SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Production Engineering) V – SEMESTER

S.No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/ Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PC501PE	Machine Tool Design	3	-	-	3	30	70	3	3
2	PC502ME	Design of Machine Elements	3	-	-	3	30	70	3	3
3	PC503ME	Dynamics of Machines	3	-	-	3	30	70	3	3
4	PC504ME	Metal Cutting and Machine Tools	3	-	-	3	30	70	3	3
5	PC502PE	Computer Aided Design and Manufacturing	3	-	-	3	30	70	3	3
LaboratoryCourse										
6	PC591PE	Computer Aided Production Drawing	-	-	2	2	25	50	3	1
7	PC592ME	Dynamics of Machines Lab	-	-	2	2	25	50	3	1
8	PC592PE	Modern Manufacturing and Testing Lab	-	-	2	2	25	50	3	1
		Total	15	-	06	21				18

PC: Professional Core PE: Professional Elective OE: Open Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)

Course Code	Course Title						Core/Elective
PC 501 PE	MACHINE TOOL DESIGN						Core
Prerequisite	Contact Hours per week				CIE	SEE	Credits
	L	T	D	P			
-	3	--	--	--	30	70	3

Course Objectives:

- To understand the basics and working principles of machine tools.
- To grasp and understand the functional and operational requirements of different types of machine tools.
- To learn the knowledge of design of different types of drives and gears to meet varied functional and operational requirements.
- To understand the hydro dynamics mechanism of machine tools.
- To learn the knowledge of hydraulic controls of machine tools.

Course Outcomes:

After completion of the course, the students will able:

- To differentiate between various machines tools & their specifications, recognize the kinematics and its mechanism of the machines.
- To recognize the drives of the machine tools at varies speeds.
- To understand the drives and analysis of the machine tool componants.
- To recognize the varies spindle speeds of machine tool elements.
- To understand the varies hydraulic controls of machine tools.

Unit-1

Classification of machine tools. Mechanisms used for converting rotary to linear motion and intermittent motion. Kinematic structures of machine tools - general purpose, special purpose, automatic screw cutting machines. Basic features of transfer machines. Numerical Control of machine tools, advantages and limitations. Schematic diagrams of NC systems.

Unit-II

Drives of machine tools; selection of range of speeds and feeds. Speed layout in GP, AP and logarithmic progression. Standardization of speeds and feeds. Productivity loss. Selection of highest and lowest speeds, range ratio. Design of ray diagram and structural diagrams for machine tool gear boxes. Determination of number of teeth and module of gears in gear box design. Rules for layout of gear box having sliding clusters. Sliding cluster and clutched drives, Ruppert drive.

Unit-III

Feed gear boxes: Norton and Meander gear boxes. Stepped and step less regulation of speeds.Strength and Rigidity design analysis. Design of beds, frames, Columns and Guide ways.Materials for structures. Methods to improve the rigidity of structures. Overall compliance of machine tool. Thermal effects - functional accuracy of machine tool.

Unit-IV

Spindle units; Spindles of lathe, Drilling, Milling and Grinding machines materials for spindles. Spindle design. Effect of clearance on the rigidity of spindle. Hydro-dynamic and Hydro-static bearings; Requirements of spindle bearings.

Unit-V

Hydraulic controls: various controls used in machine tools. Hydraulic and Pneumatic systems used in machine tools. Positive displacement pumps. Power pack. Relief valves, check valves, flow control valves, multi position direction control valves, Filters, Accumulators. Speed regulation of surface grinding machine. Hydro- copying systems.

