SPPU B.E./B.Tech MECH Sem 6 syllabus

Numerical Methods and Optimization

Course Code: 302047 Course Name : Numerical Methods and Optimization

Unit – I: Roots of Equation and Error Approximations (08 hrs.)
Roots of Equation
Bisection Method, Newton Raphson method and Successive approximation method.
Error Approximations
Types of Errors: Absolute, Relative, Algorithmic, Truncation, Round off Error, Error Propagation, Concept of convergence-relevance to numerical methods.

Unit – II: Simultaneous Equations (08 hrs.)
Gauss Elimination Method with Partial pivoting, Gauss-Seidal method and Thomas algorithm for Tri-diagonal Matrix, Jacob iteration method.

Unit – III: Optimization (08 hrs.)
Introduction to optimization, Classification, Constrained optimization (maximum two constrains): Graphical and Simplex method, One Dimensional unconstrained optimization: Newton's Method.
Modern Optimization Techniques: Genetic Algorithm (GA), Simulated Annealing (SA).

Unit – IV: Numerical Solutions of Differential Equations (10 hrs.)
Ordinary Differential Equations [ODE]
Taylor series method, Euler Method, Runge-Kutta fourth order, Simultaneous equations using RungeKutta2nd order method.
Partial Differential Equations [PDE]: Finite Difference methods
Introduction to finite difference method, Simple Laplace method, PDEs- Parabolic explicit solution, Elliptic-explicit solution.

Unit – V: Curve Fitting and Regression Analysis (08 hrs.)
Curve Fitting
Least square technique- Straight line, Power equation, Exponential equation and Quadratic equation. Regression Analysis
Introduction to multi regression analysis, Lagrange's Interpolation, Newton's Forward interpolation, Inverse interpolation (Lagrange's method only).

Unit – VI: Numerical Integration (06 hrs.)
Numerical Integration (1D only)
Trapezoidal rule, Simpson's 1/3rdRule, Simpson's 3/8thRule, Gauss Quadrature 2 point and 3 point method.
Double Integration Trapezoidal rule, Simpson's 1/3rdRule.

Books:
Text:
1. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 4/e, Tata McGraw Hill Editions
2. Dr. B. S. Garewal, Numerical Methods in Engineering and Science, Khanna Publishers,.
3. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientist, Tata Mc-Graw Hill Publishing Co-Ltd
4. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishers

References:
1. Gerald and Wheatley, Applied Numerical Analysis, Pearson Education Asia
2. E. Balagurusamy, Numerical Methods, Tata McGraw Hill
3. P. Thangaraj, Computer Oriented Numerical Methods, PHI
4. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.

Design of Machine Elements – II

Course Code: 302048 Course Name : Design of Machine Elements – II

Unit –I Spur Gears (08 hrs)
Introduction to gears: Gear Selection, material selection, Basic modes of tooth failure, Gear Lubrication Methods.
Spur Gears: Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength

(Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation.

Unit –II Helical and Bevel Gears (08 hrs)
Types of helical and Bevel gears, Terminology, Virtual number of teeth, and force analysis of Helical and Straight Bevel Gear. Design of Helical and Straight Bevel Gear based on Beam Strength, Wear strength and estimation of effective load based on Velocity factor (Barth factor) and Buckingham's equation. Mountings of Bevel Gear. (No numerical on force analysis of helical & Bevel Gear)

Unit – III Rolling Contact Bearings (08 hrs)
Types of rolling contact Bearings, Static and dynamic load carrying capacities, Stribeck's Equation,
Equivalent bearing load, Load- life relationship, Selection of bearing life Selection of rolling contact bearings from manufacturer's catalog, Design for cyclic loads and speed, bearing with probability of survival other than 90%
Taper roller bearing: Force analysis and selection criteria.
(Theoretical Treatment only)

Unit - IV:
Worm and worm gear terminology and proportions of worm and worm gears, Force analysis of worm gear drives, Friction in Worm gears, efficiency of worm gears, Worm and worm gear material, Strength and wear ratings of worm gears (Bending stress factor, speed factor, surface stress factor, zone factor) IS 1443-1974, Thermal consideration in worm gear drive, Types of failures in worm gear drives, Methods of lubrication

Unit - V:
Belt drive: Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition,
Selection of Flat and V-belts from manufacturer's catalog, belt tensioning methods, relative advantages and limitations of Flat and V-belts, construction and applications of timing belts.
Wire Ropes (Theoretical Treatment Only): Construction of wire ropes, lay of wire rope, stresses in wire rope, selection of wire ropes, rope drums construction and design.
Chain Drives (Theoretical Treatment Only): Types of chains and its Geometry, selection criteria for chain drive, Polygon effect of chain,

Modes of failure for chain, Lubrication of chains

UNIT VI:
Classification of sliding contact bearing.
Lubricating oils: Properties, additives, selection of lubricating oils, Properties & selection of bearing materials.
Hydrodynamic Lubrication: Theory of Hydrodynamic Lubrication, Pressure Development in oil film, 2DBasic Reynolds Equation, Somerfield number, Raimondi and Boyd method, Thermal considerations, Parameters of bearing design, Length to Diameter ratio, Unit bearing Pressure, Radial Clearance, minimum oil film thickness.

