DR. A. P. J. ABDUL KALAM TECHNICAL UNIVERSITY

LUCKNOW, UTTAR PRADESH

STUDY & EVALUATION SCHEME WITH SYLLABUS

FOR

B. TECH. 3rd YEAR

Manufacturing Technology

[Effective from Session: 2020-21]

Syllabus Content of B. Tech Manufacturing Technology

B. Tech Manufacturing Technology

Evaluation Scheme

SEMESTER - V

Sl.No	Subject codes	Subject	Periods			Evaluation scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KME 501	Heat and Mass Transfer	3	1	0	30	20	50		100		150	4
2	KME 502	Strength of Material	3	1	0	30	20	50		100		150	4
3	KME 503	Industrial Engineering	3	1	0	30	20	50		100		150	4
4		Dept. Elective-I	3	0	0	30	20	50		100		150	3
5		Dept. Elective-II	3	0	0	30	20	50		100		150	3
6	KME 551	Heat Transfer Lab	0	0	2				25		25	50	1
7	KME 552	Python Lab	0	0	2				25		25	50	1
8	KMT 551	Measurement & Metrology Lab	0	0	2				25		25	50	1
9	KMT 552	Mini project or Internal Assessment	0	0	2				50			50	1
10	NC*	Constitution of India/Essence of Indian Traditional Knowledge	2	0	0	15	10	25		50			
11		MOOCs(Essential for Hons. Degree)											
		Total	**17**	**3**	**8**							**950**	**22**

*The Mini project or internship (4 weeks) conducted during summer break after IV semester and will be assessed during V semester.

SEMESTER - VI

Sl. No	Subject codes	Subject	Periods			Evaluation scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KMT 601	Pneumatics and Hydraulics	3	1	0	30	20	50		100		150	4
2	KME 602	Machine Design	3	1	0	30	20	50		100		150	4
3	KME 603	Theory of Machine	3	1	0	30	20	50		100		150	4
4		Departmental Elective III	3	0	0	30	20	50		100		150	3
5		Open Elective I	3	0	0	30	20	50		100		150	3
6	KMT 651	Pneumatics and Hydraulics Lab	0	0	2				25		25	50	1
7	KME 652	Machine Design Lab	0	0	2				25		25	50	1
8	KME 653	Theory of Machine Lab	0	0	2				25		25	50	1
10	NC*	Essence of Indian Traditional knowledge/ Constitution of India	2	0	0	15	10	25		50			
11		MOOCs(Essential for Hons. Degree)											
		Total	**17**	**3**	**6**							**900**	**21**

Manufacturing Technology Departmental electives

Student can choose any elective horizontally from the pool of electives

Sem V	**Code**	**KME 051**	**KPI 051**	**KMT 051**	**KMT 052**
	Departmental Elective-I	Computer Integrated Manufacturing	Advance Manufacturing Science	Plastic Material and Manufacturing	Lean Manufacturing
Sem V	**Code**	**KME 055**	**KMT 053**	**KMT 054**	**KMT 055**
	Departmental Elective-II	Advance welding	Automation & Robotics	Mould Design and Manufacturing	Time and Motion study
Sem VI	**Code**	**KME 061**	**KMT 061**	**KMT 062/ (KME 604)**	**KMT 063**
	Departmental Elective-III	Nondestructive Testing	Machine Vision and Image Processing	Tool Design	Product Design and Development
Sem VII	**Code**	**KME 071**	**KPI 071**	**KPI 072**	**KMT 071**
	Departmental Elective-IV	Additive manufacturing	Flexible Manufacturing System	Facility Planning & Design	Advance Casting Process
Sem VII	**Code**	**KMT 072**	**KMT 073**	**KMT 074**	**KMT 075**
	Departmental Elective-V	Composite Materials	Manufacturing Strategies	Maintenance Engineering & Management	Process Planning and cost Estimation

Suggested MOOCs

It is suggested that the students may also do the following MOOCs in addition to mandatory courses. This will enhance their learning.

Sem V	**Advance Machining Process** https://swayam.gov.in/nd1_noc20_me76/preview By Prof. Manas Das, IIT Guwahati	**Control Systems** https://swayam.gov.in/nd1_noc20_ee90/preview By Prof. C. S. Shankar Ram, IIT Madras	**Work System design** https://swayam.gov.in/nd1_noc20_me70/preview By Prof. Inderdeep Singh, IIT Roorkee
Sem VI	**Product Design and Manufacturing** https://swayam.gov.in/nd1_noc20_me12/preview By Prof. J. Ramkumar, Prof. Amandeep Singh, IIT Kanpur	**Introduction to robotics** https://swayam.gov.in/nd1_noc20_de11/preview By Prof. Asokan T, Prof. Balaraman Ravindran, Prof. Krishna Vasudevan, IIT Madras	**Industrial Safety Engineering** https://swayam.gov.in/nd1_noc20_mg43/preview By Prof. Jhareswar Maiti, IIT Kharagpur
Sem VII	**Automation in Manufacturing** https://swayam.gov.in/nd1_noc20_me58/preview By Prof. Shrikrishna N. Joshi, IIT Guwahati	**Introduction to Industry 4.0 and Industrial Internet of Things**https://swayam.gov.in/nd1_noc20_cs69/preview By Prof. Sudip Misra, IIT Kharagpur	**Introduction to Composites** https://swayam.gov.in/nd1_noc20_me95/preview By Prof.Nachiketa Tiwari, IIT Kanpur
Sem VIII	**Production and Operation Management** https://swayam.gov.in/nd1_noc20_mg06/preview By Prof. Rajat Agrawal, IIT Roorkee	**Supply Chain management** https://swayam.gov.in/nd2_cec20_mg11/preview By Dr. P. Chitramani, Avinashilingam Institute for Home Science and Higher Education for Women	**Operation Research** https://swayam.gov.in/nd1_noc20_ma45/preview By Prof. Kusumdeep, IIT Roorkee

Subject Code: KME 501	Heat and Mass Transfer	L T P : 3 1 0	Credits: 4

The students will be able to		Blooms Taxonomy
CO-1	Understand the fundamentals of heat and mass transfer.	K2
CO-2	Apply the concept of steady and transient heat conduction.	K3
CO-3	Apply the concept of thermal behavior of fins.	K3
CO-4	Apply the concept of forced and free convection.	K3
CO-5	Apply the concept of radiation for black and non-black bodies.	K3
CO-6	Conduct thermal analysis of heat exchangers.	K4

UNIT-1

Introduction to Heat Transfer (L-5 Hours)

Introduction of thermodynamics and Heat Transfer, Modes of Heat Transfer: Conduction, convection and radiation, Effect of temperature on thermal conductivity of different types of materials, Introduction to combined heat transfer mechanism, General differential heat conduction equation in the rectangular, cylindrical and spherical coordinate systems, Initial and system boundary conditions.

Steady State one-dimensional Heat conduction (L-3 Hours)

Simple and Composite Systems in rectangular, cylindrical and spherical coordinates with and without energy generation, Concept of thermal resistance, Analogy between heat and electricity flow, Thermal contact resistance and over-all heat transfer coefficient, Critical radius of insulation for cylindrical, and spherical bodies.

UNIT-2

Fins (L-3 Hours)

Heat transfer through extended surfaces and its classification, Fins of uniform cross-sectional area, Error in measurement of temperature of thermometer wells.

Transient Conduction (L-3 Hours)

Transient heat conduction, Lumped capacitance method, Time constant, Unsteady state heat conduction in one dimension only, Heisler charts and their applications.

UNIT-3

Forced Convection (L-5 Hours)

Basic concepts: Hydrodynamic boundary layer, Thermal boundary layer, Approximate integral boundary layer analysis, Analogy between momentum and heat transfer in turbulent flow over a flat surface, Mixed boundary layer, Flow over a flat plate, Flow across a single cylinder and a sphere, Flow inside ducts, Thermal entrance region, Empirical heat transfer relations, Relation between fluid friction and heat transfer, Liquid metal heat transfer.

Natural Convection (L-5 Hours)

Physical mechanism of natural convection, Buoyant force, Empirical heat transfer relations for natural convection over vertical planes and cylinders, horizontal plates, cylinders and sphere, combined free and forced convection, Effect of turbulence.

UNIT-4

Thermal Radiation **(L-8 Hours)**

Basic concepts of radiation, Radiation properties of surfaces, Black body radiation Planck's law, Wein's displacement law, Stefan-Boltzmann law, Kirchhoff's law, Gray body, Shape factor, Black-body radiation, Radiation exchange between diffuse non-black bodies in an enclosure, Radiation shields, Radiation combined with conduction and convection; Absorption and emission in gaseous medium; Solar radiation; Greenhouse effect, Radiation network analysis.

UNIT-5

Heat Exchanger **(L-5 Hours)**

Different types of heat exchangers, Fouling factors, Overall heat transfer coefficient, Logarithmic mean temperature difference (LMTD) method, Effectiveness-number of transfer unit (NTU) method and Compact Heat Exchangers.

Condensation and Boiling **(L-3 Hours)**

Introduction of condensation phenomena, Heat transfer relations for laminar film condensation on vertical surfaces and on outside& inside of a horizontal tube, Effect of non-condensable gases, Drop wise condensation, Heat pipes, Boiling modes, pool boiling, Hysteresis in boiling curve, Forced convection boiling.

Introduction to Mass Transfer **(L-2 Hours)**

Introduction of Fick's law of diffusion, Steady state equimolar counter diffusion, Steady state diffusion through a stagnant gas film, Heat and Mass Transfer Analogy -Convective Mass Transfer Correlations

Reference Books:-

1. Fundamentals of Heat and Mass Transfer, by Incroperra& DeWitt, John Wiley and Sons
2. Heat and Mass Transfer by Cengel, McGraw-Hill
3. Heat Transfer by J.P. Holman, McGraw-Hill
4. Heat and Mass Transfer by Rudramoorthy and Mayilsamy, Pearson Education
5. Heat Transfer by Ghoshdastidar, Oxford University Press
6. A text book on Heat Transfer, by Sukhatme, University Press.
7. Heat Transfer by Venkateshan, Ane Books Pvt Ltd
8. Schaum's outline of Heat Transfer by Pitts & Sisson McGraw-Hill
9. Heat and Mass Transfer by R Yadav, Central Publishing House.

Subject Code: KME 502	Strength of Material	L T P : 3 1 0	Credits: 4

Course Outcomes: The student will be able to		Blooms Taxonomy
CO 1	Understand the concept of stress and strain under different conditions of loading	K2
CO 2	Determine the principal stresses and strains in structural members	K3
CO 3	Determine the stresses and strains in the members subjected to axial, bending and torsional loads	K3
CO 4	Apply the concepts of stresses and strain in solving problems related to springs, column and pressure vessels	K3
CO 5	Calculate the slope, deflection and buckling of loaded members	K3
CO 6	Analyze the stresses developed in straight and curved beams of different cross sections	K4

Unit I **8 Hours**

Compound stress and strains: Introduction, normal stress and strain, shear stress and strain, stresses on inclines sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's circle for plane stress, three dimensional states of stress & strain, equilibrium equations, generalized Hook's law, theories of failure. Thermal Stresses.