Suggested Reading:

1. G C Sen & Bhattacharya, *Principles of machine tools,* New Central Book Agency, Calcutta.
2. N K Mehta, *Machine Tool Design and Numerical Control,* Tata McGraw-Hill Publishing co. Ltd.
3. S.K.Basu, *Design of machine tools,* Allied Publishers
4. S R Majumdar, *Hydraulic Systems- Principles & Maintenance*, Tata Mc.Graw-Hill Publishing Company *Limited; New* Delhi

Course Code	Course Title						Core/Elective
PC502ME	DESIGN OF MACHINE ELEMENTS						Core
Prerequisite	Contact Hours per week				CIE	SEE	Credits
	L	T	D	P			
	3	--	--	--	30	70	3

Course Objectives:

- Importance of codes, materials, manufacturing processin design of mechanical components
- Importance of theories of failure and effects of fatigue and stress concentration on the life of the component
- Learn the concepts required to design machine components like keys, shafts, couplings
- Will learn to determine size of rivets, welds and cotter joints for specific applications
- Will Understand the concepts used for designing machine components like cotters, bolts, nuts

Course Outcomes:

- Identify & Use codes and standards, selection proper material & perform static design.
- Analyze cyclic loading conditions and provide fatigue design of components
- Analyze machine elements like keys, shafts and couplings,
- Evaluate various joining techniques like welding, riveting and cotter joints.
- Synthesize an d design screw threads for fasteners and power screw applications.

UNIT-I

Steps involved in Design, Design considerations of Machine Elements, Materials used and their specifications. Codes and standards used in design. Practice of using Design data book. Concept of Aesthetics & Ergonomics in design, Preferred numbers. Manufacturing considerations in design. Concept of Value analysis, Principles of concurrent design,

Types of loads and simple stresses. Principal stresses, Stresses due to Biaxial and Triaxial loads. Stress concentration effects, Factor of safety. Theories of failures. Design of components subjected to impact loading.

UNIT-II

Design for Fatigue: Fluctuating stresses, fatigue strength and endurance limit Stress concentration factor and Notch sensitivity. Factors affecting fatigue strength. S-N diagram, Soderberg and Modified Goodman's diagrams for fatigue design, Cumulative fatigue - Miner's rule.

UNIT-III

Design of shafts: solid, hollow and splined shafts under torsion and bending loads. Design of keys. Design of couplings – Industrial Flange coupling, Flexible rubber bush couplings.

UNIT-IV

Design of Joints: Cotter and Knuckle joints. Design of rivetted and welded joints under direct and eccentric loads.

UNIT-V

Design of Screw threads: Design of bolts and nuts, Locking devices for nuts, Bolts of uniform strength. Design of gasket joints, Bolted joints under eccentric loads, Differential and Compound Screws, Design of power Screws and screw jack.

Suggested Reading:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publ, 3rd Edn. 2010.
2. J.E. Shigley & Charles R. Mischke "Mechanical Engineering Design", Tata McGraw-Hill.,6th ed.2010.
3. P. Kannaiah, Machine Design, Sci-Tech Publ., 2009.
4. P.C. Sharma & D.K. Aggarwal, "Machine Design", S.K. Kataria & Sons, 10th edn, 2003
5. V. B. Bhandari, "Design Data Book " 2nd edition, ", Tata McGraw-Hill Publ, 2019

Note : Solution of Numerical problems using Design data book should be practiced.

Course Code	Course Title						Core/Elective
PC503ME	DYNAMICS OF MACHINES						Core
Prerequisite	Contact Hours per week				CIE	SEE	Credits
	L	T	D	P			
Kinematics of Machines	3	--	--	--	30	70	3

Course Objectives:

- To know effect of inertia of links, and external forces on the input torque, and forces developed at joints in typical mechanisms in motion; understand the gyroscopic couple and its effect on vehicles inmotion.
- To know the working principles and characteristics of typical governors, as also the function of flywheels.
- To know the concept of unbalancing rotating and reciprocating masses in single and multi-cylinder in line and radial engines.
- To understand the phenomena of free of free and forced, including the effect of damping for single dof systems, and concepts of isolating vibration.
- To determine natural frequencies of undammed, damped and forced vibrating systems of one, two and multi degree freedom systems.