Books:
Text:
1) Bhandari V.B, Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
2) Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. Ltd.
3) Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
4) Juvinal R.C, Fundamentals of Machine Components Design, John Wiley and Sons.

References:
1. Black P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, Machine Components Design, West Publishing Co. and Jaico Publications House.
3. Hall A.S., Holowenko A.R. and Laughlin H.G, Theory and Problems of Machine Design, Schaum's Outline Series
4. C.S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learing Pvt. Ltd.
5. D. K. Aggarwal & P.C. Sharma, Machine Design, S.K Kataria and Sons
6. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learing Pvt. Ltd.
7. Design Data - P.S.G. College of Technology, Coimbatore.
8. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
9. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers

Manufacturing Process II

Course Code: 302051 Course Name : MANUFATCURING PROCESS – II

Credit 03

Unit – I Theory of Metal cutting (07hrs)
Single point cutting tool: Tool geometry, Mechanics of shearing (orthogonal and oblique), Shear plane angle, Shear stress, strain and Shear strain rate. Process parameters and their effect on machining. Merchant's circle of forces (analytical) Estimation of shear force, Normal shear force, Friction force, Normal friction force, Material Removal Rate (MRR), Cutting power estimation, Calculation of Total power and Specific energy. Introduction to tool dynamometers. Machinability - Factors affecting machinability, Tool life, Tool wear, Types of tool wear and remedial actions, Cutting fluid and their types, Effect of process parameters on tool life, Taylor's tool life equation (Derivation along with numerical).

Unit – II Machine tools and their application (07 hrs)
Drilling machine: Types of drills and operations. Twist drill geometry, Types of drilling machine, Tool holder. Machining time calculations. Milling machine: Types of milling machines, Cutter-types and geometry and their applications. Universal dividing head, Methods of Indexing: Simple, Compound, Differential. (Numericals based on simple and compound Indexing).Machining time calculations Broaching: Introduction to broaching, Broach tool geometry, Planner and Boring Machines: Introduction.

Unit – III Finishing processes (07hrs)
Grinding machines
Introduction: Types and Operations of grinding machines.
Grinding wheel – Shapes, Designation and selection, Mounting, Balancing and Dressing of grinding wheels, Machining time calculation for cylindrical and plunge grinding.
Super-finishing processes – Introduction to Honing, Lapping, Buffing and Burnishing. (Construction, working and controlling parameters)

Unit – IV Advanced Machining Processes (07 hrs)
Introduction, classification of advanced machining processes. Principles, Working, Process Parameters, Advantages, Limitations and Application for following processes:
Electric Discharge Machining (EDM), LASER Beam Machining

(LBM), Abrasive Jet Machining (AJM), Ultra Sonic Machining (USM) and Electro Chemical Machining (ECM)
Introduction to micro machining.

Unit –V CNC Technology (07 hrs)
Introduction, Classification, Construction and working of NC, CNC, DNC and machining center.
CNC axes and drives. Automatic Tool Changer (ATC) and Automatic pallet changer (APC)
CNC Programming: Word address format (WAF) –ISO Standards, G & M codes, Type of CNC Control systems, Manual part programming (plain milling and Turning), Subroutine, Canned cycles.

Unit –VI Jigs and fixtures (07 hrs)
Concept of degree of freedom, 3-2-1 principle of location, General guidelines to design Jigs and fixtures, advantages of jig and fixtures
Jigs: Definition. Elements of jig with the types, Location guidelines, Principles of clamping, Principles of guiding element, Channel jig, Template jig, Plate jig, Angle plate jig, Turn over jig, Box jig, and Latch type jig.
Fixtures: Definition. Elements of fixtures, Location guidelines, Principles of clamping, Principles of setting element, Turning fixture, Welding fixture, Milling fixture, Introduction to Assembly and Inspection fixtures. Indexing fixtures.
Concept, elements and advantages of modular fixture, Pokayoke concept in jigs and fixtures.

Books:
Text:
1. S. K Hajra Choudhury , Elements of workshop technology – Vol. II,, Media Promoters And Publishers, Mumbai
2. Amitabh Ghosh and Asok kumar Mallik, Manufacturing science, Ellis Horwood Ltd
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications
4. P. C. Sharma, Production Engineering, S. Chand Publication.

References:
1. Production technology –HMT, Tata McGraw Hill publication
2. Lindberg, Roy A., Processes and materials of manufacture, P H I Learning
3. Serope Kalpakjian and Steven R. Schmid, Manufacturing Processes for Engineering Materials, Pearson Education, Fourth Edition.
4. G. K Lal, Fundamentals of Design and Manufacturing, Alpha

Science International Ltd(2005)
5. M.C Shaw, Metal Cutting Principles, Oxford university press
6. Yoram Koren , Numerical Control of Machine Tools Khanna Publication
7. P. K Mishra, Non- conventional machining, Narosa Publishing House
8. V. K Jain, Advanced machining processes , Allied Publisher, New Delhi
9. M. H. A Kempster, An Introduction to Jig and Tool Design, ELBS
10. P. H. Joshi, Jigs and fixtures , Tata McGraw Hill
11. P. N. Rao, CAD/CAM Principles and Applications, McGraw Hill Education, Third Edition.
12. Cyrll Donaldson, George H. LeCain and V. C. Goold, Tool design, Tata McGraw- Hill. Third Edition