Unit II **8 Hours**

Stresses in Beams: Pure Bending**,** normal stresses in beams, shear stresses in beams due to transverse and axial loads, composite beams.

Deflection of Beams: Differential equation of the elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams

Torsion: Torsion, combined bending & torsion of solid & hollow shafts, torsion of thin walled tubes.

Unit III **8 Hours**

Helical and Leaf Springs: Deflection of springs by energy method, helical springs under axial load and under axial twist (respectively for circular and square cross sections) axial load and twisting moment acting simultaneously both for open and closed coiled springs, laminated springs.

Columns and Struts: Buckling and stability, slenderness ratio, combined bending and direct stress, middle third and middle quarter rules, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling, Ranking Gordon formulae, examples of columns in mechanical equipment and machines.

Unit IV **8 Hours**

Thin cylinders & spheres: Introduction, difference between thin walled and thick walled pressure vessels, thin walled spheres and cylinders, hoop and axial stresses and strain, volumetric strain.

Thick cylinders: Radial, axial and circumferential stresses in thick cylinders subjected to internal or external pressures, compound cylinders, stresses in rotating shaft and cylinders, stresses due to interference fits.

Unit V **8 Hours**

Curved Beams: Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression.

Unsymmetrical Bending: Properties of beam cross-section, slope of neutral axis, stress and deflection in unsymmetrical bending, determination of shear center and flexural axis (for symmetry about both axis and about one axis) for I-section and channel section.

Text Books:

1. Strength of materials by Sadhu Singh, Khanna Book Publishing Co. (P) Ltd.
2. Strength of Material by Rattan, MC GRAW HILL INDIA
3. Mechanics of Materials by B.C. Punmia, Laxmi Publications (P) Ltd.

Reference Books:

1. Mechanics of Materials by Hibbeler, Pearson.
2. Mechanics of material by Gere, Cengage Learning
3. Mechanics of Materials by Beer, Jhonston, DEwolf and Mazurek, MC GRAW HILL INDIA
4. Strength of Materials by Pytel and Singer, Harper Collins
5. Strength of Materials by Ryder, Macmillan.
6. Strength of Materials by Timoshenko and Yσungs, East West Press.
7. Introduction to Solid Mechanics by Shames, Pearson
8. Mechanics of material by Pytel, Cengage Learning
9. An Introduction to Mechanics of Solids by Crandall, MC GRAW HILL INDIA
10. Strength of Materials by Jindal, Pearson Education
11. Strength of Materials by Basavajaiah and Mahadevappa, University Press.

Subject Code: KME 503	Industrial Engineering	L T P : 3 1 0	Credits: 4

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand the concept of production system, productivity, facility and process planning in various industries	K2
CO2	Apply the various forecasting and project management techniques	K3
CO3	Apply the concept of break-even analysis, inventory control and resource utilization using queuing theory	K3
CO4	Apply principles of work study and ergonomics for design of work systems	K3
CO5	Formulate mathematical models for optimal solution of industrial problems using linear programming approach	K4

Unit-I:

Overview of Industrial Engineering: Types of production systems, concept of productivity, productivity measurement in manufacturing and service organizations, operations strategies, liability and process design.

Facility location and layout: Factors affecting facility location; principle of plant layout design, types of plant layout; computer aided layout design techniques; assembly line balancing; materials handling principles, types of material handling systems, methods of process planning, steps in process selection, production equipment and tooling selection, group technology, and flexible manufacturing.

Unit II:

Production Planning and control: Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; materials requirement planning (MRP) and MRP-II; routing, scheduling and priority dispatching, concept of JIT manufacturing system

Project Management: Project network analysis, CPM, PERT and Project crashing.

Unit III:

Engineering economy and Inventory control: Methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements, time-cost trade-off, resource levelling; Inventory functions, costs, classifications, deterministic inventory models, perpetual and periodic inventory control systems, ABC analysis, and VED analysis.

Queuing Theory: Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Classification of Queuing models.

Unit IV

Work System Design: Taylor's scientific management, Gilbreths's contributions; work study: method study, micro-motion study, principles of motion economy; work measurement –time study, work sampling, standard data, Predetermined motion time system (PMTS); ergonomics; job evaluation, merit rating, incentive schemes, and wage administration.

Product Design and Development: Principles of product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, and concurrent engineering.

Unit V:

Operational Analysis: Formulation of LPP, Graphical solution of LPP, Simplex Method, Sensitivity Analysis, degeneracy and unbound solutions.transportation and assignment models; Optimality test: the stepping stone method and MODI method, simulation.

Books and References:

1. Industrial Engineering and Production Management by Martand T Telsang S. Chand Publishing
2. Industrial Engineering and Production Management by M. MahajanDhanpatRai& Co. (P) Limited
3. Industrial Engineering and Management by Ravi Shankar, Galgotia Publications Pvt Ltd
4. Production and Operations Management by Adam, B.E. & Ebert, R.J., PHI
5. Product Design and Manufacturing by ChitaleA.V. and Gupta R.C., PHI
6. Operations Research Theory & Applications by J K Sharma, Macmillan India Ltd,
7. Production Systems Analysis and Control by J.L.Riggs, John Wiley & Sons
8. Automation, Production Systems & Computer Integrated Manufacturing by Groover, M.P. PHI
9. Operations Research, by A.M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education
10. Operations Research by P. K. Gupta and D. S. Hira, S. Chand & Co.

Subject Code: KME 551	Heat and Mass Transfer Lab	L T P : 0 0 2	Credits: 1

The students will be able to		Blooms Taxonomy
CO1	Apply the concept of conductive heat transfer.	K3
CO2	Apply empirical correlations for both forced and free convection to determine the value of convection heat transfer coefficient	K3
CO3	Apply the concept of radiation heat transfer for black and grey body.	K3
CO4	Analyze the thermal behaviour of parallel or counter flow heat exchangers	K4
CO5	Conduct thermal analysis of a heat pipe	K4

List of Experiments

Minimum eight experiment of the following

1. To determine thermal conductivity of conductive material(s).
2. To determine thermal conductivity of insulating material(s).
3. To determine heat conduction through lagged pipe.
4. To determine heat transfer through fin under natural convection.
5. To determine the heat transfer Rate and Temperature Distribution for a Pin Fin.
6. Determination of thermal conductivity of different types of fluids.
7. Experiment on Stefan's Law - determination of emissivity, etc.
8. Experiment on convective heat transfer through flat plate solar collector.
9. To compare LMTD and Effectiveness of Parallel and Counter Flow Heat Exchangers.
10. To find the heat transfer coefficient for Forced Convection in a tube.
11. To find the heat transfer coefficient for Free Convection in a tube.
12. To conduct experiments on heat pipe.
13. To study the rates of heat transfer for different materials and geometries.
14. Visit to a Thermal Power Station for practical exposure.

Subject Code: KME 552	Python Lab	L T P : 0 0 2	Credits: 1

Course outcomes: The students will be able to		Blooms Taxonomy
CO1	Apply conditional statement, loops condition and functions in python program	K3
CO2	Solve mathematical and mechanical problems using python program	K3
CO3	Plot various type of chart using python program	K3
CO4	Analyze the mechanical problem using python program	K4

List of Python Program

1. Write a program to find root of quadratic equation
2. Write a program to find and delete repeating number in Given List
3. Write a program to input and print the element sum of user defined matrix
4. Write a program to input and multiply two different matrices
5. Write a program to compute eigen value and vector of a given 3*3 matrix using NumPy
6. Write a program to find a solution of linear equations in y-mx+c
7. Write a program to draw line using equation y=mx+c
8. Write the program to determine the intersection point of two line.
9. Draw various types of charts using matplotlib
10. Write a program to perform equations of uniform motion of kinematics :

i. $v = u + at0$
ii. $s = ut + ½(at^2)$
iii. $v^2 = u^2 – 2as$

11. Write a menu driven program to perform following properties of thermodynamics as given below:

i. First Law of thermodynamics (U = Q - W), where ΔU is the change in the internal energy. Q is the heat added to the system, and W is the work done by the system.
ii. Efficiency of Heat Engine = TH – TC / TH where TH &TC is the temperature of HOT and COLD Reservoirs.

12. Write the menu program to find the to find the out relationship between stress and strain curve as given below:

i. Young's Modulus
ii. Shear Modulus
iii. Poisson Ratio

13. Write the program to determine the shear force and bending moment in beams.
14. Write a program to find maxima/minima of functions of two variables and evaluate some real definite and finite integrals.
15. Write a Program to find out unknown magnitude of TB and TD of unknown tension can be obtained from two scalar equations of equilibrium i.eEF_x = 0 and EF_y =0.
16. Write a program to perform interpolation of equally and unequally spaced data.
17. Write a program to calculate total pressure exerted in ideal fluid as equation is given below: $p+1/2(\rho v^2) + \rho gh =$constant
    Where P is Pressure, V is Velocity of fluid, ρ is density and h is the height of the container.
18. Write a program to find numerical differentiation using Finite differences Method by importing NumPy and plot the numerical values using matplotlib libraries of python.

19. Write a program for bresenham's line drawing algorithm.
20. Write a program for geometric transformation of a given object.

Subject Code: KMT 551	Measurement & Metrology Lab	L T P : 0 0 2	Credits: 1

Course outcomes: The students will be able to		Blooms Taxonomy
CO1	Apply knowledge of basics of Measurements, Metrology and Measuring devices.	K3
CO2	Apply the concepts of various measurement systems & standards with regards to realistic applications.	K3
CO3	Use sensors, transducers and terminating devises with associated parameters	K3
CO4	Apply basic principles and devices involved in measuring surface textures.	K3

MEASUREMENT & METROLOGY LAB

Minimum 8 experiments out of following (or such experiment) are to be performed:

1. Study the working of simple measuring instruments- Vernier calipers, micrometer, tachometer.
2. Measurement of effective diameter of a screw thread using 3 wire method.
3. Measurement of angle using sine bar & slip gauges. Study of limit gauges.
4. Study & angular measurement using level protector.
5. Adjustment of spark plug gap using feeler gauges.
6. Study of dial indicator & its constructional details.
7. Use of dial indicator to check a shape run use.
8. Use of dial indicator and V Block to check the circularity and plot the polar Graph.
9. Study and understanding of limits, fits & tolerances.
10. Experiment on measurement of pressure.
11. Study of temperature measuring equipments.
12. Measurement using Strain gauge.
13. Measurement of speed using stroboscope.
14. Experiment on measurement of flow.
15. Measurement of vibration/power.
16. Experiment on dynamometers.

17 To study the displacement using LVDT.

Semester – V: Departmental Elective – I: Specialization – Manufacturing and Automation

Subject Code: KME 051	Computer Integrated Manufacturing	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understand the basic concepts of automation, computer numeric control machining	K2
CO 2	Understand the algorithms of line generation, circle generation, transformation, curve, surface modeling and solid modeling	K2
CO 3	Understand group technology, computer aided process planning, flexible manufacturing, Industry 4.0, robotics	K2
CO 4	Understand information system and material handling in CIM environment, rapid prototyping	K2
CO 5	Apply the algorithms of line & circle generation and geometric transformations	K3
CO6	Develop CNC program for simple operations	K3

Unit 1

Introduction to Computer Integrated Manufacturing (CIM): Introduction to CAD, CAM, CIM, Automated Manufacturing system; Need of automation, Basic elements of automation, Levels of automation, Automation Strategies, Advantages & disadvantages of automation, Historical development and future trends. Computer Integrated Manufacturing, Computers in manufacturing industries.

