MINOR IN MECHANICAL ENGINEERING

Eligibility: Students of all branches Except Mechanical Engineering				
Subject Code	Subject Name	No of Hours		
		Lecture	Tutorial	Practical
MEMR1	Engineering Mechanics	3	1	-
MEMR2	Strength of materials and Fluid mechanics	3	1	-
MEMR3	Manufacturing Processes	4	-	-
MEMR4	Concepts of Thermal Engineering	3	1	-
MEMR5	Concepts of Mechanical Design	3	1	-
MEMR6	Computer Aided Design & Manufacturing	4	-	-
MEMR7	Additive Manufacturing	4	-	-

MEMR1	ENGINEERING MECHANICS	L	T	P	C	Int	Ext
		3	1	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

COURSE OBJECTIVES:

1. Learn and understanding the basic principles of mechanics of rigid bodies, various types of force systems in plane and to analyze problems in a simple and logical manner.
2. Understanding the concept of centroids of various standard geometrical shapes as well as composite areas and center of gravity of material bodies, the concept of moment of inertia an area and material bodies.
3. Learn principles of dynamics and understanding the kinematics and kinetics of rectilinear, curvilinear translation, rotation about fixed axis and general plane motion of rigid bodies.
4. Learn the concept of simple harmonic motion, basics of mechanical vibrations.

COURSE OUTCOMES:

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

1. Apply principles of mechanics, static equilibrium equations to various types of force systems in order to determine the resultant, unknown forces and moments.
2. Determine the centroids and center of gravity of standard geometric shapes as well as composite areas. Calculate the area moment of inertia and mass moment of inertia of standard shapes as well as composite sections.
3. Apply fundamental concepts of kinematics and kinetics of particles and rigid bodies to the analysis of simple and practical problems
4. Determine velocity and acceleration of a particle under simple harmonic motion
5. Formulate free Undamped Vibration of Single Degree of Freedom Systems.

COURSE CONTENT:

UNIT-1	CO1	12
Basic Concepts & Force systems in a plane: Principles of statics, composition and resolution of forces, equilibrium of concurrent forces in a plane, method of projections, Method of moments, Couple, equilibrium of parallel forces in a plane, resultant and equillibrum of general case of forces in a plane, plane trusses-method of joints. **Friction:** Concept of friction, laws of friction, simple contact friction, wedge friction.		
UNIT-2	**CO2**	**12**
Centroid and Centre of Gravity: Centroids of simple shapes from first principles, centroids of composite plane figures, centre of gravity of three dimensional bodies (Right circular cone and Hemi sphere). **Moment of Inertia:** Area moment of inertia - Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections, Mass moment inertia of circular plate, Cylinder, Cone and Sphere		
UNIT-3	**CO3**	**12**
Kinematics: Rectilinear translation, Curvilinear translation, Rotation about fixed axis, General Plane motion of rigid bodies. **Kinetics:** Rectilinear translation, Work and energy, Impulse momentum, Collision of elastic bodies-direct central impact, Curvilinear translation, Rotation about fixed axis, General plane motion of rigid bodies.		
UNIT-4	**CO4,5**	**12**

Simple Harmonic Motion: Introduction, velocity and acceleration of a particle moving with SHM, SHM related terms, oscillation of a vertical elastic string, stiffness of the spring.
Mechanical Vibrations: Introduction, causes and effects of vibration, classification of vibration, basic features of vibrating system, springs in series, springs in parallel and equivalent spring constant, free undamped vibration of single degree of freedom systems.

LEARNING RESOURCES:

TEXT BOOKS:

1. Engineering mechanics by S. Timoshenko, D. H. Young, J V Rao and Sukumar Pati - 5th edition, McGraw Hill Education (India) Private Limited, (For concepts).
2. Engineering mechanics-statics and dynamics by A. K. Tayal - 14th edition, Umesh publications (For numerical problems).
3. Engineering Mechanics by S.S. Bhavikatti, 5th edition, New Age International Pvt Ltd Publishers.

REFERENCE BOOKS:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall.
2. J. L. Meriam and L. G. Kraige, Engineering Mechanics: Dynamics, Wiley, 2011.
3. Singers Engineering Mechanics: Statics and Dynamics, K.Vijaya Kumar Reddy and J Suresh Kumar, 3rd Edition SI Units - BSP Books Pvt. Ltd. Publications.
4. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications.