Course Outcomes:

- Analyse static and dynamic forces in slider crank and other mechanisms; determine the magnitude of gyroscopic couple and its effect on vehicles in motion.
- Evaluate the performance of various types of governors and design flywheels considering speed and energy fluctuation
- Analyse problems of balancing in rotating and reciprocating machinery.
- Evaluate the natural frequencies of single and two degree of freedom systems in free and forced vibration mode, also considering the effect of damping.
- Determine the natural frequencies and mode shapes of multi degree of freedom systems, including by Dunkerley, Raleigh and Holzer methods.

UNIT-I

Static and Dynamic Force Analysis: *Static equilibrium:* Constraint and Applied forces, Static Force analysis of Single slider crank mechanism without Friction, Principle of Superposition.

Dynamic Equilibrium: d'Alambert's Principle, Equivalent offset inertia force, Dynamic force Analysis of Slider Crank Mechanism,

Engine Force Analysis: Piston effort, Force along connecting rod, thrust on sides of cylinder, crank effort. Thrust on bearing. Dynamically Equivalent System for Connecting Rod.

Gyroscope: Gyroscopic Couple, gyroscopic effects on aeroplanes, naval ships.

Stability of two wheel vehicle only.

UNIT-II

Governors: Working principle of governor, Classification & types of governors, analysis of Watt, Porter, and Hartnell governors. Characteristics of governors:

Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

Flywheels: Functions, Differences between flywheel and governor, turning moment diagrams, flywheel analysis for I-C Engines and presses.

UNIT - III

Balancing: Static balancing, Dynamic balancing, balancing of several masses rotating in several planes, consideration of bearing forces, balancing of reciprocating masses, primary balancing shaking forces in single cylinder engine, partial balancing and its effects, secondary balancing.

UNIT - IV

Vibrations: Vibrations of Single degree freedom system (axial, transverse and torsional), Equivalent system of combination of springs, Stepped shaft, Whirling speed of shafts.

Damped Vibrations: Types of damping, Vibrations with viscous damping

Forced Damped Vibrations: Magnification factor, Resonance, Vibration isolation and Transmissibility.

UNIT –V

Vibration Analysis of Multi Degree Freedom Systems: Torsional Vibrations of Two rotor, three rotor and Geared systems. Natural frequencies of two degree freedom systems Modes of vibration approximate methods for determining natural frequencies: Dunkerley's method, Rayleigh's method. Holzer's method (only Theory).

Suggested Reading:

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill, 2010
2. Thomas Bevan, the Theory of Machines, CBS Publishers & Distributors, 2004.
3. John J.Uicker, J r. G o r d o n, R.Pennock, Joseph E.Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003.
4. J.S. Rao and Gupta, Theory and Practice of Mechanical Vib rations, Prentice Hall, 1984.
5. R.L.Nortan, "Kinematics and Dynamics of Machinery", Tata McGraw Education Pvt. Ltd , New Delhi, 2009.
6. Ghosh and Mallik, Theory of Mechanisms and Machines, Affiliated East-West Press, 1988.

Course Code	Course Title						Core/Elective
PC504ME	**METAL CUTTING & MACHINE TOOLS**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives:

- To learn the tool material, geometry and mechanics of metal cutting for turning, drilling and milling.
- To know the heat distribution, tool wear, tool life, and machinability
- To learn the principle and working of various machine tools like lathe, shaper, planer, milling, drilling and grinding machines etc.
- To learn various types of fixtures, conventional and unconventional machining processes.

Course Outcomes:

- Understand the cutting tool geometry, mechanism of chip formation and mechanics of orthogonal cutting.
- Understand the thermal aspects of metal cutting, influence of tool wear on tool life and machinability.
- Identify basic parts and operations of machine tools including lathe, shaper, planer, milling, drilling, and boring machines.
- Design locating and clamping devices to produce a component.
- Understand the principles of various finishing processes and gear manufacturing processes
- Understand the principle and working of various unconventional machining processes.