Unit 2

Principles of Computer Graphics:

Point plotting, drawing of lines, Bresenham's circle algorithm.

Transformation in Graphics:

2D transformations – rotation, scaling, translation, mirror, reflection, shear – homogeneous transformations – concatenation, 3D transformations.

Curves: Introduction to Hermite cubic splines, Bezier curves, B-spline curves, NURBS

Surface Modeling: Polygon surfaces, Quadric surfaces, Superquadric surfaces and blobby objects

Solid modeling: Boolean set operations, Primitive instancing, Sweep representation, Boundadry representation, Constructive solid geometry,

Unit 3

Computer Aided Manufacturing:

NC in CAM – Principal types of CNC machine tools and their construction
features – tooling for CNC – ISO designation for tooling – CNC operating system
Programming for CNC machining – coordinate systems – manual part programming – computer assisted part programming.

Unit 4

Group Technology: Group technology, Cellular Manufacturing, CAPP – Variant and Generative systems- Concurrent Engineering and Design for Manufacturing.

Flexible Manufacturing System: characteristics – economics and technological justification – planning, installation, operation and evaluation issues – role of group technology and JIT in FMS – typical case studies future prospects, Industry 4.0.

Robotics: Classification and specification – drive and controls – sensors - end effectors - grippers-tool handling and work handling – machine vision – robot programming concepts – case studies in assembly.
Introduction to Programmable logical controller

Unit 5
Data and information in CIM: Management information system in CIM environment, MRP – MRP II – ERP - Capacity planning.

Material handling in CIM environment: Types – AGVS – AS/RS – Swarf handling and disposal of wastes – single and mixed mode assembly lines – quantitative analysis of assembly systems.

Rapid prototyping: Need for rapid prototyping, Basic principles and advantages of RP, General features and classifications of different RP techniques with examples.

Books and References:
1. MikellP.Groover - Automation , Production Systems and Computer IntegratedManufacturing, Second edition, Prentice Hall of India.
2. Ibrahim Zeid - CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd.,Company Ltd., New Delhi.
3. YoramKoren,Control of machine tools,McGraw-Hill.
4. Hearn & Baker, Computer Graphics, Prentice Hall of India
5. Sunil Kumar Srivastava, Computer Aided Design: A Basic and Mathematical Approach, I K International Publishing House
6. P.Radhakrishnan, - CAD/CAM/CIM, New Age International (P) Ltd., New Delhi

Semester – V: Departmental Elective – I: Specialization – Production Engineering/ Industrial Production Engineering

Subject Code: KPI 051	Advance Manufacturing Science	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the principles of material removal mechanism of advanced machining processes.	K2
CO-2	Understand the basic concept of advance metal forming processes.	K2
CO-3	Understand the basic concept of advance casting processes.	K2
CO-4	Understand the basic concepts of advance welding process.	K2
CO-5	Understand various hybrid modern manufacturing methods.	K2

UNIT-1

Introduction (3 Hours)

Types of advanced manufacturing processes, Evolution, need, and classification of advanced machining processes.

Advanced Machining Processes (5 Hours)

Introduction Need & benefits, application and working principle, Advantages & Disadvantages of Abrasive jet machining (AJM) Water jet machining (WJM) Abrasive water jet machining (AWJM), Advance abrasive finishing process, Abrasive Flow Finishing, Magnetic Field Assisted Abrasive Finishing, Magneto Rheological Finishing.

UNIT-2

Advanced Machining Processes continued... (7 Hours)

Process principle, Mechanism of material removal, Process Parameters, Process Capabilities, and Applications of Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes.

UNIT-3

Advanced Metal Forming Processes (6 Hours)

Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming and Contour roll forming.

UNIT-4

Advanced Casting Processes (7 Hours)

Metal mould casting, Continuous casting, Squeeze casting, Vacuummould casting, Evaporative pattern casting, Ceramic shell casting.

Advance Welding Processes: Magnetic arc welding, Friction welding, Explosive welding, Ultrasonic welding, Laser welding, Electron beam welding

UNIT-5 (8Hours)

Derived and Hybrid Modern manufacturing Methods: Introduction of process like rotary ultrasonic machining , electro stream drilling, shape tube electro machining, wire electro discharge machining, electro chemical grinding, electro chemical honing, electro chemical deburring and electro chemical spark machining.

Reference Books:-

1. "Materials and Processes in Manufacturing" (8th Edition), E.P. De Garmo, J. T Black, R.A.Kohser, Prentice Hall of India, New Delhi (ISBN 0-02-978760).
2. "Manufacturing Science" A. Ghosh, and A.K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
3. "Non traditional Manufacturing Processes", G.F.Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7).
4. H. Abdel and G. El-Hofy, Advanced Machining Processes: Non traditional and Hybrid Machining Processes, 1 st edition, McGraw-Hill Professional, 2005. ISBN: 978- 0071453349.

Semester – V: Departmental Elective – I: Specialization – Plastic Engineering

Subject Code: KMT 051	Plastic Materials & Manufacturing	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand various methods of preparation of different plastic materials and properties of polymers based on the structure.	K2
CO2	Understand various methods of preparation of different plastic materials.	K2
CO3	Understand the knowledge of processing of plastic materials by injection moulding, extrusion, and blow moulding.	K2
CO4	Understand the basics of Plastics mould design and also product design.	K2
CO5	Understand how the plastics materials are tested for its chemical, mechanical, electrical, optical, thermal, and permanence properties.	K2

Unit –I

Structure of Plastics : Molecules –Crystallinity – Effect of Crystallinity on properties – cross linked plastics – Determination of Molecular weight – Effect of Molecular weight on processing and properties

– Molecular weight distribution. Linear, branched and cross linked structures in polymers. Flexibility and movement of macromolecules. Glass transition temperature (Tg). Relationship

Unit-II

Plastic Materials Sources of raw materials, general purpose plastics, engineering plastics and thermosets plastics, thermo setting and elastomers general high performance plastics, properties of plastics materials, alloys and blending. Properties and applications of polyethylene, polypropylene ABC PVC, nylons, poly acetates, polycarbonates, phenol formaldehyde, melamine formaldehyde.

Unit-III

Plastics Manufacturing Processes Basic concepts of injection moulding, processvariables, blow moulding, compression moulding Extrusion process and their process variables and rotational moulding.

Unit-IV

Basic concept of mould design Selection of proper mould design, single, multi cavity semiautomatic and automatic moulds cooling system, injection and feeding system. Design of product features i e wall thickness rib bosses, radii and draft.

Unit-V

Plastic Material Testing Importance of testing, standard and specifications, national, international standards, test specimen preparation, preconditioning and test atmosphere. Introduction to Mechanical testing, thermal testing, Electrical & Optical testing.

Books and References:

1. Hand book of plastics material and technology
2. Back plastics product design
3. Engineering Plastics, Parmar, Khanna Book Publishing Co., Delhi
4. Mathur AB &Bhardwaj IS, Testing and evaluation of plastics

5. Strong A Brent, Plastics materials and processing.

Semester – V: Departmental Elective – I: Specialization – Manufacturing Engineering

Subject Code: KMT 052	Lean Manufacturing	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand the concepts, theories of Lean Manufacturing, including key aspects of Just in Time, 5S and Kaizen.	K2
CO2	Understand the systematic manufacturing for eliminating waste in system. To account the waste generated from uneven workloads and overburden and then reduces them in order to increase value and reduce costs.	K2
CO3	Develop an understanding of basic of maintenance and full production systems.	K3
CO4	Identify similar parts and group them together in order to take advantage of the similarities in design and production by the help of Group technology.	K3
CO5	Identify and remove waste in value streams to increase the efficiency of a given value stream.	K3

Unit I

Race without a Finish Line: Competitive Advantage, Just-in-Time and Total Quality Management, Evolution of Manufacturing, The Quality Movement, The Imperative.

Value – Added and Waste Elimination : Value – added focus, sources of waste ,JIT Principles, The meaning of JIT. 5S housekeeping Concepts, 5S auditing, Kaizen activities, Kaizen workshop, Benefits of kaizen.

Unit II

Elements Of Lean Production : Small-Lot Production, Lot-Size Basics, Lot Sizing, Lot-Size Reduction, Facilitating small Lot Sizes.

Setup-Time Reduction: Improve Setups? Why Bother?, Setup-Reduction Methodology, Techniques for Setup Reduction, setup-Reduction Projects.

Unit III

Maintaining and Improving Equipment: Equipment Maintenance, Equipment Effectiveness, Preventive Maintenance Program, Total Productive Maintenance, Implementing TPM.

Pull Production Systems: Production Control Systems, Process Improvement, How to Achieve Pull Production, Other Mechanisms for Signal and Control, To Pull or Not to Pull.

Unit IV

Focused Factories and Group Technology: Ways of Doing Work, Facilities Layout, Group Technology, Focused Factory, Establishing Product, Chapter Supplement. Work cells and Cellular Manufacturing: Work cell Concepts, Work cell Applications, Work Design, Workers in Cells, Equipment Issues, Implementing, Getting Started.

Unit V

Lean Systems: Introduction to value stream mapping, VSM Principles, VSM TOOLS, Current Value stream mapping, Future State Mapping.

Text Books:

1. John M Nicholas -Competitive Manufacturing Management, TMH, Edition-2001.
2. Ronald G Askin and Jeffrey B Goldberg, Design and Analysis of Lean, John Wiley - 2001

References :

1. Pascal Dennis -Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System, Second Edition, ISBN
2. John Miltenburg -Manufacturing Strategy, ISBN, Second Edition.
3. Don Tapping,TomLuyster and Tom Shuker -Value Stream Management, Productivity Press.

Semester – V: Departmental Elective – II: Specialization – Manufacturing and Automation

Subject Code: KME 055	Advance welding	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understand the physics of arc welding process and various operating characteristics of welding power source.	K2
CO 2	Analyse various welding processes and their applications.	K3
CO 3	Apply the knowledge of welding for repair & maintenance, along with the weldability of different materials.	K3
CO 4	Apply the concept of quality control and testing of weldments in industrial environment.	K3
CO 5	Evaluate heat flow in welding and physical metallurgy of weldments.	K4

UNIT-I:

Introduction: Introduction to welding, application, classification and process selection criterion. Health & safety in welding.

Welding Arc: Physics of welding arc, arc initiation, voltage distribution, arc characteristics, arc efficiency, arc temperatures and arc blow.Mechanism and types of metal transfer.

Welding Power Sources: Types of welding power sources, operation characteristics and specifications.

UNIT-II:

Welding Processes: Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW) Gas Tungsten Arc Welding (GTAW) Plasma Arc, Submerged Arc Welding, Electro gas and Electroslag, Resistance welding, Friction welding, Brazing, Soldering & Braze welding. Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding.

