Other university B.E./B.Tech - G
MECH Level 3 syllabus

Theory of Machine – II

Course Code: 302043

Course Name : Theory of Machine – II

Credits TH:--03 TW/OR:--01

Unit – I: Spur Gear
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, interference and under cutting – Methods to avoid interference. Minimum number of teeth on gear and pinion only, Force analysis and Friction in gears.

Unit – II: Helical, Bevel, Worm and Worm Wheel
Helical and Spiral Gears: terminology, geometrical relationships, tooth forces, torque transmitted and efficiency, virtual number of teeth for helical gears Bevel Gear & Worm and worm wheel: terminology, geometrical relationships, tooth forces, torque transmitted.
Bevel Gear: Theoretical treatment only

Unit – III Gear Trains
Types of Gear Trains, analysis of epicyclic gear trains, Holding torque – Simple, compound and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel epicyclic Gear train.

Unit –IV Cam and Follower
Types of cams and followers, analysis of standard motions to the follower, Determination of cam profiles for different follower motions, Methods of control: pressure angle, radius of curvature and undercutting. Jump phenomenon of Eccentric cam, Introduction to advanced cam curves (up to 3-4- 5 Polynomial cam only)

Unit –V Synthesis of Mechanism

Steps in synthesis process: Type, number and dimensional synthesis. Tasks of Kinematic synthesis: Path, function and motion generation (Body guidance). Precision Positions, Chebychev spacing, Mechanical and structural errors. Three position synthesis of four bar mechanism using Freudenstein's equation. Analytical synthesis using kinematic coefficient in four bar mechanism.

Unit –VI Step–Less-Regulation (Theoretical Treatment only) & Gyroscope

Continuous Variable Transmissions - Geometry, Velocity and torque analysis of Faceplate variators, conical variators, Spheroidal and cone variators, Variators with axially displaceable cones, PIV drives. Gyroscopes, Gyroscopic forces and Couples, Gyroscopic stabilisation for ship and Aeroplane, Stability of four wheel vehicle moving on curved path.

Books:

Text:

1. S. S. Rattan, Theory of Machines, Third Edition, McGraw Hill Education (India) Pvt. Ltd. New Delhi.
2. Bevan T, Theory of Machines, Third Edition, Longman Publication.
3. A. G. Ambekar, Mechanism and Machine Theory, PHI.
4. N. K. Mehta, Machine Tool Design and Numerical Control, Tata McGraw Hill Publication,
5. J. J. Uicker, G. R. Pennock, J. E. Shigley, Theory of Machines and Mechanisms, Third Edition, International Student Edition, OXFORD.

References:

1. Ghosh Malik, Theory of Mechanism and Machines, East-West Pvt. Ltd.
2. Hannah and Stephans, Mechanics of Machines, Edward Arnolde Publication.
3. R L Norton, Kinematics and Dynamics of Machinery, First Edition, McGraw Hill Education (India) P Ltd. New Delhi
4. Sadhu Singh, Theory of Machines, Pearson
5. D.K. Pal, S.K. Basu, Design of Machine Tools, Oxford & Ibh Publishing Co Pvt. Ltd.
6. Dr. V. P. Singh, Theory of Machine, Dhanpatrai and sons.
7. C. S. Sharma & Kamlesh Purohit, "Theory of Machine and Mechanism", PHI.

Manufacturing Processes

PCC-ME 303 Manufacturing Processes

4.5 Credits

Module: 1
Conventional Manufacturing processes: Casting and Moulding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Module: 2
Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk-forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.

Module: 3
Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.

Module: 4
Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding. Additive manufacturing: Rapid prototyping and rapid tooling

Module:5
Machine Tools:
(a) Lathe: Principle, types, operations, turret/capstan, semi/automatic, Tool layout.

(b) Shaper, slotted, planer, operation, drive.
(c) Milling, Milling cutter, up & down milling, dividing head indexing, Max chip thickness, power required.
(d) Drilling and boring, reaming tools, Geometry of twist drill, Grinding, Grinding wheel, Abrasive, cutting action, grinding wheel specification, Grinding wheel wear, alterations, wear, fracture wear, dressing and trimming. Max chip thickness and guest criteria, Fla and cylindrical grinding, Centerless grinding, Superfinishing, Honing lapping, Polishing

Text Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems
3. Degarmo, Black &Kohser, Materials and Processes in Manufacturing

Fluid Machinery

PCC-ME 302 Fluid Machinery

4.5 Credits

Module: 1
Introduction – Classification of fluid machinery.

Module: 2
Dynamic action of fluid jet – Impact of fluid jet on fixed and moving flat places, impact of jet on fixed and moving curved vanes, flow over radial vanes, jet propulsions.