WEB RESOURCES:

1. https://nptel.ac.in/courses/122104015/
2. https://nptel.ac.in/courses/112103109/

MEMR2	Strength of Materials & Fluid Mechanics	L	T	P	C	Int	Ext
		3	1	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

COURSE OBJECTIVES:

1. To make students imbibe concepts like stress, strain, elastic constant relations, axial deflection in mechanical components using theoretical correlations and laboratory test methods.
2. To make students understand concepts of torsion, bending deflection and stresses in bars and beams, using analytical correlations and laboratory test methods.
3. To make students understand fundamentals on fluid properties, fluid flow principles using theoretically and practically.
4. To make students understand basic operating principles of rotodynamic machines like turbines & pumps and imbibe them to draw the performance characteristic curves practically.

COURSE OUTCOMES: At the end of the course, the students will be able to:

1. Calculate the stresses and strains in axially loaded members.
2. Analyze the shafts subjected to torsion
3. Identify the importance of various fluid properties at rest and apply general governing equations for fluid friction during pipe flow.
4. Illustrate the distinctive features of pelton wheel, hydraulic pumps, such as reciprocating & centrifugal Pumps, and their performance characteristics.

UNIT1: [CO1][15]

Introduction, properties of Engineering materials, axial loads, deflections, normal stress and normal strain, relation between normal stress and strain, shear load, shear stress and shear strain, elastic constants and relation between them. Stress-strain curve for ductile and brittle materials. Thermal stresses and strains. Tensile stress, axial deflection measurement on mild steel using UTM.

UNIT2: [CO2][15]

Torsion in hollow and solid circular members, Torsion test on TOR-steel bar. Relation between load, shear force and bending moment, shear force and bending moment in cantilever, simply supported and overhanging beams. Deflections in beams (Macaulay's method), normal and shear stresses in beams. Deflection measurement in beams using three point bend test.

UNIT-3: [CO3][15]

Definition of fluid-Properties of fluids, types of fluids, continuity equation, Euler's equation, Bernoulli's equation for Incompressible fluid flows (Simple numerical problems), Measurement and determination of coefficient of discharge of venturimeter using Bernoulli Principle. Fluid flow Types, Reynolds experiment, laws of fluid friction, Darcy-Wiesbach equation, concept of boundary layer, measures of boundary layer thickness, Need for dimensional analysis, dimensionless parameters.

UNIT-4: [CO4][15]

Introduction to rotodynamic machines, Classification of water turbines, heads and efficiencies related to hydraulic power plant, working principle of impulse and reaction turbines; draw the performance characteristic curves and determination of overall efficiency of a pelton wheel practically. Working principle of a single acting reciprocating pump and single stage centrifugal pump. Drawing the operating characteristics of the single stage centrifugal pump and practical determination of discharge and head of centrifugal pump.

List of Laboratory Experiments

1. Tensile stress, axial deflection measurement on mild steel using UTM.
2. Torsion test on TOR-steel bar.
3. Deflection measurement in beams using three point bend test.
4. Measurement and determination of coefficient of discharge of venturimeter using Bernoulli Principle.
5. To draw the performance characteristic curves and determination of overall efficiency of a pelton wheel.
6. To draw the operating characteristic curves of the single stage centrifugal pump and to determine the discharge and head from it.

TEXT BOOKS:

1. Mechanics of Materials by Gere and Timoshenko, CBSPublishers& Distributors.
2. Mechanics of Solids by Singh, Pearson Education.
3. Hydraulics and Fluid Mechanics --P.N.Modi & S.M. Seth, Standard Book House, New Delhi, 1977.
4. Fluid Mechanics and Hydraulic Machines – R.K.Bansal, Lakshmi Publications Pvt Ltd, New Delhi, Revised Ninth Edition, 2015.

REFERENCE BOOKS:

1. Strength of materials by Sadhu Singh, Khanna Publishers.
2. Advanced Solid Mechanics by L.S. Srinath
3. Strength of materials by G. H. Ryder, Mc Millan India Ltd.,
4. Fluid Mechanics & Fluid Power Engineering - D.S.Kumar, SK Kataria & Sons, New Delhi, 2012 Re Print.
5. Fluid Mechanics (fundamentals and applications), By Yunus A. Cengel, John M. Cimbala, Mc Graw Hill Publishers, 4th Edition, 2019.
6. Hydraulic Machines - Jagadish Lal, Metropolitan Book Co Pvt Ltd, 1994.