Advances in Welding Processes: Narrow Gap, Tandem (Twin / Multi Wire) Welding, A-TIG, Hybrid Welding processes**,** Magnetically impelled arc butt (MIAB) welding**,** welding automation and robotic applications.

UNIT-III:

Heat Flow Welding: Weld thermal cycle, Temperature distribution, Peak temperature; Heat Affected Zone (HAZ), heating, cooling and solidification rates.

Welding Metallurgy: Fundamentals of physical metallurgy, Principle of solidification of weld metal, Reactions in weld pool - Gas metal reaction, Slag metal reaction, factors affecting changes in microstructure and mechanical properties of HAZ, Micro and macro structures in weld metal and HAZ

UNIT-IV:

Repair & Maintenance Welding: Hardfacing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Weldability: Effects of alloying elements on weldability, carbon equivalent, welding of plain carbon steel, Stainless steel, Cast Iron and Aluminium alloys, Welding of Dissimilar Materials

UNIT-V:

Weld Design: Types of welds & joints, Welding Symbols, Weld defects and Remedies, Residual Stresses & Distortion, Inspection and testing of welds: Introduction to Non Destructive Techniques; Destructive Techniques - Bulk and Microhardness test, Wear test and types, corrosion test, tensile test, bend test, SEM, EDS and XRD.

Welding Codes, WPS&PQR: Introduction to welding codes, ISO, ASME and BIS specifications, Welding Procedure Specification (WPS) & Procedure Qualification Record (PQR), Welding of pipe-lines and pressure vessels.

Books and References:

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principals and Practices, by- Edwars R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, KhannaPublishsers.
4. Welding Technology Fundamentals by William. A. Bowditch.
5. Welding Technology by N K Srinivasan.
6. Welding Engineering and Technology by R S Parmar.
7. Modern Welding Technology by Howard B Cary and Scott Helzer.
8. Welding Handbooks (Vol. I & II)
9. Advanced Welding Processes, Woodhead publishing, J. Norrish
10. ASME Sec. IX, Boiler and Pressure Vessel Code

Semester – V: Departmental Elective – II: Specialization – Manufacturing Engineering

Subject Code: KMT 053	Automation & Robotics	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understand basics of automation and their role in industry	K2
CO 2	Understand mechanical structures of industrial robots and their operational workspace characteristics	K2
CO 3	Understand the various power transmission systems used to drive robots	K2
CO 4	Develop the ability to analyze and design the motion for articulated systems.	K3
CO 5	Apply the concepts robot programming for various applications and economics analysis	K3

UNIT- I:

Automation:

Definition, Advantages, goals, types, need, laws and principles of Automation.Elements of Automation.

Fluid power and its elements, application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems, Role of Robotics in Industrial Automation.

UNIT- II:

Manufacturing Automation:

Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multi model and mixed model production lines.

Programmable Manufacturing Automation CNC machine tools, Machining centres, Programmable robots, Robot time estimation in manufacturing operations.

UNIT- III:Robotics

Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Power Source.

Robot anatomy, configuration of robots, joint notation schemes, work volume, manipulator kinematics, position representation, forward and reverse transformations, homogeneous transformations in robot kinematics, D-H notations, kinematics equations, introduction to robot arm dynamics.

UNIT -IV:Robot Drives and Power Transmission Systems

Robot drive mechanisms: Hydraulic / Electric / Pneumatics, servo & stepper motor drives. Mechanical transmission method: Gear transmission, Belt drives, Rollers, chains, Links, Linear to Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearings.

Robot end Effectors:

Classification of End effectors – active and passive grippers, Tools as end effectors, Drive system for grippers. Mechanical, vacuum and magnetic grippers. Gripper force analysis and gripper design.

UNIT- V:

Robot Simulation:

Methods of robot programming, Simulation concept, Off-line programming, advantages of offline programming.

Robot Applications:

Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation. Limitation of usage of robots in processing operation.Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference.

Books and References:

1. An Introduction to Robot Technology, by CoifetChirroza, Kogan Page.
2. Robotics for Engineers, by Y. Koren, McGraw Hill.
3. Robotic: Control, Sensing, Vision and Intelligence, by Fu, McGraw Hill.
4. Introduction to Industrial Robotics, by Nagrajan, Pearson India.
5. Robotics, by J.J. Craig, Addison-Wesley.
6. Industrial Robots, by Groover, McGraw Hill.
7. Robotic Engineering - An Integrated Approach : Richard D. Klafter Thomas A.
8. Robots & Manufacturing Automation, by Asfahl, Wiley.

Semester – V: Departmental Elective – II: Specialization – Manufacturing Engineering

Subject Code: KMT 054	Mould Design and Manufacturing	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand mold making process	K2
CO2	Understand about various methods of preparation of different moulds.	K2
CO3	Understand the knowledge of different kind of moulding.	K2
CO4	Understand inspection of mold	K2
CO5	Understand knowledge in machining process related to moulding.	K2

Unit – I

Moulding considerations: Draft, radii, dimensional tolerances, wall thicknesses, ribs and bosses, inserts, sink marks, undercuts, feeding system, gate location, flow pattern, shrinkage and post moulding shrinkage. Design of Plastic under static load; Design of Plastic under Dynamic load-Gear, Bearing. Metal insert, hinge, fasteners.

Unit – II

Injection mould design: Single, multicavity, semi-automatic and automatic moulds. Types of injection mould, their application, detailed structure and working. Feed system, Temperature control system, Ejection System, Standard Mould base. Split Mould and types of mechanism.

Unit – III

Design concepts for compression moulds, transfer moulds and blow moulds. Extrusion Dies - Types of extrusion dies and design characteristics.

Unit – IV

Mould material, Material selection for mould making, Properties of steels for moulds. Nonferrous metals for moulds. Polishing technology in mold making: Definition of surface roughness, basis of polishing technology, Effect of mold materials on polishability, Types of polishing tools, Methods of polishing.

Unit – V

Jig boring, Pantograph, Profile grinding, Electrical discharge machining, hobbingprocess.Classification of NC machine tools, NC Part Programming.Geometry, Motion and Additional statements, Macro- statement Open and closed loops. Control of point to point systems-Incremental open loop control, Incremental close loop, Absolute close loop.

Reference Books

1. David H Morton Jons John wellis “Polymer product design materials and processing”
2. Rao NS “Design data for plastics engineers”
3. Rao NS “design formula for plastics engineers”
4. Joshi MV “dies for plastics extrusion”
5. Millar ,Edward “plastics product design part A& B”
6. DYM “product design with plastics”
7. Beck “plastics product design”
8. Dubois “plastics product design engineering hand book”
9. Malloy , Robert, A “plastics part design for injection moulding”
10. Bebb,R.H., “Plastics Mould Design Vol.1 Compression and Transfer Moulds
11. PyeR.G.W., “Injection MOULD Design for Thermoplastics”

12. DYM, “Injection Moulds and Moulding”
13. Lee NC “Blow moulding design guide”
14. ”Mold making handbook for Plastic Engineers”, KlusStokhert (Edt.),Hanser Publishers, NY,1983
15. “CAD/CAM” HP Groover&EWZimmers, Jr. Prentice Hall India Ltd.
16. Stoeckhert “Menning, Mold making handbook”, 2nd edition, Hanser Publishers, Munich.
17. “Mold Engineering”, Herbert Rees, Hanser Publishers, NY. George Menges& Paul Mohren
18. “How To Make Injection Molds”, Hanser Publishers.
19. “Plastics Mold Engineering”, DuBois; J. Harry and Pribble; W. I. (Eds.),SPE Polymer Technology

Semester – V: Departmental Elective – II: Specialization – Manufacturing Engineering

Subject Code: KMT 055	Time & Motion Study	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Develop a case for productivity improvement in any manufacturing	K3
CO2	Calculate the basic work content of a specific job for employees of an organization. Thereby they will be able to calculate the production capacity of man power of an organization	K3
CO3	Provide appropriate allowances for the jobs under analysis.	K3
CO4	Conduct a method study in any organization with the objective of improving a process, material movement system or design of a work place	K3
CO5	Develop time standards for operations, identify production bottlenecks and improvise operations	K3
CO6	Devise appropriate wage and incentive plan for the employees of an organization	K3
CO7	Analyze the existing methods of working for a particular job and develop an improved method through questioning technique.	K4

UnitI

Introduction to industrial Engineering, productivity, measurement of productivity

UnitII

Introduction to work-study.The basic procedure of work-study. Work study for establishing the standard time for a given activity. Method study, procedure for Method study, Principles of motion economy, Filming techniques and micro motion analysis, recording technique. Construction of process chart, Gantt chart, SIMO chart, string chart, Travel chart, Multiple activity chart, Sampling process, Critical examination analysis. Primary, secondary and tertiary stages. Search for alternatives. Steps involved in evaluation of alternatives

Unit III

Introduction to work measurement, objectives of work measurement, Techniques of work measurement.Basic procedure in time study. Advantages and limitations of time study. Time recording techniques in time study. Performance rating standard allowances, personal allowance, fatigue allowance, production delay allowance. Factors affecting the rating.Synthetic rating method.

Unit-IV

Work sampling, process of work sampling, predetermined motion time systems, standard data system, job evaluation and merit rating. work factor method. Method time measurement system, basic, motion time study system

Unit-V

Wages and incentive plans. relationship between wages productivity and cost. Case studies

REFERENCE:

1. ILO International labor organization “Introduction to work study” TATA McGraw Hill
2. M.E.Mundel” Motion and Time study”
3. R.M.Barynes “Motion and Time study”
4. E.S.Buffa “Modern production management” TATA McGraw Hill

5 Dr.A.K.Singh “Time and motion study” Jaico publishing houses

Subject Code: KMT 601	Pneumatics And Hydraulics	L T P : 3 1 0	Credits: 4

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand the main components of the hydraulic and pneumatic systems and their functions and symbols.	K2
CO2	Understand the advantages and disadvantages of hydraulic/pneumatic systems, and be aware of the underlying principles.	K2
CO3	Describe the construction, operation principles, and uses of auxiliary equipment, such as filters, oil coolers, oil heater and accumulators.	K3
CO4	List and follow safety rules as they apply to the hydraulics/pneumatics field	K3
CO5	Select hydraulic fluids based on their classifications and properties.	K4
CO6	Design and predict simple linear actuator and hydrostatic transmission circuits.	K5

Unit I

Introduction to Fluid Power And Drives Fluid Power Systems – Application of fluid power – Properties of hydraulics fluids – Hydraulics pumps – Characteristics – Pump Selection -, Hydraulics Actuators – Linear, Rotary – Selection – Characteristics – Cylinder Mountings, cushioning, pipe fittings.

Unit II

(Fluid Power Elements) Pressure control valves, flow control valves, directional control valves – working principle and construction, special type valves, servo valves, Cartridge valves Actuation methods, Shock absorbers – Accumulator – Symbol for fluid power elements.

Unit III

(Hydraulics Circuits) Hydraulics circuits – automatic reciprocating circuit – speed control circuit - Meter in - Meter out – Sequencing Circuits – Synchronizing circuits Accumulator circuit – Safety circuits – Hydraulic Motor braking System. Design of Hydraulic circuits.