UNIT-I

Cutting Tool Materials: High carbon steel, HSS, Stellites, Carbides, Coated carbides, Diamonds, Tool material properties; **Tool Geometry:** Nomenclature of single point cutting tool by ASA & ORS systems. Geometry of drills, milling cutters; **Chip Formation:** Types of chips, BUE, Chip breakers; **Machining:** Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant‟s analysis, Shear angle, Solutions of Merchant and Lee & Shafer.

UNIT-II

Thermal Aspects of Metal Cutting: Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications; **Tool Wear, Tool Life and Machinability:** Types of wear, mechanism of tool wear, Tool life & Machinability, Machinability index. Taylor‟s tool life equation; **Economics of Machining:** Tool life for maximum production, minimum cost.

UNIT-III

Machine Tools: Constructional features and specifications of machine tools, various operations on Lathe, Types of Lathes - capstan and turret Lathes; Drilling, Milling and Boring machines. Indexing methods, differences between shaper, planer and slotter, Tool holding and work holding devices Quick return mechanisms.

UNIT-IV

Grinding Machines: Types of grinding, Abrasives and bonds used for grinding wheels. Specification and selection of grinding wheels; Broaching, Lapping, Honing, Polishing, Buffing, Super Finishing and Burnishing.

Screws and Gear Manufacturing: Tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.

UNIT-V

Jigs and Fixtures: Design principles for location and clamping. Quick clamping devices Types of Jigs and fixtures. Applications of Jigs and Fixtures.

Unconventional Machining: Principle of working, merits, demerits and applications of USM, AJM, EDM, ECM, LBM and EBM

Suggested Reading:

1. B.L. JuneJa and Shekon, "Fundamentals of Metal Cutting & Machines Tools", Wiley Eastern Ltd. 1987.
2. P.N. Rao, "Manufacturing Technology – Metal Culling & Machine Tools", Vol. 2, Tata McGraw Hill Education Pvt. Ltd, 2010.
3. Amitab Ghosh and Mallick, "Manufacturing Science", Affiliated East West Press 1985.
4. P.K Misha, "Non Traditional Machining Processes", Narosa Publications, 2006.
5. V.K.Jain “Advanced Machining Processes“ Allied Publishers, Hyderabad, 2011.
6. A. Bhattacharyya, “Metal Cutting Theory and Practice” New Central Book Agency (P) Ltd. Calcutta, 1996.
7. Stephan Radavich, “Gear Manufacturing”, CRC Press, ,1 Edn,2011

Course Code	Course Title						Core/Elective
PC502PE	**COMPUTER AIDED DESIGN AND MANUFACTURING**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Computer aided design and its standards
- Geometric modelling and its types and techniques
- NC machine and Part programming of machining
- Advanced NC machines, Basic exposure to industrial robots and Group Technology
- Importance and significance of CAPP, CAQC, Reverse engineering and Rapid Prototyping

Course Outcomes

After completing this course, the student will be able to:

1. Appraise about the product life cycle and CAD standards. Analyse the geometric transformations.
2. Differentiate the types of geometric modelling and apprehend the application of geometric modelling w.r.t real time applications.
3. Execute the part programming for machining.
4. Identify the working of CNC, DNC, Robots and analyse the applications of GT.
5. Differentiate the various CAPP, CAQC techniques and understand the advancement in CAM technologies i.e. reverse engineering and rapid prototyping.

Unit -I

Fundamentals of CAD: Introduction to CAD and its tools, Product life cycle, sequential and concurrent engineering,Computer Aided Design, Coordinate systems,2D transformations.CAD standards- Graphical Kernel System (GKS), Data exchange standards- IGES, STEPetc.Types of CAD database, various types of network.