DIGITAL LIBRARY

1.http://nptel.iitm.ac.in/video.php?subjectId=112101095

2.http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-ROORKEE/strength%20of%20materials/homepage.htm

3.http://nptel.iitm.ac.in/courses/IIT-MADRAS/Strength_of_Materials/Pdfs/5_1.pdf

4.http://www.youtube.com/watch?v=E6bPBhZsMUI&feature=relmfu

5. https://nptel.ac.in/courses/112/105/112105269/

6. https://nptel.ac.in/courses/112/104/112104118/

7. https://nptel.ac.in/courses/112/103/112103249/

8. https://nptel.ac.in/courses/112/104/112104117/

COURSE RELEVANT WEBSITES:

1. www.me.mtu.edu/~qingdai/Courses/MEEM%205150/

2.www.calstatela.edu/faculty/sfelsze/me402.htm.

3. www.assakkaf.com/courses/enes220/**lectures**/**lecture**29.pdf
4. www2.mae.ufl.edu/nkim/egm5533/solution/Chap01Student.pdf
5. www.hydraulicspneumatics.com
6. http://www.efluids.com/
7. http://fluid.power.net/

MEMR3	MANUFACTURING PROCESSES	L	T	P	C	Int	Ext
		4	-	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

COURSE OBJECTIVES:

- To motivate and challenge students to understand and develop an appreciation of the processes in correlation with material properties which change the shape, size and form of the raw materials into the desirable product by conventional
- To provide the fundamental knowledge regarding the working principle, specifications, parts and various operations performed various tools.

COURSE OUTCOMES:

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

1. Identify merits and demerits in selection of Conventional casting processes in manufacturing and estimate bulk forming in hot and cold working processes
2. Identify the importance of welding processes in manufacturing based on the type of industrial application.
3. Demonstrate the role of additive manufacturing using rapid prototyping methods in the design process
4. Identify basic parts and operations and mechanisms of machine tools of lathe and drilling milling
5. Identify basic parts and operations of machine tools of and grinding
6. Demonstrate press working tools major components, types of Drawing dies, bending dies and related calculations

COURSE CONTENT:

UNIT-1	CO1	12
Conventional Manufacturing processes: Casting and moulding: Introduction to Casting, terminology, Pattern-types, materials and allowances, moulding sand properties.Metal casting processes: Sand casting, Investment Casting, Centrifugal and Die Casting with related equipment. Introduction to bulk forming, Fundamentals of hot and cold working processes, Rolling and types, forging, extrusion		
UNIT-2	**CO2,CO3**	**12**
Welding: Gas welding, TIG and MIG welding Resistance welding process. Solid-liquid state joining processes: Brazing, soldering and adhesive bonding. Introduction to Rapid prototyping-types-Selective Laser Sintering (SLS) Stereo lithography (SLA), Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM) and Applications.		
UNIT-3	**CO4**	**12**
Lathe: Constructional details, specifications, classification of lathes. Lathe accessories - various work holding devices, operations. **Drilling Machines:** Types and specifications, drilling operations Milling Machines: Working Principle, Size and Specification, Up and Down Milling, Types of milling machines, operations.		
UNIT-4	**CO5 , CO6**	**12**
Grinding Machines: General Principles, Wheel materials, Selection and specification of grinding wheels, Truing and Dressing of grinding wheels, types of grinding machines. **Sheet metal forming** - Blanking and piercing, Forces and power requirement in these operations, shear, die deign – simple problems. Drawing, number of draws, drawing dies design – simple problems. Stretch forming, Bending, Spring back effect, types of bending, Coining, Spinning, Types of presses		

and press tools.

List of Experiments:

1. Pattern making: Solid pattern
2. **Moulding :** Stepped cone pulley, Hand wheel, Bush
3. Taper turning and external thread cutting using lathe
4. Internal Taper turning and internal thread cutting using lathe
5. Drilling of a small hole using drilling machine
6. Spur gear cutting in milling machine
7. Surface grinding

LEARNING RESOURCES:

TEXT BOOKS:

- Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
- Workshop Technology Vol. II by Hazra Chowdary , Media Promoters & Publishers, 1983

REFERENCE BOOKS:

- Degarmo, Black & Kohser, Materials and Processes in Manufacturing
- Materials and Processes in Manufacturing by E.Paul De Garmo, J.T.Black and Ronald A.Kohser , John Wiley & Sons, 2003.