Unit IV

Pneumatic Systems Pneumatic fundamentals Filter, regulator, lubricator, air motors, air cylinders, pneumatic valves, Basic Pneumatic circuits – Hydro Pneumatic Systems – air- oil cylinder, air – oil reservoir, air – oil intensifier and simple circuits.

Unit V

Fluid Logic Control Principle of fluid Logic control, Basic fluidic devices - Fluid sensors Fluidic circuits – sequencing control, continuous reciprocation, Electrical controls – electrical components – simple electro hydraulic/ pneumatic circuits. PLC application in fluid power control.

Reference Books:

1. A Fluid Power with applications Antony Esposito
2. B. Pneumatic Systems – Principles and Maintenance Mazumdar S. R
3. Sadhu Singh, Fluid Machinery, Khanna Publishing House
4. Oil Hydraulics Systems – Principles and Maintenance Mazumdar S. R
5. D. Industrial Hydraulics John Pipenger& Tyler Hicks
6. E. Fluid Power Chandashekhara P. K.
7. A.K. Babu, Automobile Mechanics, Khanna Publishing House
8. F. Automobile Engineering Vol. I Kripal Singh

Subject Code: KME 602	Machine Design	L T P : 3 1 0	Credits: 4

Course Outcomes: The student will be able to		Blooms Taxonomy
CO 1	Recall the basic concepts of Solid Mechanics to understand the subject.	**K2**
CO 2	Classify various machine elements based on their functions and applications.	**K2**
CO 3	Apply the principles of solid mechanics to machine elements subjected to static and fluctuating loads.	**K3**
CO 4	Analyze forces, bending moments, twisting moments and failure causes in various machine elements to be designed.	**K4**
CO 5	Design the machine elements to meet the required specification.	**K5**

Unit I **8 Hours**

Introduction

Definition, Design requirements of machine elements, Design procedure, Standards in design, Standards designation of carbon & alloy steels, Selection of preferred sizes, Selection of materials for static and fatigue loads, Design against Static Load

Design against Fluctuating Loads

Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Design for finite & infinite life, Soderberg, Goodman, Gerber criteria

Unit II **8 Hours**

Riveted Joints

Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint

Welded Joints

Stress relieving of welded joints, Butt Joints, Fillet Joints, Strength of Butt Welds, Strength of parallel fillet welds, Strength of transverse fillet welds

Shafts

Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity, Keys, Types of keys, Selection of square and flat keys, Strength of sunk key

Unit III **8 Hours**

Spur Gears

Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

Helical Gears

Terminology, Proportions for helical gears, Force components on a tooth of helical gear, Virtual number of teeth, Beam strength and wear strength of helical gears, Dynamic load on helical gears, Design of helical gears.

Introduction, Classification and Applications of Bevel & Worm Gears

Unit IV **8 Hours**

Sliding Contact Bearing

Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing.

Rolling Contact Bearing

Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing.

Unit V **8 Hours**

IC Engine Parts

Selection of type of IC engine, General design considerations, Design of Cylinder and cylinder head; Design of piston, piston ring and gudgeon pin;

Friction Clutches

Clutches, Difference between coupling and clutch, Single plate friction clutch, Torque transmitting capacity, Multi-Disk Clutches, Friction Material

Note: Design data book is allowed in the examination

Text Books:

1. Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Co.
2. Design of Machine Elements, Sharma and Purohit, PHI.

Reference Books:

1. Mechanical Engineering Design, 9e – Joseph E. Shigely, McGraw Hill Education.
2. Machine Design-Maleev and Hartman, CBS Publishers.
3. Design of Machine Design-M.F. Spott, Pearson Education.
4. Elements of Machine Component Design, Juvinal&Marshek, John Wiley & Sons.
5. Machine design, Robert L. Norton, Pearson Education
6. Theory & Problem of Machine Design (Schaum's Outline Series) Hall, Holowenko, Laughlin, Tata McGraw Hill Co.
7. Machine Design-Sharma and Agrawal, S.K. Kataria& Sons.
8. Machine Design, U C Jindal, Pearson Education.

Subject Code: KME 603	Theory of Machines	L T P : 3 1 0	Credits: 4

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand the principles of kinematics and dynamics of machines.	K2
CO2	Calculate the velocity and acceleration for 4-bar and slider crank mechanism	K3
CO3	Develop cam profile for followers executing various types of motions	K3
CO4	Apply the concept of gear, gear train and flywheel for power transmission	K3
CO5	Apply dynamic force analysis for slider crank mechanism and balance rotating & reciprocating masses in machines.	K3
CO6	Apply the concepts of gyroscope, governors in fluctuation of load and brake & dynamometer in power transmission	K3

Unit I **(09 Hours)**

Introduction, mechanisms and machines, kinematics and kinetics, types of links, kinematic pairs and their classification, types of constraint, degrees of freedom of planar mechanism, Grubler's equation, mechanisms, inversion of four bar chain, slider crank chain and double slider crank chain.

Velocity analysis: Introduction, velocity of point in mechanism, relative velocity method, velocities in four bar mechanism, instantaneous center.

Acceleration analysis: Introduction, acceleration of a point on a link, acceleration diagram, Corioli's component of acceleration, crank and slotted lever mechanism,.

Unit II **(10 Hours)**

Cams: Introduction, classification of cams and followers, cam profiles for knife edge, roller and flat faced followers for uniform velocity, uniform acceleration

Gears and gear trains: Introduction, classification of gears, law of gearing, tooth forms and their comparisons, systems of gear teeth, length of path of contact, contact ratio, minimum number of teeth on gear and pinion to avoid interference, simple, compound, reverted and planetary gear trains, sun and planet gear train.

Unit III **(08 Hours)**

Force analysis: Static force analysis of mechanisms, D'Alembert's Principle, dynamics of rigid link in plane motion, dynamic force analysis of planar mechanisms, piston force and crank effort. Turning moment on crankshaft due to force on piston, Turning moment diagrams for single cylinder double acting steam engine, four stroke IC engine and multi-cylinder engines, Fluctuation of speed, Flywheel.

Unit IV **(09 Hours)**

Balancing: Introduction, static balance, dynamic balance, balancing of rotating masses, two plane balancing, graphical and analytical methods, balancing of reciprocating masses, balancing of single cylinder engine.

Governors: Introduction, types of governors, characteristics of centrifugal governors, gravity controlled and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors. Effort and Power of governor

Unit V **(09 Hours)**

Brakes and dynamometers: Introduction, Law of friction and types of lubrication, types of brakes, effect of braking on rear and front wheels of a four wheeler, dynamometers, belt transmission dynamometer, torsion dynamometer, hydraulic dynamometer

Gyroscope: Space motion of rigid bodies, angular momentum, gyroscopic couples, gyroscopic stabilization, ship stabilization, stability of four wheel and two wheel vehicles moving on curved paths.

Text / Reference Books

1. Kinematics and dynamics of machinery: Wilson and Sadler, Third edition, Pearson.
2. Theory of Mechanisms and Machines: Amitabh Ghosh and Ashok Kumar Mallik, Third Edition Affiliated East-West Press.
3. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press
4. Kinematics and dynamics of machinery: R L Norton, McGraw Hill
5. Theory of Machines: S.S. Rattan, McGraw Hill
6. Theory of Machines: Thomas Bevan, CBS Publishers.

Suggested Software

MechAnalyzer

Subject Code: KMT 651	Pneumatics & Hydraulics Lab	L T P : 0 0 2	Credits: 1

The students will be able to:		Blooms Taxonomy
CO1	Analyze the performance of fluid power systems.	K4
CO2	Analyze Operation control systems.	K4
CO3	Describe hydraulic circuit's components using hydraulic symbols	K3
CO4	Identify pressure and power losses in hydraulic conduits	K4
CO5	Recognize the different types of hydraulic pumps.	K4
CO6	Classify, draw and recognize the different types of control valves.	K4

PNEUMATICS & HYDRAULICS LAB

1. List of experiments
2. Study of the single acting & double acting hydraulic& pneumatic cylinders .
3. Study of symbols used in single and double acting hydraulic & pneumatic cylinders.
4. Study of constructional detail and performance characteristics of linear pumps.
5. Study of constructional detail and performance characteristics of rotary pumps.
6. Determination of viscosity index of hydraulic fluids by using redwood viscometer.
7. Study and operation of solenoid valves and relay timers.
8. To operate a single acting cylinder using 3/2 push button valves on a electro pneumatic kit
9. To operate a single acting cylinder using 3/2 push button valves on a electro pneumatic kit
10. To operate a 5/2 pilot operated valve by using double acting cylinder on a electro pneumatic kit.
11. Design of Hydraulic/Pneumatic circuit of a single acting and double acting cylinders.

Subject Code: KME 652	Machine Design Lab	L T P : 0 0 2	Credits: 1

Course Outcomes: The student will be able to		Blooms Taxonomy
CO-1	Apply the principles of solid mechanics to design various machine Elements subjected to static and fluctuating loads.	**K3**
CO-2	Write computer programs and validate it for the design of different machine elements	**K4**
CO-3	Evaluate designed machine elements to check their safety.	**K5**

A Design of Machine Elements

1. Design a knuckle joint subjected to given tensile load.
2. Design a riveted joint subjected to given eccentric load.
3. Design of shaft subjected to combined constant twisting and bending loads
4. Design a transverse fillet welded joint subjected to given tensile load.
5. Design & select suitable Rolling Contact Bearing for a shaft with given specifications
6. Design a cylinder head of an IC Engine with prescribed parameters.
7. Design of Piston & its parts of an IC Engine

B. Computer Programs for conventional design

Computer and Language: Students are required to learn the basics of computer language such as C/C++/MATLAB so that they should be able to write the computer program.

1. Design a pair of Spur Gear with given specifications to determine its various dimensions using Computer Program in C/C++.
2. Design a pair of Helical Gear with given specifications to determine its various dimensions using Computer Program in C/C++.
3. Design of Sliding Contact Bearing with given specifications & determine its various parameters using Computer Program in C/C++.

Subject Code: KME 653	Theory of Machines Lab	L T P : 0 0 2	Credits: 1

The students will be able to:		Blooms Taxonomy
CO1	Demonstrate various mechanisms, their inversions and brake and clutches in automobiles	K2
CO2	Apply cam-follower mechanism to get desired motion of follower.	K3
CO3	Apply the concepts of gears and gear train to get desired velocity ratio for power transmission.	K3
CO4	Apply the concept of governors to control the fuel supply in engine.	K3
CO5	Determine the balancing load in static and dynamic balancing problem	K3

List of Experiments

(Minimum eight experiments out of the following)

NOTE: Student has to write computer program in C / C++ / Python and to run to compute the output values for at least ONE experiments.