Unit –II

Geometric Modeling: Types of geometric modeling. Wireframe modeling -representation of analytic and synthetic curves, Hermite curves, Bezier curves, B-splinecurves, NURBS, Entities of surface modelling, Analytic surface entities andbicubicpatches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep**.**

UNIT-III

Numerical Control Machine Tools: Features and elements of NC, Positional, paraxial and contouring types. Definitions of axes. Definitions of interpolation, post -processor, preparatory and miscellaneous functions, Canned cycles, Tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components. Programming with MACROS.

UNIT-IV

Computer Numerical Control: CNC, DNC and Adaptive control systems. Machining centers.
Industrial Robots: Robot Anatomy, Configurations, Programming methods and Applications.
GT: Part families, layout, part classification and coding system. Opitz, MICLASS, CODE system

UNIT-V

CAPP: Variant and Generative process planning. **FMS & CIMS:** Building blocks of Flexible Manufacturing systems and their control, Elements of CIMS.
Computer Aided Inspection and QC: Coordinate Measuring Machine, Non-contact inspection: Machine vision, Scanning Laser Beam Devices Quality control. CAD/CAM Integration.
Introduction to Rapid Prototyping Technique and Reverse Engineering.

Suggested Readings:

1. Arvid R. Eide, Roland D. Jenison, Lane H. Mashaw, Larry L. Northup, "Introduction to EngineeringDesign" McGraw -Hill, 1998.
2. Ibrahim Zeid. CAD/CAM, Theory and Practice, McGraw. Hill Inc. New York, 2011.
3. Grover, MP and Zimmers E.W. CAD/CAM, Prentice Hall of India, 1989.
4. Rao, PN. CAD/CAM: Principles and Applications, 2nd Edition, Tata McGraw Hill, New Delhi, 2004.
5. YoramKoren, Computer Control of Manufacturing Systems, McGraw Hill Int, New York, 1994.
6. Ishrat M Mirzana, "CAD/CAM", Radiant Publishing House, 4th Edition, Hyderabad, 2014
7. Elanchezhian. C. Sunder Selwyn. T. Shanmuga Sunder, G, Computer Aided Manufacturing, Laxmi
Publications (P) Ltd., 2nd Edition, New Delhi, 2007.

Course Code	Course Title						Core/Elective
PC591PE	**COMPUTER AIDED PRODUCTION DRAWING LAB**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

The objectives of this course is to impart knowledge of

- To learn design criteria of machine components, importance of production drawing in selection of materials and manufacturing process.
- To learn application of principles to design various machine components by applying limits, tolerances, surface finish and many more techniques of production drawing.

Course Outcomes

After completing this course, the student will be able to:

- Create various models of the machine components.
- Prepare the production drawings of the parts from the given assembly drawing
- Indicate details pertaining to manufacturing requirements and generate the bill of materials.
- Prepare the process sheet for the components drawn.
- Demonstrate the documentation and presentation skills

List of Experiments

1. Part modeling from given assembly drawings (Stuffing Box, Steam Engine Cross Head, Universal Coupling, Foot Step Bearing, Eccentric and Drill Jig) using any solid modeling package.
2. Geometrical dimensioning and tolerance representation on part drawings of above mentioned drawings.
3. Conventional practices indicating Dimensional, Form & Position tolerances.
4. Calculation of limits, suggestion of suitable fits for mating parts with Interference detection.
5. Surface finish, surface treatments- specification and indication methods on the drawings.
6. Generation of production drawings in 2D from part models representing Limits, fits, tolerances, Surface finish, geometrical and form tolerance etc.
7. Preparation of Process sheet incorporating Tool work orientation diagrams.

***Suggested Reading**:*

1. K. L. Narayana, P. Kannaiah and K. Venkat Reddy, "*Production Drawing"*, New Age International (P) Ltd. Revised edition 1997.
2. P. Narasimha Reddy, T. A. Janardhan Reddy and C. Srinivas Rao, "*Production Drawing Practice"*, Hi-Tech Publishers, 2001.