WEB RESOURCES:

- https://nptel.ac.in/courses/112/104/112104195/
- https://nptel.ac.in/courses/112/105/112105233/

MEMR4	CONCEPTS OF THERMAL ENGINEERING	L	T	P	C	Int	Ext
		3	0	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

COURSE OBJECTIVES:

1. To learn about Thermodynamic system types and examples, work and heat interactions, and balance of energy between system and its surroundings.
2. To learn about I law and II law of thermodynamics and their applications
3. To know about the Gas power cycles used in IC engines and working of Various IC engines.
4. To know about the fundamentals of refrigeration and air conditioning systems

COURSE OUTCOMES:

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

1. Identify different thermodynamic systems and estimate the work and heat transfer for different non flow processes.
2. Apply I law and II law of thermodynamics for various thermodynamic systems.
3. Estimate thermal efficiency of Otto, Diesel and Dual cycles and also able to understand the working of various IC engines.
4. Demonstrate the basic concept of refrigeration and air conditioning systems

COURSE CONTENT:

UNIT-1	CO1	12
FUNDAMENTALS: System & Control volume; Property, State & Process; Exact & Inexact differentials; Temperature, Definition of thermodynamic equilibrium and Zeroth law; **WORK & HEAT:** Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, gravitational, spring and shaft work-- Definition of heat; examples of heat/work interaction in systems.- simple problems on work and heat.		
UNIT-2	**CO2**	**12**
FIRST LAW OF THERMODYNAMICS FOR NON-FLOW PROCESSES: First law applied to a cycle and to a process, Concept of total energy E; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. Simple problems on non-flow processes. **FIRST LAW FOR FLOW PROCESSES:** Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices. Simple problems on flow processes. **SECOND LAW OF THERMODYNAMICS:** Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Heat engine, Refrigerator and Heat pump concepts		
UNIT-3	**CO3**	**12**
Gas Power Cycles: Air standard cycles-air standard efficiency, Otto, Diesel and Dual cycles. Simple problems. **I.C. Engines:** Classification of I.C. Engines, working principles of four stroke and two stroke Petrol and Diesel engines, Differences between 2 stroke and 4 stroke, Petrol and Diesel engines, applications of I.C. Engines.		
UNIT-4	**CO4**	**12**
Refrigeration: Necessity of refrigeration, applications, Ton of refrigeration, COP, Air refrigeration system and Vapor compression refrigeration principles only. Advantages and disadvantages of the systems. **Air conditioning:** Air conditioning importance, Psychrometric terms, relations, processes, Chart,		

summer air conditioning system discussion only.

LIST OF EXPERIMENTS:

1. Determine the viscosity of given oil using Redwood Viscometer
2. Determine the flash and fire points of a given fuel using Cleveland's apparatus
3. Draw VTD on a given 4 stroke diesel engine model
4. Draw PTD on a given 2 stroke petrol engine model
5. Conduct a load test on 4 stroke diesel engine test rig with electrical bulb loading
6. Conduct a load test on 4 cylinder 4 stroke petrol engine with hydraulic dynamometer

LEARNING RESOURCES:

TEXT BOOK(S):

1. Engineering Thermodynamics- Nag, P.K, 2005, Tata McGraw-Hill Publishing Co. Ltd.
2. Thermal Engineering- M.M. Rathore, McGrawHill, 2010.

REFERENCE BOOK(S):

1. Thermal Engineering - Er. R.K. Rajput, Lakshmi Publications, 2010.
2. Treatise on Heat Engineering - V.P.Vasandhani and D.S. Kumar, 4th Edition Metropolitan Book Co. Pvt Ltd.

WEB REFERENCE:

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://www.coursera.org/learn/thermodynamics-intro
3. http://web.mit.edu/16.unified/www/FALL/thermodynamics/thermo.pdf
4. http://autoclub.rso.siuc.edu/frange.html\
5. http://www.howstuffworks.com/engine1.htm

MEMR5	CONCEPTS OF MECHANICAL DESIGN	L	T	P	C	Int	Ext
		3	1	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

COURSE OBJECTIVES:

1. To understand machine design procedure and able to know how to apply the concepts of stress analysis under static conditions to design machine components.
2. Able to design Temporary joints like threaded joints and permanent joints like welded joints for different engineering applications.
3. To understand design of Flexible drives like Flat & V- belts and Rigid drives like gear drives
4. To furnish information on advanced strength of materials and to introduce the basic concepts, background and methodology of FEM