1. To study various types of kinematics links, pairs, chains & Mechanisms
2. To study Whitworth Quick Return Motion Mechanisms, Reciprocating Engine Mechanism, and Oscillating Engine Mechanism
3. To study of inversions of four bar linkage
4. To study of inversions of single/double slider crank mechanisms
5. To study various types of gear (Helical, cross helical, worm, bevel gear) and gear profile (involute and cycloidal) and condition for interference Helical, cross helical, worm, bevel gear
6. To compute the output velocity invarious gear trains
7. To study gyroscopic effects through models
8. To determine gyroscopic couple on Motorized Gyroscope
9. To perform experiment on dead weight type governor to prepare performance characteristic Curves, and to find stability & sensitivity
10. To perform experiment on spring controlled governor to prepare performance characteristic Curves, and to find stability & sensitivity
11. To determine whirling speed of shaft theoretically and experimentally
12. To perform the experiment for static / dynamic balancing
13. To perform experiment on brake
14. To perform experiment on clutch
15. To perform the experiment for static / dynamic balancing.
16. To perform experiment on longitudinal vibration
17. To perform experiment on transverse vibration

Semester – VI: Departmental Elective – III: Specialization – Manufacturing and Automation

Subject Code: KME 061	Nondestructive Testing	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understand the concept of destructive and Non-destructive testing methods.	K2
CO 2	Explain the working principle and application of die penetrant test and magnetic particle inspection.	K2
CO3	Understand the working principle of eddy current inspection.	K2
CO 4	Apply radiographic techniques for testing.	K3
CO 5	Apply the principle of Ultrasonic testing and applications in medical and engineering areas.	K3

UNIT I:

Introduction to NDT, DT, advantages & limitations of NDT, classification of NDT methods, Comparison with DT, Terminology, Flaws and Defects. Scope of NDT.Codes, Standards and Certifications in NDT.

Visual Inspection– Equipment used for visual inspection, Borescopes, Application of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection, Visual Inspection in Welding.

UNIT II:

Liquid Penetrant Testing – Principle, Scope, Testing equipment, Advantages, Limitations, types of penetrants and developers, standard testing procedure, Zyglo test, Illustrative examples and interpretation of defects.

Magnetic Particle Inspection – Principle, Scope, Testing equipment, Advantages, Limitations, Application of MPI& standard testing procedure, DC & AC magnetization, Skin Effect, different methods to generate magnetic fields, Illustrative examples and interpretation of defects.

UNIT III:

Radiographic Testing – Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photoelectric effect, coherent scattering and Incoherent scattering, Beam geometry.

X-ray Radiography – Principle, equipment & methodology, applications, source, types of radiations and limitations; γ-ray Radiography – Principle, equipment, γ-ray source & technique; Radiography Image Quality Indicators, Film Processing, advantages of γ-ray radiography over X-ray radiography. Precautions against radiation hazards.

UNIT IV:

Ultrasonic Testing – Introduction, Principle, Piezoelectricity and Piezoelectric Transducers, Wave propagation, Ultrasonic probes, selection of angle probes, Acoustic Impedance, Reflection and transmission coefficient, Snell's law, standard testing procedure & calibration, advantages & limitations. Data representation - A-scan, B-scan, C-scan.Applications in inspection of welded joints, castings, forgings and dimensional measurements.Introduction to TOFD& Phased Array Ultrasonic Testing.

UNIT V:

Special NDT Techniques:

Eddy Current Inspection– Introduction, Principle, Methods, scope, Equipment, types of probes, Sensitivity, standard testing procedure, advanced ECT methods, advantages and limitations.

Acoustic Emission Technique– Introduction, Types of AE signal, Principle, Advantages & Limitations, Interpretation of Results, Applications.

Holography, Thermography– Introduction, Principle, advantages, limitations and applications.

Books and References:

1. Non-Destructive Testing and Evaluation of Materials, by- Prasad, McGraw Hill Education.
2. Practical Non-destructive Testing, by- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Woodhead Publishing.
3. Non-Destructive Testing Techniques, by- Ravi Prakash, New Age International.
4. Non destructive Testing Handbook, by Robert C. McMaster, American Society for Nondestructive.
5. Introduction to Non destructive Testing: A Training Guide, by- Paul E. Mix, wiley.
6. Electrical and Magnetic Methods of Non-destructive Testing, by- J. Blitz, springer.
7. Practical non destructive testing by Raj, Baldev.
8. Basics of Non-Destructive Testing, by Lari& Kumar, KATSON Books.
9. ASME Sec. V, boiler and pressure vessel code

Semester – VI: Departmental Elective – III: Specialization – Manufacturing Engineering

Subject Code: KMT 061	Machine Vision & Image Processing	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Blooms Taxonomy
CO 1	Understand the fundamentals of Image Processing	K2
CO 2	Understand theory behind each image processing algorithm	K2
CO3	Differentiate between computer and machine vision as well as their applications	K2
CO 4	Understand importance in applications including security, healthcare, industry, mobility.	K2
CO 5	Analyse images and videos	K4

UNIT I

Introduction Digital image representation; fundamental steps in image processing; elements of digital image processing systems: image acquisition, storage, processing and display. 2. Digital Image Fundamentals : Structure of the human eye; image formation; brightness adaptation and discrimination; a simple image model; uniform and non-uniform sampling and quantization; some basic relationships between pixels; neighbors of a pixel; connectivity; Labeling. Distance measures; imaging geometry.

UNIT II

Image Enhancement in the spatial domain 4L Basic gray level transformations-histogram processing-Enhancement using arithmetic/logic operations-Basics of spatial filtering-comparison between smoothing and sharpening spatial filters.

UNIT III

Image Enhancement in the frequency domain 4L1D Fourier transform-2D Fourier transform and its Inverse-Smoothing & sharpening frequency domain filters (Ideal, Butterworth, Gaussian)-homomorphic filtering.

Image compression 4L Fundamentals-Image compression, Error-free compression: Huffman coding, block coding, constant area coding, variable length coding; bit-plane coding; lossless predictive coding.

UNIT IV

Machine Vision 12L Introduction, definition, human visual system. Active vision system, increasing of machine vision. Machine vision components, hardware's and algorithms, image function and characteristics, image formation & image sensing frequency space analysis, Fourier transform, convolution algorithms, image gaussion, image enhancement, image analysis and segmentation data reduction, feature extraction, edge detection, image recognition and decisions, m/c learning, image processing, machine vision edges detection, application in the area such as inspection part identification, industrial robot control, mobile robot application. Industrial MVs in production and services, structure of industrial m/c vision, generic standards, rules of thumb, image formation, illumination, optics, interfacing machine vision system. Vision system calibration.

UNIT V

2D&3D vision 6L 16 Competing technologies, principle, CCD, Videcon and other cameras, data capture. Triangulation geometry, resolution, passive and active 3-D stereo imaging, data processing

References:

1.Principles of Artificial Intelligence by N.J.Nilsson, Kaufmann.
2. Introduction to AI and Expert Systems by D.W.Patterson, Prentice Hall.
3. Image Processing, Analysis and Machine Vision by Milan Sonka, Vaclav Hlavac, Roger Boyle, 2nd Edition, PWS Publishers.
4. Machine Learning, V.K. Jain, Khanna Publishing House
5. Robotics (Control, Sensing, Vision and Intelligence) by K. S. Fu, R. C. Gonzalez and C. S. G. Lee, McGrawHill Publications.

Semester – VI: Departmental Elective – III: Specialization – Manufacturing Engineering

Subject Code: KMT 062	Tool Design (Same as KME 604)	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Explain the design criterion for single and multipoint cutting tools for different machines.	K2
CO2	Design jigs and fixtures with required tolerances and economy.	K3
CO3	Design the dies for casting and injection moulding processes.	K3
CO4	Design the dies for casting and injection moulding processes.	K3
CO5	Select a suitable control system, drives and kinematic mechanism for a machine tool.	K3

UNIT I: Cutting Tools

Single point Cutting Tools: Tooling, requirements of a tool designer, general tool design procedure, design of single point lathe tool: design of shank dimension using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry; solid type tool, brazed tip tool, long index able insert, throwaway index able insert types and chip breakers.

Multi Point Cutting Tool: Drill bit design of elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry; design of milling cutter: design of elements like number of teeth and height circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry.

UNIT II: Jigs and Fixtures

Jigs & Fixtures: Tolerance analysis and procedure of designing; the economic calculations, location of the work piece, degree of freedom, references surfaces, resting components, fixture elements for surface concentric and radial locations, clamping of the work-piece, review of cutting forces, principles and methods of clamping; quick clamping devices, standards; guiding elements for tools, gauge for cutter, jig bushes, indexing methods, design of jigs/fixtures/accessories for drilling, milling, turning, broaching, grinding, and welding.

UNIT III: Sheet Metal, Bending and Drawing

Design of dies: Simple piercing and blanking process, design of inverted die, compound die, progressive dies, rules for developing stock, strip layouts for progressive dies, types of progressive dies, load centre, analytical and graphical method to determine load centre (i.e. centre of pressure), miscellaneous dies, shaving, horn, cam actuated and precision lamination dies, fine blanking dies, principles - design considerations.

Bending dies: Theory of bending, blank development, spring back effect, spring back factor, methods of correction to overcome spring back, types of bending dies, pressure pad dies, forces in bending, construction and working principles, press brake tooling, curling, flanging principles of stretch forming – stretch forming dies.

UNIT IV: Die Casting Dies and Injection Moulding

Design of dies for metal casting : Casting dies, terminology applicable to process, terminology applicable to dies, alignment of metal flow in hot chamber, horizontal cold chamber and vertical cold chamber machines, modification for casting of deep core or with limitations of stroke, design

for various elements, effect of off-centre cavity layout, necessity of balancing, types of dies, parameters influencing the runner and gate design, ejection mechanism, ejection elements and various locations, die locking mechanism, trimming , types of trim dies and alloys suitable for die making.

Injection Moulding: Injection moulding machine and its elements, general configuration of a mould, 2-plate and 3-plate mould, gate, runner, parting surface, ejection system, core and cooling system, introduction to compression die, transfer die, blow moulding dies, extrusion dies, forming and calendaring dies.

Unit 5: Control, drives and structure

Machine tool control systems, control systems for speed and feed changing, adaptive control systems, CNC machines.

Kinematics of machine tools, motion transmission, design of hydrostatic, hydrodynamic and antifriction guideways, design of spindles, design of speed gear boxes and feed box, feed drives, stepped and stepless regulations of speed, feed diagram, ray diagrams and design considerations.

Vibration in machine tools, lubrication, rigidity, and reliability in machine tools

Text Book

1. Machine Tool Design and Numerical Control by N.K. Mehta, McGraw Hill

Reference Books:

2. Principles of Machine Tools by G.C. Sen and A. Bhattacharya, Central Book Agency
3. Design of Machine Tools by D. K Pal and S. K. Basu, Allied Publishers
4. Machine Tool Design, Vol. I, II, III and IV, N. S. Acherkhan, Mir Publishers
5. Jigs and Fixtures, by Joshi, Tata McGraw Hill, New Delhi.
6. Theory and Application of Metal Cutting, by Juneja, Wiley Eastern Ltd
7. Basic Die Making & Advance Die Making by D. Eugene Ostergaard, McGraw Hill
8. Injection Mould Design by R.G.WPye, Longman Scientific & Technical Publishers

Semester – VI: Departmental Elective – III: Specialization – Manufacturing Engineering

Subject Code: KMT 063	Product Design And Development	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand the product design and development processes in manufacturing industry.	K2
CO2	Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.	K2
CO3	Undertake a methodical approach to the management of product development to satisfy customer needs.	K3
CO4	Carry out cost and benefit analysis through various cost models.	K3
CO5	Competence with a set of tools and methods for product design and development	K3
CO6	Analyse the methodologies for product design, development and management.	K4

UNITI:Introduction to Product Design:

Introduction to PDD, Applications, Relevance, Product Definition, Scope, Terminology. Design definitions, the role and nature of design, old and new design methods, Design by evolution. Examples such evolution of bicycle, safety razor etc. Need based development, technology based developments. Physical reliability & Economic feasibility of design concepts.