Module: 3
Euler's fundamental equation, degree of reaction.

Module: 4
Hydraulic turbines, introduction, classification, impulse turbine, construction details, velocity triangles, power and efficiency calculations, reaction turbines; constructional details, working principle, velocity triangles, power and efficiency calculations, draft tube, cavitation, governing.

Module: 5
Principle of similarity in fluid machinery; unit and specific quantities, testing models and selection of hydraulic turbines.

Module: 6
Positive displacement pumps: Reciprocating pump; working principle, classification, slip, indicator diagram, effect of friction and acceleration, theory of air vessel, performance characteristics gas gear oil pump and screw pump.

Module: 7
Rotodynamic pumps: Introduction, classification, centrifugal pump;

main components, working principle velocity triangle, effect of shape of blade specific speed, heats, power and efficiency, calculations minimum steering speed, multi-stage pumps, performance characteristic,
comparison with reciprocating pump.

Text Books:
1. G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, Third Edition, CRC Press,2004.
2. Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
3. Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hall international, 1969.
4. Hydrantic Machine by Jagdish Lal
5. Hydraulics & Hydraulic Machines by Vasandari
6. Hydrantic Machine by RD Purohit

Heat Transfer

PCC-ME 301Heat Transfer

4.5 Credits

Module: 1
Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two-dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.

Module:2
Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection-Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

Module: 3
Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.

Module: 4
Types of heat exchangers, Analysis and design of heat exchangers using bothLMTD and ε-NTU methods.

Module: 5

Boiling and Condensation heat transfer, Pool boiling curve.

Module: 6
Introduction mass transfer, Similarity between heat and mass transfer

Text Books:
1. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002

Kinematics of Machine

PCC-ME 304 Kinematics of Machine

4 credits

Module 1
Introduction: Classification of mechanisms: -Basic kinematic concepts and Definitions-Degree of freedom, mobility-Grashof's law, Kinematic inversions of four bar chain and slider crank chains.

Module 2
Kinematic analysis of plane mechanism: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coriolis component of acceleration.

Module 3
Friction devices: Belt drive, Clutch, Shoe brakes, Band and block brakes.

Module 4
Gear: gear terminology, Involute and Cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting.
Gear Train: Analysis of simple, compound, reverted and epicyclic gear train with problems.

Module 5
Balancing of rotating masses: Balancing of rotating masses in the same plane by a single revolving mass. Balancing of several rotating masses in the same plane. Balancing of several rotating masses in different planes by two revolving masses in suitable planes.

Module 6
Governors: Watt, Porter, Proel & Hartnell Governors, Effect of friction, controlling force, governor effort and power, sensitivity and isochronisms.

Text Books:
[1.] Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
[2.] CleghornW.L. , Mechanisms of Machines, Oxford University Press, 2005.
[3.] Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGrawHill, 2009.

[4.] Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East- West Pvt. Ltd, New Delhi, 1988.

Refrigeration and Air Conditioning

REFRIGERATION & AIR CONDITIONING

Credits:1

Unit-1
Refrigeration:
Introduction to refrigeration system, Methods of refrigeration, Carnot

refrigeration cycle, Unit of
refrigeration, Refrigeration effect & C.O.P.
Air Refrigeration cycle:
Open and closed air refrigeration cycles, Reversed Carnot cycle, Bell Coleman or Reversed Joule air
refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot
strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Unit-2
Vapour Compression System:
Single stage system, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of
change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate &
superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration
cycle, Multistage vapour compression system requirement, Removal of flash gas, Intercooling,
Different configuration of multistage system, Cascade system.

Unit-3
Vapour Absorption system;

Working Principal of vapour absorption refrigeration system, Comparison between absorption &
compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration
diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water
vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison. Three fluid
system.

Refrigerants:
Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants,
Secondary refrigerants and CFC free refrigerants. Ozone layer depletion and global warming
considerations of refrigerants

Unit-4

Air Conditioning:

Introduction to air conditioning, Psychometric properties and their definitions, Psychometric chart,
Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort
chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat
transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF
), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP). Air Washers,
Cooling towers & humidifying efficiency.

Unit-5

Refrigeration Equipment & Application:

Elementary knowledge of refrigeration & air conditioning equipmentse.g compressors, condensers,
evaporators & expansion devices, Food preservation, Cold storage, Refrigerates Freezers, Ice plant,
Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans,
Basic difference between comfort and industrial air conditioning.

MACHINE DESIGN-II

UNIT I

Principle of transmission and conjugate action
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, Forces components on a tooth of helical gear, Virtual

number of teeth, Beam strength& wear strength of helical gears, Dynamic load on helical gears, Design
of helical gears.