COURSE OUTCOMES:

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

1. Analyze the behavior of machine components under static loading conditions using stress analysis
2. Design mechanical springs, threaded and welded joints under static and fatigue loading conditions.
3. Identify and design proper belt drive for the application.
4. Create new solutions for the existing problems using FEA approaches and apply FEA to structural systems (bar problems)

COURSE CONTENT:

UNIT-1	CO1	12
Basics: Basic procedure of machine design, requirements and design of machine elements, traditional design methods, use of standards in design. **Materials & their Properties:** Mechanical properties of materials, Common engineering materials and their properties. **Design for Static Strength:** Simple Stresses in bar problems, Combined stresses, Torsional and Bending stresses - stress strain relation, Factor of safety and its importance in design. **Stress concentration:** Stress concentration, stress concentration factors, reduction of stress concentration.		
UNIT-2	**CO2**	**12**
Mechanical Springs: Introduction, Materials, Types of springs, Design of helical springs under axial load and fatigue loading. **Threaded and Welded Joints**: Basic types, bolt of uniform strength, materials and manufacture, eccentrically loaded bolted joints. Welded Joints: Types of welded joints, Design of joints with initial stresses, eccentrically loaded welded joints.		
UNIT-3	**CO3**	**12**
Design of Belt Drives: Flat and V-belts, Belt constructions, Geometrical relationships, Analysis of belt tensions, condition for maximum power. **Design of Spur Gears**: Classification of gears, Terminology of spur gear, standard systems of Gear Tooth, Force analysis, Gear tooth failures, Beam Strength of gear teeth, lubrication, Lewis Equation. **Design of Helical Gears**: Terminology of helical gears, virtual number of teeth, Tooth proportions, force analysis, Beam Strength of helical gears, effective load on gear tooth, wear strength of helical gears. Lewis Equation.		
UNIT-4	**CO4**	**12**
Finite Element Method: Introduction, Objectives and Methods of Engineering Analysis, FDM Vs FEM, FEM Advantages, Disadvantages, FEM Applications, FEM Procedure		

One Dimensional Elements: Finite Element Modeling, coordinates and shape functions, Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Problems related to simple Axially loaded members.

LIST OF EXPERIMENTS:

1. STATIC ANALYSIS of 2D truss
2. Static analysis of 3D truss
3. Static analysis of Beams
4. Stress Concentration factor for plate with hole.

LEARNING RESOURCES:

TEXT BOOKS:

1. Design of Machine Elements by V.B. Bhandari, Tata McGraw Hill, 3rd Edition, 2017
2. Machine Design by P.C. Sharma & D.K. Agarwal., S.K. Kataria & Sons , 2003.
3. Machine Design by R.S. Khurmi & J.K. Guptha , S. Chand , 2012.
4. Introduction to Finite Elements in Engineering, Chandraputla, Ashok and Belegundu, PHI, 3rd edition, 2003.

REFERENCE BOOKS:

1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.
4. An Introduction to Finite Element Method, JN Reddy / Me Graw Hill, 2nd Edition, 1993

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WEB RESOURCES:

1. https://www.machinedesign.com/basics-design/flat-belts
2. http://qtcgears.com/spotlight/plasticgears.php

MEMR6	COMPUTER AIDED DESIGN & MANUFACTURING	L	T	P	C	Int	Ext
		4	-	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

COURSE OBJECTIVES:

1. To provide adequate information about the product life cycle, concepts of CAD software and its applications.
2. Students will learn theory and practice related to Geometric modeling, and free form surface modeling.
3. To provide information about numeric control and to impart knowledge on CNC programming.
4. To improve knowledge on computer assisted part programming and process planning.