UNITII: Morphology of Design

Divergent, transformation and convergent phases of product design. Identification of need, Analysis of need. Design for what? Design criteria, functional aspects. Aesthetics, ergonomics, form (structure). Shape, size, color. Mental blocks, Removal of blocks, Ideation Techniques. Creativity, Checklist.

UNITIII: Transformations

Brainstorming &Synectics.Morphologicaltechniques.Utility concept, Utility value, Utility index. Decision making under multiple criteria.Economic aspects of design.Fixed and variable costs. Break-even analysis.

UNITIV: Reliability

Reliability considerations, Bath tub curve, Reliability of systems in series and parallel. Failure rate, MTTF and MTBF. Optimum spares from reliability consideration. Design of displays and controls, Man-Machine interface, Compatibility of displays and controls.Ergonomicaspects.Anthropometric data and its importance in design. Applications of Computers in product design.

UNIT V: Product Appraisal

Information and literature search, patents, standards and codes. Environment and safety considerations.Existing techniques such as work-study, SQC etc. which could be used to improve method & quality of product.Innovation versus Invention.Technological Forecasting.

Recommended Books:

1. Product Design & Manufacturing - A.K.Chitale&R.C.Gupta, PHI (EEE).
2. Product design and Development-Karl Ulrich-PHI

3. The Technology of Creation Thinking - R.P. Crewford – Prentice Hall
4. The Art of Thought – Grohem Walls – Bruce & Co., New York
5. Product Design & Decision Theory - M.K. Starr - Prentice Hall
6. Engg . Product Design -C .D. Cain, Bussiness Books.
7. Industrial design for Engineers –W .H. Mayall, Itiffe.
8. Design Methods – seeds of human futures – J. Christopher Jones, John Wiley & Sons.
9. Human Factor Engg. – MccormickE.J., McGrawHill.
10. Engineering: An Introduction to Creative profession – G.C. BeakleyHw leach, Macmillan.
11. Industrial Design In Engineering – A marriage of Techniques – Charles H .Flurscheim, The Design Council - London.
12. Reliability Engineering, S.C.Sharma, Khanna Book Publishing Co.

B. Tech Manufacturing Engineering
Evaluation Scheme
Effective in Session 2021-22 (Yet to Finalize)

SEMESTER- VII

Sl. No.	Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1		HSMC-1/HSMC-2	3	0	0	30	20	50		100		150	3
2		Departmental Elective-IV	3	0	0	30	20	50		100		150	3
3		Departmental Elective-V	3	0	0	30	20	50		100		150	3
4		Open Elective-II	3	0	0	30	20	50		100		150	3
5		Lab-1	0	0	2				25		25	50	1
6		Mini Project or Internship Assessment*	0	0	2				50			50	1
7		Project	0	0	8				150			150	4
8		MOOCs (Essential for Hons. Degree)											
		Total	**12**	**0**	**12**							**850**	**18**

***The Mini Project or internship (5 - 6 weeks) conducted during summer break after VI semester and will be assessed during VII semester.

SEMESTER- VIII

Sl. No.	Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1		HSMC-2/HSMC-1	3	0	0	30	20	50		100		150	3
2		Open Elective-III	3	0	0	30	20	50		100		150	3
3		Open Elective-IV	3	0	0	30	20	50		100		150	3
4		Project	0	0	18				100		300	400	9
5		MOOCs (Essential for Hons. Degree)											
		Total	**9**	**0**	**18**	**27**						**850**	**18**

Semester – VII: Departmental Elective – IV: Specialization – Manufacturing and Automation

Subject Code: KME 071	Additive manufacturing	L T P : 3 0 0	Credits: 3

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understanding the basics of additive manufacturing/rapid prototyping and its advantages and disadvantages	K2
CO 2	Understanding the role of additive manufacturing in the design process and the implications for design.	K2
CO 3	Understanding the processes used in additive manufacturing for a range of materials and applications	K2
CO 4	Understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.	K2
CO 5	Apply knowledge of additive manufacturing for various real-life applications	K3

UNIT I

Introduction

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and Indirect Processes; Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.

UNIT II

Development of Additive Manufacturing Technology

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems.

Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

UNIT III

Additive Manufacturing Processes

Vat Photo polymerization; Materials, Reaction Rates, Photo polymerization Process Modelling, Scan Patterns

Powder Bed Fusion Processes; Material, Powder Fusion Mechanism, Process Parameters and Modeling, powder Handling

Extrusion Based System; Basic principles, plotting and Path Control, Other Systems

Material Jetting; Materials, Material Processing Fundamentals, Material Jetting Machines

Directed Energy Deposition Processes; General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing-Structure-Properties Relationships

UNIT IV: Design & Software Issues

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM.

Software Issue for Additive Manufacturing; Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL files Manipulation, Beyond the STL file, Additional Software to Assist AM

UNIT V

Material Design & Quality Aspects

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities

Applications

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson , DSavid W. Rosen , Brent Stucker, Springer.
2. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser.
3. Additive Manufacturing, by- AmitBandyopadhyay, Susmita Bose, CRC Press.
4. Rapid Prototyping: Principles and Applications, by -Chee Kai Chua, Kah Fai Leong, Chu Sing Lim.

Semester – VI: Departmental Elective – V: Specialization – Production Engineering/ Industrial Production Engineering

Subject Code: KPI 071	Flexible Manufacturing System	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the manufacturing systems, flexibility, components of FMS	K2
CO-2	Understand production, planning, scheduling and simulation of FMS	K2
CO-3	Understand concepts of group technology and economics issues in the application of FMS	K2
CO-4	Understand the application of FMS in various operations & involvement of AI in flexible manufacturing system.	K2
CO-5	Apply the concepts of scheduling and simulation in FMS	K3

UNIT-I: Understanding of FMS
Introduction To FMS, Evolution of Manufacturing Systems, objective and Need, Benefits, Components, Types of Flexibility, Merits, Demerits and Applications of Flexibility.

Composition of FMS, CNC machines, robots, automatic storage and retrieval, automatic material handling, computerized control, Hierarchy of Computer Control ,Computer Control of Work Centre and Assembly Lines, FMS Supervisory Computer Control.

UNIT-II: Planning, scheduling and control of flexible manufacturing systems:
Process planning, machine loading, cycle time, machine output vs cycle time, methods to reduce cycle time, machine balancing.

Scheduling, data requirement for scheduling, mater production scheduling, Gantt charts, scheduling rules, scheduling in FMS, Single Product, Single Batch, N–Batch Scheduling Problem, Knowledge Based Scheduling System.

Dispatching, Dispatch activities.

UNIT-III: **FMS simulation and data base**
Application of Simulation, Model of FMS, Simulation Software, Limitation, Manufacturing Data Systems, Data Flow, FMS Database Systems, Planning For FMS Database.

Design of FMS: Performance Evaluation of FMS, Analytical model and Simulation model of FMS.

UNIT-IV: Group technology and justification of FMS
Introduction, Matrix Formulation, Mathematical Programming Formulation, Graph Formulation, Knowledge Based System for Group Technology, Economic Justification Of FMS, Implementation issues and maintenance of FMS, Application of Possibility Distributions in FMS Systems Justification.

UNIT-V: Applications of FMS and factory of the future

FMS Application in Machining, Sheet Metal Fabrication, Prismatic Component Production, Aerospace Application, FMS Development Towards Factories of The Future, Artificial Intelligence and Expert Systems in FMS, Design Philosophy and Characteristics for Future, case studies.

Books and References:

1. Jha, N.K. “Handbook of Flexible Manufacturing Systems”, Academic Press Inc., 1991.
2. Radhakrishnan P. And Subramanyan S., “CAD/CAM/CIM”, Wiley Eastern Ltd., New Age International Ltd., 1994.
3. Raouf, A. And Ben-Daya, M., Editors, “Flexible Manufacturing Systems: Recent Development”, Elsevier Science, 1995.
4. GrooverM.P., “Automation, Production Systems And Computer Integrated Manufacturing”, Prentice Hall Of India Pvt., New Delhi, 1996.
5. Reza A Maleki “Flexible Manufacturing system” Prentice Hall of Inc New Jersey, 1991
6. TaiichiOhno, “Toyota Production System: Beyond Large-Scale Production”, Productivity Press (India) Pvt. Ltd. 1992.

Semester – VII: Departmental Elective – V: Specialization – Production Engineering/ Industrial Production Engineering

Subject Code: KPI 072	Facility Planning and Design	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the group technology, Plant Layout, material handling systems, & their constituents	K 2
CO-2	Understand the various plant layout design algorithms and quantitative models.	K 2
CO-3	Apply various graphical and computerised layout techniques & algorithms for plant layout development	K 3
CO-4	Analyse various types of plant layouts, and factors affecting facility location and its layout	K 4
CO-5	Evaluate different plant layout alternatives within given constraints	K 5
CO-6	Development of part families, machine cell formation for implementation of Group Technology and their balancing	K 4
CO-7	Able to suggest a material handling system for a plant under given constraints	K 4

UNIT -I

Factory Planning: Introduction, factors to be considered

Plant Location and Site Selection: Levels of plant location, rural, urban and suburban location of plants, factors influencing the plant location, optimum plant location, location theories.

UNIT -II

Plant Layout: Introduction of production system, scope, objectives, importance, and types of plant layout, characteristics of a good plant layout, factoring affecting plant layout, procedure of developing a plant layout, different graphical and computerisedplant layout design techniques, installation and evaluation of plant layout, optimum plant layout.

UNIT -III

Group Technology: Definition, objectives, planning, part families and machine cell formation, evaluation of machine cells, types of GT layout, benefits of GT, implementation of GT.

UNIT -IV

Line Balancing: Definitions, heuristic and analytical methods of balancing the assembly and production line, single and mixed model line balancing, alternatives to line balancing.

UNIT -V

Materials Handling: Definition, scope, objectives, principles, importance, factors in materials handling problem, analysis of materials handling, types and selection of materials handling equipment's, aids and techniques in materials handling equipment selection. Planning of material flow, advantages of planned material flow, flow planning principles, flow patterns, analysis of material flow.