Course Code	Course Title						Core/Elective
PC592ME	**DYNAMICS OF MACHINES LAB**						**Core**
Prerequisite	**Contact Hours per week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
Theory of Machines	**--**	**--**	**--**	**2**	**25**	**50**	**1**

Course Objectives:

- To understand the effects and importance of kinematic and dynamic analysis of mechanisms
- To understand effects and analysis of Single degree freedom vibration systems
- To study the gyroscope, governors and cams
- To carry out the static and dynamic analysis of four bar mechanisms and drives

Course Outcomes:

- To experimentally quantify the effect of inertia forces in systems like flywheel, gyroscope and governors.
- To evaluate vibrational characteristics of various systems experimentally.
- To Synthesize balancing method of multi plane rotating masses.

List of Experiments

1. Centrifugal Governors: Experiment on Performance Characteristic Curves.
2. Estimation of Gyroscopic Couple & Understanding of Gyroscopic Effects on a rotating disc.
3. Static and Dynamic Balancing of Rotating Masses.
4. Determination of Moment of Inertia of Connecting Rod by compound pendulum method.
5. Damped and Undamped Torsional Vibrations of Single and Double Rotor System.
6. Single DOF (Degrees of Freedom) of Spring Mass Damper System. (Damped and Undamped Systems).
7. Free and Forced Vibration of Simply Supported Cantilever Beam.
8. Dunkerley Method to Find Fundamental Frequencies.
9. Critical Speed of Shaft.
10. Modal Analysis of Beam.
11. Cam Analysis of Cams.
12. Any Experiment explaining dynamic aspects of mechanical systems.

Additional Experiments Suggested

1. Determination of Moment of Inertia of Flywheel.
2. Experiment with Bifilar System.

Demonstration Experiments (Can‟t be allocated in final exams)

1. Velocity Ratios of Simple, Compound, Epicyclic and Differential Gear Trains.
2. Virtual Lab Experiment I – Governors.
3. Virtual Lab Experiment II – Natural Frequency of Cantilever beam.

Note: Minimum ten experiments should be conducted in the semester.

Suggested Reading:

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill, 2010
2. John J.Uicker, J r. G o r d o n, R.Pennock, Joseph E.Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003.
3. Lab manual supplied by department.

Course Code	Course Title						Core/Elective
PC592PE	**Modern Manufacturing and Testing Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To study the features of CNC machine tool.
- To know application of various CNC machine.
- To understand various production processes.
- To understand the working principles of various Modern manufacturing methods.
- To have knowledge of various NDT method*s.*

Course Outcomes

After completing this course, the student will be able to:

1. Decide on the process parameters to be adopted and applicability of various materials that are suitable for mechanical energy based machining processes
2. Decide on the process parameters to be adopted and applicability of various materials that are suitable for electrical and thermal based machining processes
3. Will be able to understand the CNC control in modern manufacturing system.
4. Will be able to distinguish between various manufacturing processes.
5. Will be able to select appropriate manufacturing process to manufacture any component.

List of Experiments:

A: Computer Aided Manufacturing Practice.

1. Step turning and taper turning on CNC.
2. External multiple turning cycles.
3. Grooving and threading operation.
4. Contour milling on CNC.
5. Circular pocketing on CNC

B: Modern Manufacturing Practice.

6. Experiments on Electro Discharge Machine.
7. Develop simple objects using 3D printing technology.
8. Exercise on spinning / flow forming operations.
9. Manufacturing of simple components with composite materials.
10. Study of simple dies and performing blanking and piercing operations by using mechanical presses.

C: Non Destructive Testing.

11. Detection of surface flaws of materials with visible dye.
12. Detection of surface flaws of materials with fluorescent dye.
13. Detection of sub surface flaws using Magnetic Particle Testing using Dry Powder.
14. Detection of sub surface flaws using Magnetic Particle Testing using Wet Powder.

Note: At least ten experiments should be conducted.