UNIT II Bevel gears
Terminology of bevel gears, Force analysis, Virtual number of teeth, Beam strength and wear strength
of bevel gears,Effective load of gear tooth, Design of a bevel gear system.

Worm Gears
Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in
worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing system.

UNIT III
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,
Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing,

UNIT IV
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, Selection of rolling
contact bearing, Lubrication of ball and roller bearing, Mounting of bearing

UNIT V
IC ENGINE parts,
Selection of type of IC engine, General design considerations, Design of cylinder and cylinder head;
Design of piston and its parts like piston ring and gudgeon pin etc.; Design of connecting rod; Design of
crankshaft

Books and References:

1. Design of Machine Elements-V.B. Bhandari, Tata McGraw Hill Co.
2. Machine Design-Sharma and Agrawal, S.K. Kataria& Sons.
3. Machine Design, U C Jindal, Pearson Eductaion.
4. Design of Machine Elements, Sharma and Purohit, PHI.
5. Design of Machine Eesign-M.F. Spott, Pearson Eductaion
6. Machine Design-Maleev and Hartman, CBS Publishers.
7. Mechanical Engineering Design, 9e – Joseph E. Shigely, McGraw Hill Education.
9. Elements of Machine Component Design, Juvinal&Marshek, John Wiley & Sons.

Theory of Machines

Unit I

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

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

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

Balancing:
Introduction,static balance, dynamic balance, balancing of rotating masses,two plane
balancing, graphical and analytical methods, balancing of reciprocating masses,
Governors:
Introduction, types of governors, characteristics of centrifugal governors, gravitycontrolled
and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors. Effort and Power of governor

Unit V

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

Text/Reference Books:
1. Kinematics and dynamics of machinery: Wilson and Sadler, Third edition, Pearson.

2. Theory of Mechanisms and Machines: AmitabhaGhosh and Ashok kumarMallik, 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 Mchines: S.S. Rattan, McGraw Hill
6. Theory of Mchines: Thomas Bevan, CBS Publishers.

Fluid Machinery

UNIT-I
Introduction: Impulse of Jet and Impulse Turbines:
Classification of Fluid Machines & Devices, Application of momentum and moment of
momentum equation to flow through hydraulic machinery, Euler's fundamental equation.
Introduction to the hydrodynamic thrust of the jet on a fixed and moving surface (flat &curve),
Classification of turbines, Impulse turbines, Constructional details, Velocitytriangles, Power
and efficiency calculations, Governing of Pelton wheel

UNIT-II
Reaction Turbines:
Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency
calculations, Degree of reaction, Draft tube, Cavitation in turbines, Principles of similarity,
Unit and specific speed, Performance characteristics, Selection of water turbines.

UNIT-III
Centrifugal
Pumps:
Classifications of centrifugal pumps, Vector diagram, Work done by impellor, Efficiencies of
centrifugal pumps, Specific speed, Cavitation & separation, Performance characteristics.

UNIT-IV
Positive Displacement and other Pumps:

Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels,
Comparison of centrifugal and reciprocating pumps, Performance characteristics.

UNIT-V
Hydraulic accumulator, Hydraulic intensifier, Hydraulic Press, hydraulic crane, hydraulic lift,
hydraulic Ram,hydraulic coupling, hydraulic torque converter, airlift pump, jet pump

Design of Machine Elements

Design of Machine Elements

Module: 1
Introduction to design: Steps in design process, design factors, practical considerations in design,
selection of materials, strength of mechanical elements, impact load, shock load, fatigue loading,
effects of surface, size, temperature and stress concentration, consideration of creep and thermal
stress in design. (Lectures8)
Module: 2
Design of shafts: stresses in shafts, design of static loads, combined stresses, reversed bending and
steady loads, design of shafts based on deflection and strength, critical speed of shafts. Analysis and
design of sliding and rolling contact bearings,
Module: 3
Riveted joint: Stresses in riveted joint, design of riveted joints with central and eccentric loads,
boiler and tank joints, structural joints.
Bolt Joints: Stresses in bolt joint, design of bolt joints with central and eccentric loads.
Welded joints: types of welded joints, stresses, design of welded joints subjected to axial, torsional
and bending loads, welds subjected to fluctuating loads.
Module: 4
Design of Clutches: Friction clutches, uniform wear and uniform pressure assumptions, centrifugal
clutches.
Brakes: Design of internal expansion elements, assumptions, design

of external contraction
elements, band type brakes.

Module: 5

Design of transmission elements: spur, helical, bevel and worm gears;

Springs: stresses in helical springs, deflection of helical compression and tension springs, springs
subjected to fatigue loading, concentric and helical torsion spring, critical frequency of springs, leaf
springs, and design of automotive leaf springs.