Recommended Books:

1. Francis, R.L., McGinnis, L.F., and White, J.A.,"Facility Layout and Location: An Analytical Approach", Prentice Hall of India 2004
2. Meyers, F.E., and Stephens, M.P., "Manufacturing Facilities Design and Material Handling", Prentice-Hall, Inc. 2000

3. Groover,M.P.,"Automation, Production Systems and ComputerIntegrated Manufacturing",2nd 2001 Ed., Pearson Education Inc. Delhi
4. Sule,D.R.,"Manufacturing Facilities-Location, Planning, and Design", PWS Publishing Company 1984
5. Tompkins,J.A., White, J.A.,Bozer,Y.A.,Frazelle, E.H.,Tanchoco, J.M., and Tervino,J.,"Facilities Planning",2nd 1996 Ed., John Willey & Sons

Semester – VII: Departmental Elective – IV: Specialization – Manufacturing Engineering

Subject Code: KMT 071	Advance Casting Process	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the mould production and equipments and how internal cavities are produced.	K2
CO-2	Understand and apply the principles of melting and pouring systems and develop analytical relation between input and output process parameters.	K2
CO-3	Understand the various advance casting techniques.	K2
CO-4	Analyze the thermal, metallurgical aspects during solidification in casting and welding and their role on quality of cast or weld objects.	K4
CO-5	Analyze the concept of cooling rate of materials in metal casting.	K4
CO-6	Design the gating and riser system needed for casting and requirements to achieve defect free casting.	K6

UNIT-I: Production of Moulds and Cores

Mould production - equipment for moulding, moulding technique - pattern utilisation, hand and machine compaction, machine moulding, mould drying and hardening. Cores and core making - core boxes, compaction, core hardening, closing of moulds.

UNIT-II: Melting and Pouring

Melting Practice : Classification of melting furnaces, brief description of construction and operation of various furnaces - cupola and its design, electric arc furnaces, electric induction furnaces. Melting charge, melting conditions, melting losses, special melt treatment, melt quality control and recent development in metal melting.Pouring : Metal temperature, pouring equipment and techniques.

UNIT-III: Details Study of Following Casting Techniques

Shell moulding - Basic operation, production systems, characteristics of shell moulded casting and D-process. Investment Casting - expandable pattern process. Pattern production, investment, pattern removal and firing, casting.Factor influencing casting quality characteristics of precision investment casting.Investment casting from permanent casting.Die-casting - Gravity die-casting, pressure-die casting, die-casting machines, casting techniques, characteristics of die - castings.Centrifugal casting - Fundamental principles, methods production techniques, characteristics of centrifugal casting.

UNIT-IV: Solidification of Castings

Crystallization and development of cast structure - Nucleation, Growth and dendrite growth, independent nucleation, eutectic freezing, paratactic relations, structure of castings - significance and practical control cast structure, grain shape and orientation, grain size, refinement and modification of cast structure. Concept of progressive and directional solidification, solidification time and derivation of Chvorinov's equation influence of mould characteristics and cast metal. Properties on solidification, process numerical methods for heat flow analysis.

UNIT-V: Feeding of Castings

Feeding characteristics of alloys, geometric influences on solidification.Methods of the feeding of castings - cost and concept of yield, orientations, gating technique, casting temperature and pouring speed, design and location of feeder heads.Aids to feeder head efficiency, junction of feeder head and casting, use of padding, chills and insulators.

REFERENCE :

1. Beeley P.R., “Foundry Technology” (Buttersworth) Heine and Rosenthal, “Principles of Metal Cutting” (TMH) “
2. Engineering Plastics, Parmar, Khanna Book Publishing Co., Delhi Metal Casting” ASME Handbook P.C.Mukherji, “Metal Casting Technology”

Semester – VII: Departmental Elective – V: Specialization – Manufacturing Engineering

Subject Code: KMT 072	Composite Materials	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the composite material concept, need and different types of matrix available.	K2
CO-2	Understand about various fibers their properties and their selection.	K2
CO-3	Understand how composites are classified based on matrix and fibers	K2
CO-4	Understand processing and manufacturing techniques of composite material	K2
CO-5	Understand the mechanical testing of composites and analysis of laminated plates.	K2

COMPOSITE MATERIALS

UNIT-I: Overview of Composite material
Classifications of Engineering Materials, Concept of composite materials.

Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.

UNIT-II:Types of Reinforcements/Fibers
Role and Selection of reinforcement materials.Types of fibres: Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc.

Mechanical properties of fibres: Material properties that can be improved by forming a composite material and its engineering potential.

UNIT-III:Various types of composites
Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC).

Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites.

UNIT-IV:Fabrication methods
Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression moulding, resin transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs.

Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films, maximum stress and strain criteria, Von Mises Yield criterion for isotropic materials.
UNIT-V:Testing of Composites and Analysis

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.

Analysis of laminated plates: equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.

Books and References:

1. Materials characterization, Vol. 10, ASM hand book.
2. Mechanical Metallurgy, by G. Dieter, McGraw Hill.
3. Analysis and Performance of Fiber Composites, by Agarwal, McGraw Hill.
4. Thermal Analysis of Materials, by R.F. Speyer, Marcel Decker.
5. Engineering Mechanics and Composite Materials, by Daniels, Oxford University Press.
6. Material Science and Engineering (SIE) with CD, by Smith, McGraw Hill.
7. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
8. Engineering Materials: Polymers, Ceramics and Composites, by A.KBhargava Prentice Hall India.

Semester – VII: Departmental Elective – V: Specialization – Manufacturing Engineering

Subject Code: KMT 073	Manufacturing Strategies	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand modern product development theories and customer needs.	K2
CO-2	Understand product tears down methods and product modularity.	K2
CO-3	Understand concepts of modelling and morphological analysis.	K2
CO-4	Understand material properties and economic factors influencing design	K2
CO-5	Understand the significance of value engineering.	K2

UNIT I: Product Design and Development

Product development verses design, modern product development theories and methodologist in design. Product development teams.Product development planning, technical and business concerns. Understanding customer needs, Establishing product functions. Functional decomposition, modeling process, Function trees system functionality, augmentation.

Aggregation, common basis, functional modeling methods

UNIT II: Benchmarking

Product tear down and experimentation, benchmarking and establishing engineering specification. Product portfolios and portfolio architecture.

Tear down process, tear down methods, post teardown reporting, benchmarking approach, support tools, setting specifications, portfolio architecture, types, platform, functional architecting, optimization selection. Product modularity, modular design.

UNIT III:Concepts and Modeling

Generation of concepts, information gathering and brain storming, directed search,morphological analysis, combining solutions. Decision making, estimation of technical feasibility, concept selection process, selection charts, measurement theory, numerical concept scoring, design evaluation scheme, concept embodiment, geometry and layout, system modeling, modeling of product metrics, selection of model by performance specifications, physical prototyping, informal and formal models.

UNIT IV: Design materials & human factors in product design

Material properties, metals, plastics, rubber, woods & factors considered while designing for metals, plastics, rubber, woods etc, Anthropometry factors, physiological factors, psychology factors, anatomy factors.

Economic factors influencing design, product value, safety, reliability & environmental considerations, economic analysis, break even analysis, profit & competitiveness, economics of a new product design.

UNIT V: Value engineering in product design

Introduction, historical perspective, nature & measurement of value, importance of value, value analysis job plan, creativity, steps for solving & value analysis, value analysis tests

Principal stress trajectories(force flow lines), balanced design, criteria & objective of design, material toughness, resilience, designing for uniform strength.

TEXT BOOKS:

1. Chitale A. K., Gupta R. C., "Product Design & Manufacturing", Prentice Hall India Ltd., ISBN: 978-81-203-4282-8
2. RoozenburgN.F.M., Eekels J., "Product Design : Fundamentals & Methods", IFS (Publications) Ltd and Springer-Verlag London UK

REFERENCE BOOKS:

1. Dale Huchingson R "New Horizons for Human Factors in Design " McGraw Hill Company 19811. Indistrial Design-Mayall
2. RoozenburgNFM and J. Eekels, "Product Design: Fundamentals and Methods A Wiley Series in Product Development", John Wiley and Sons.

Semester – VII: Departmental Elective – V: Specialization – Manufacturing Engineering

Subject Code: KMT 074	Maintenance Engineering & Management	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the basics of maintenance planning.	K2
CO-2	Understand the preventive maintenance and maintenance schedules.	K2
CO-3	Understanding of repair methods for basic machine elements.	K2
CO-4	Understanding of repair methods for material handling equipment.	K2
CO-5	Cost comparison with and without CM.	K4

UNIT-I:Principles and practices of maintenance planning

Basic Principles of Maintenance Planning – Objectives and Principles of Planned Maintenance Activity – Importance and Benefits of Sound Maintenance Systems.

Reliability and Machine Availability – MTBF, MTTRAndMWT – Factors of Availability – Maintenance Organization – Maintenance Economics.

UNIT-II:Maintenance policies – preventive maintenance

Maintenance Categories – Comparative Merits of Each Category – Preventive Maintenance, Maintenance Schedules, Repair Cycle – Principles and Methods of Lubrication – TPM.

UNIT-III:Condition monitoring

Condition Monitoring – Cost Comparison with And Without CM – On-Load Testing and Offload Testing – Methods and Instruments for CM – Temperature Sensitive Tapes – Pistol Thermometers – Wear-Debris Analysis.

UNIT-IV:Repair methods for basic machine elements

Repair Methods for Beds, Slideways, Spindles, Gears, Lead Screws and Bearings – Failure Analysis – Failures and Their Development – Logical Fault Location Methods – Sequential Fault Location.

UNIT-V:Repair methods for material handling equipment

Repair Methods for Material Handling Equipment – Equipment Records –Job Order Systems -Use of Computers in Maintenance.

Books and References:

1. SrivastavaS.K., “Industrial Maintenance Management”, – S. Chand And Co., 1981.
2. Venkataraman .K “Maintancence Engineering And Management”, PHI Learning, Pvt. Ltd., 2007.
3. Bhattacharya S.N., “Installation, Servicing And Maintenance”, S. Chand And Co., 1995.
4. White E.N., “Maintenance Planning”, I Documentation, Gower Press, 1979.
5. GargM.R., “Industrial Maintenance”, S. Chand & Co., 1986.
6. Higgins L.R., “Maintenance Engineering Hand Book”, McGraw Hill, 5th Edition, 1988.
7. Armstrong, “Condition Monitoring”, BSIRSA, 1988.
8. Davies, “Handbook Of Condition Monitoring”, Chapman &Hall, 1996.

Semester – VII: Departmental Elective – V: Specialization – Manufacturing Engineering

Subject Code: KMT 075	Process Planning and Cost Estimation	L T P : 3 0 0	Credits: 3

Course Outcomes: The students will be able to		Blooms Taxonomy
CO-1	Understand the various processes planning and learn to estimate cost.	K2
CO-2	Learn to estimate various cost elements.	K2
CO-3	Learn to estimate production cost.	K2
CO-4	Learn to fix foundry cost.	K2
CO-5	Learn the find machining time estimation.	K2

UNIT-I:Overview of process planning

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection.

UNIT-II:Process planning activities

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies.

UNIT-III:Introduction to cost estimation

Importance of costing and estimation –methods of costing-elements of cost estimation. Types of estimates – Estimating procedure- Estimation labour cost, material cost- allocation of overhead charges- Calculation of depreciation cost.

UNIT-IV:Production cost estimation:

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

UNIT-V:Machining time calculation

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

Books and References:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technologyBooks, Dec 2002.
2. OstwalalP.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley,1998.
3. Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.
4. ChitaleA.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
5. Process planning and cost estimation by M. Adithan.
6. Process planning and cost estimation by B. Vijayaramanath.