COURSE OUTCOMES:

1. Design the product life cycle, CAD software concepts, and their applications
2. Define parametric modeling techniques to ensure they adhere to engineering specifications.
3. Demonstrate the functioning of NC, CNC, and adaptive control machining comprehensively.
4. Demonstrate proficiency in manual and computer-assisted part programs

COURSE CONTENT:

UNIT-1	CO1	12
Fundamentals of Computer Graphics: Product cycle, sequential and concurrent engineering Fundamentals of CAD, Applications of computer for design, Benefits of CAD, CAD system architecture, Input devices. **CAD standards:** Graphical Kernel System (GKS), Data exchange standards- IGES, STEP, CALS etc., and Communication standards. **Geometric Transformations:** Coordinate systems, Transformation Principles, Translation, Scaling, Rotation, Matrix Representations and Homogeneous Coordinates, Composite transformations, Viewing Transformation.		
UNIT-2	**CO2**	**12**
Geometric Modeling: Representation of curves, Hermite curves, Bezier curves, B-spline curves, Surface modeling and entities, surface patch, Coons and bi-cubic patches, Bezier and B-spline surfaces. **Solid Modeling:** Solid entities, Solid representation, Sweep representation, Constructive solid geometry and Boundary representation, Solid modeling based applications.		
UNIT-3	**CO3**	**12**
Introduction to Computer Aided Manufacturing (CAM): Introduction to Numerical Control (NC), Numerical control modes, NC elements, Structure of CNC machine tools, Spindle design, Drivers, Designation of axes, Drives & actuation systems, Feedback devices, CNC tooling, Automatic tool changers & Work holding devices. **CNC Programming:** Part programming fundamentals, Manual part programming Methods, Preparatory functions, G- Codes, Miscellaneous Functions M Codes, Writing Part programs for typical components, Tool length compensation, Canned cycles, Cutter radius compensation.		
UNIT-4	**CO4**	**12**
Computer Aided Part Programming: Concept of CAP, APT Language, Geometry Commands, Motion Commands like point to point Continuous path commands, Post processor commands, Compilation of control commands, Writing complete Part programs for typical components with APT. **Computer Aided Process Planning (CAPP):** Introduction to CAPP, Variant & Generative methods of CAPP, advantages of CAPP.		

LIST OF EXPERIMENTS:

1. Manual Part Programming Lathe: Step turning

2. Manual Part Programming Lathe: Internal operation
3. Manual Part Programming Lathe: Thread Cutting
4. Manual Part Programming Milling: linear and circular interpolation
5. Manual Part Programming Milling: Drilling and pocketing
6. Modelling, part program generation, and tool path simulation using any one of the CAM software packages like CATIA, Master CAM.

LEARNING RESOURCES:

TEXT BOOK(s):

1. Automation, Production systems and Computer Integrated Manufacturing by M.P.Groover, Pearson Education / PHI.
2. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology,7th edition, Pearson
3. Yoram Koren, Computer control of manufacturing system, 1st edition

REFERENCE BOOK(s):

1. CAD/CAM by M.P.Groover and E.W.Zimmers, Pearson Education / PHI.
2. CAD/CAM by P.N.Rao, TMH

WEB RESOURCES:

1. http//ocw.mit.ac.in//

MEMR7	ADDITIVE MANUFACTURING	L	T	P	C	Int	Ext
		4	0	-	4	30	70
	MINORS – MECHANICAL ENGINEERING						

Course Objectives:

1. To provide the basics of Additive manufacturing Process.
2. To give an idea of Reverse Engineering concept in the present scenario.
3. To provide knowledge on types of Additive manufacturing techniques
4. To introduce to and development of new tooling techniques for manufacturing.

Course Outcomes:

The students will be able to

1. Describe the importance of Reverse Engineering and CAD Modeling in Additive Manufacturing
2. Distinguish different Liquid Based Additive Manufacturing System
3. Illustrate the Solid Based Additive Manufacturing System
4. Summarize the working principles of Powder Based Additive Manufacturing System

Course Content:

UNIT-1	CO1	12
Introduction: Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes- Advantages and Applications. **Reverse Engineering and CAD Modeling:** Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation- Software for AM.		
UNIT-2	**CO2**	**12**
Tooling: Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling. **Liquid Based Additive Manufacturing System**: Stereo-lithography Apparatus (SLA): Principle, pre- build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoats issues, materials, advantages, limitations and applications.		
UNIT-3	**CO3**	**12**
Solid Based Additive Manufacturing System: Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM)-Principle, details of process, process variables, products, materials and applications. Laminated Object Manufacturing (LOM)-Working Principle, Details of processes, materials, advantages, limitations and applications.		
UNIT-4	**CO4**	**12**
Powder Based Additive Manufacturing System: Selective Laser Sintering (SLS)-Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS)-Processes, materials, advantages, limitations, Applications.		

LEARNING RESOURCES:

REFERENCE BOOKS

1. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.

4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005. 14
5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
6. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112/103/112103306/