; Integration of mechanical systems with electrical, electronic and computer systems.

Unit 4
Introduction to Robot Technology: Robot Physical configuration, basic Robot motions. Types of Manipulators: Actuators and Transmission System: Pneumatic, Hydraulic and Electrical actuators; Feed Back Systems and Sensors: Encoders and other feed back systems, vision, ranging systems, tectile sensors.

Unit 5
Robot Programming: Teach pendent and computer programming of robots. Programming Languages; Introduction to Industrial Applications of Robots for material transfer, machine loading / unloading, welding, assembly and spray painting operations

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8PI4.1: RAPID PROTOTYPING

4L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Overview of Rapid Product Development (RPD): Product Development Cycle: Definition of RPD; Components of RPD, Classification and advantages of Rapid Prototyping. Rapid prototyping process: Process chain, 3D modeling, data conversion and transmission, checking and preparing, building and post processing. Issues in RP and emerging trends.

Unit 2
Stereo-lithography: Principle, Process parameter, process details, Data preparation, data files and machine details, Applications. Solid Ground Curing (SGC) Principle of operation, Machine details, Applications. Other similar commercial RP systems. Micro Fabrication.

Unit 3
Laminated Object Manufacturing (LOM), process details, applications. Fused Deposition Modeling (FDM): Principle, Process parameter, Path generation and applications. Multi-Jet Modeling systems (MJM), Other similar commercial RP systems. Selective Laser Sintering (SLS): Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, 3D Printing (3DP), Ballistic particle manufacturing (BPM), Laser Engineered Net Shaping (LENS).

Unit 4
Rapid Tooling (RT): Introduction to RT; Indirect RT processes – Silicon rubber molding, Epoxy tooling, Spray metal tooling and Investment Casting; Direct RT processes-Laminated Tooling, Powder Metallurgy based technologies, Welding based technologies, Direct pattern making (QuickCast, Full Mold Casting); Emerging Trends in RT.

Unit 5
Reverse Engineering: Geometric data acquisition; 3D reconstruction. Applications. Rapid Prototyping Data formats:STL format; Defects and repair of STL files Software for RP: Solid view, magics, mimics, magic communicator, etc. Processing Polyhedral Data: Polyhedral B-Rep modeling. Application of RP in manufacturing: Engineering applications, Medical applications.

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8PI4.2: MANAGEMENT INFORMATION SYSTEMS

4L+ 0T 100 Marks Ex. Hrs: 3

Unit 1
Organisation & Types, Decision Making, Data & information, Characteristics & Classification of information, Cost & value of information, Various channels of information & MIS.

Unit 2
Foundation of Information System : Introduction to Information System in Business Fundamentals of Information System, Solving Business Problems with Information System, Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS-dataflow diagram, flow chart etc.

Unit 3
Business application of information technology, electronic commerce, Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations, Information system for managerial Decision Support, Information System for Strategic Advantage

Unit 4
Managing Information Technology, Enterprise & Global Management, Security & Ethical Challenges, Planning & Implementing Change. Reports: Various types of MIS reports, GUI & Other Presentation tools.

Unit 5
Advanced concepts in information system: Enterprise Resource Planning: introduction, various modules like Human Resources, Finance, Accounting, Production & Logistics. Supply Chain Management, CRM, Procurement Management System Object Oriented modeling case studies.

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8PI4.3: PRODUCT DESIGN AND LAUNCHING

4L+ 0T 100 Marks Ex. Hrs: 3

Unit 1 Importance of new product-Definition-importance-Development Process.
Importance of new product for growth of enterprise. Definition of product and new product. Responsibility for new product development. Demands on product development team. Classification of products from new product development. Point of view- Need based/Market pull products, Tech. push, Platform based, Process based and customized products. New product development process and organization. Generic product development process for Market Pull Products. Modification of this process for other types of products.

Unit 2 Need analysis- Problem Formulation
Establishing economic existence of need, Need Identification and Analysis, Engineering Statement of Problem, Establishing Target Specification.

Unit 3 Generation of Alternatives and Concept Selection
Concept generation- a creative process, Creativity, Road Elects to creative thinking-Fear of criticism and Psychological set. Tools of creativity like brain storming, Analogy, Inversion etc., Creative thinking Process.
Concept feasibility and Concept Selection, Establishing Engineering Specification of Products.

Unit 4 Preliminary & detailed design- Design Review
Preliminary design- Identification of subsystems, Subsystem specifications, Compatibility.
Detailed design of subsystems, component design, Preparation of assembly drawings.
Review of product design from point of view of Manufacturing, Ergonomics and aesthetics.

Unit 5 Management of New Product – development and Launch.
New Product Management's Challenges – Maintaining focus, Promotion of Right Culture, Management of Creativity, Top Management attention. Design Team Staffing and Organization. Setting key mile stone, Identification of Risk Areas, Project Execution and Evaluation Product Launch Strategies. Project Planning – Project Task matrix, estimation of time & resources, project scheduling.

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8PI5: CAM LAB. 3 P MM 100

Experiments to be Performed (Minimum Five Experiments)

1. 1. To prepare part programming for plain turning operation.
2. 2. To prepare part programming for turning operation in absolute mode.
3. 3. To prepare part program in inch mode for plain turning operation.
4. 4. To prepare part program for taper turning operation.
5. 5. To prepare part program for turning operations using turning cycle.
6. 6. To prepare part program for threading operation.
7. 7. To prepare part program for slot milling operation.
8. 8. To prepare part program for gear cutting operation.
9. 9. To prepare part program for gear cutting using mill cycle.
10. 10. To prepare part program for drilling operation.
11. 11. To prepare part program for multiple drilling operation in Z-axis.
12. 12. To prepare part program for multiple drilling in X-axis.
13. 13. To prepare part program for multiple drilling in X and Z axis using drilling cycle.

8PI6: SIMULATION LAB.

3 P MM 100

1. 1. Generate Pseudo Random No. using different Techniques.
2. 2. Develop an Analytical Model for a given physical system.
3. 3. Develop a Monte-Carlo Simulation Model for a given physical system.

4. 4. Find a area of an irregular 2-D shape using Monte-Carlo Simulation
5. 5. Find the effectiveness of simulation on a physical Stochastic System
6. 6. Develop an algorithm for a selected Simulated Study and write the program in a high level language.
7. 7. Modeling of manufacturing system using simulation software such as ARENA

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8PI7: AUTOMATION & ROBOTICS LAB.

2 P MM 50

(Minimum ten Experiments)

1. 1. To detect the sensor scanning system to overcome limitation of fixed sensors on various robotic applications, ultrasonic sensor, laser range finders, infrared detectors and miniature.
2. 2. To find the horizontal and vertical movement up to 180o in either direction.
3. 3. To detect objects with infrared ray detector.
4. 4. To determine object distance (3cm – 300cm).
5. 5. To detect distance (10cm to 80 cm) with infrared object detector.
6. 6. To determine 5 Axis Robotic Arm movement and its degree of rotation.
7. 7. To lift the object and place 100m away in various directions.
8. 8. To find the gripper movement (0 to 50mm).
9. 9. To study various Robotic Arm Configurations.
10. 10. To study Pick and Place Robot
11. 11. Design and assembly of hydraulic / pneumatic circuit.
12. 12. Study of power steering mechanism using cut piece model
13. 13. Study of reciprocating movement of double acting cylinder using pneumatic direction control valves
14. 14. Use of direction control valve and pressure control valves clamping devices for jig and fixture.
15. 15. Study of robotic arm and its configuration
16. 16. Study the robotic end effectors
17. 17. Study of different types of hydraulic and pneumatic valve