Refrigeration and Air Conditioning

Course Code: 302049 Course Name : Refrigeration and Air Conditioning

Unit I: Applications of Refrigeration and Air Conditioning and Refrigerants [8 hrs]

Applications

Domestic Refrigerator, Domestic Air Conditioners, Automotive Air Conditioners, Evaporative
coolers, water coolers, Commercial Refrigeration- Dairy, Cold storage, Ice plant, Commercial Air
Conditioning-Multiplex, Hospitals.

Refrigerants

Classification of refrigerants, Designation of refrigerants, Desirable properties of refrigerants,
environmental issues, Ozone depletion and global warming, ODP, GWP & LCCP, selection of
environment friendly refrigerants, secondary refrigerants, anti-freeze solutions, Zeotropes and
Azeotropes, refrigerant: recovery reclaims, recycle and recharge.

Unit II: Vapour Refrigeration Systems [8 hrs]

Vapour compression systems

Working of simple vapour compression system, representation of vapour compression cycle (VCC)
on T-s and P-h diagram, COP, EER, SEER, IPLV, NPLV, effect of operating parameters on

performance of VCC, actual VCC, methods of improving COP using flash chamber, sub-cooling,
liquid vapour heat exchanger, comparison of VCC with Reverse Carnot cycle.
Vapour absorption systems
Introduction, Working of simple vapour absorption system (VAS), desirable properties of binary
mixture (aqua-ammonia), performance evaluation of simple VAS (simple numerical treatment),
actual VAS, Li-Br absorption system, three fluid system (Electrolux refrigeration), applications of
VAS, comparison between VCC and VAC

Unit III: Multiple pressure Refrigeration Systems [8 hrs]
Introduction, need of multistage system, Intermediate pressure, two stage compression with flash
gas removal and liquid intercooler, single compressor with multiple evaporator: individual and
multiple expansion valves, individual compressors, cascade system: application and
numerical(numerical only by using p-h chart),
Introduction to cryogenics (Linde - Hampson cycle) and applications (no numerical treatment)

Unit IV: Psychrometry and Air conditioning load estimation [8 hrs]
Psychrometry
Basic Psychrometry and processes, BPF of coil, ADP, adiabatic mixing of two air streams, SHF,
RSHF, GSHF, ESHF. Factors contributing to cooling load, Numerical based on load analysis
Human Comfort
Thermodynamics of human body, comfort and comfort chart, factors affecting human comfort,
concept of infiltration and ventilation, indoor air quality requirements,

Unit V: Air Conditioning Systems [8 hrs]
Air Conditioning Systems
Working of summer, winter and all year round AC systems, all air system, all water system, air
water system, variable refrigerant flow and variable air volume systems, unitary and central air

conditioning.
Components of refrigeration and air conditioning systems
Working of reciprocating, screw and scroll compressors, working of air cooled, water cooled and
evaporative condensers, working of DX, Flooded, Forced feed evaporators, Expansion devices –
Capillary tube, TXV, EXV, operating and safety controls.

Unit VI [8 hrs]
Air Distribution Systems
Part A] Ducts
Classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct
(friction losses, dynamic losses), air flow through simple duct system, equivalent diameter, Methods
of duct system design: equal friction, velocity reduction, static regain method (numerical on duct
system design)
Part B] Air handling unit
Air handling unit, Fan coil unit, types of fans used air conditioning applications, fan laws, filters,
supply and return grills, sensors (humidity, temperature, smoke).

Books:
Text:
1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill
2. Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983
3. McQuiston, — Heating Ventilating and air Conditioning: Analysis and Design‖ 6th Edition,
Wiley India
4. Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpatrai & Company, New Delhi
5. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt.
Ltd, New Delhi,1994.
6. Ballaney P.L., Refrigeration and Air conditioning, Khanna Publishers, New Delhi, 1992

References:
1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000
2. Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International

editions 1982.
3. Threlkeld J.L, Thermal Environmental Engineering, Prentice Hall Inc., New Delhi

4.Aanatnarayan, Basics of refrigeration and Air Conditioning, Tata McGraw Hill Publications
5. Roger Legg, Air Conditioning System Design, Commissioning and Maintenance
6. ASHRAE & ISHRAE handbook

Mechatronics

Course Code: 302050

Course Name : Mechatronics

TH:--03 OR:- 01

UNIT 1: Introduction to Mechatronics, Sensors & Actuators (08 Hrs)
Introduction to Mechatronics and its Applications; Measurement Characteristics: Static and Dynamic; Sensors: Position sensors-Potentiometer, LVDT, incremental Encoder; Proximity sensors-Optical, Inductive, Capacitive; Temperature sensor-RTD, Thermocouples; Force / Pressure Sensors-Strain gauges; Flow sensors-Electromagnetic; Actuators: Stepper motor, Servo motor, Solenoids; Selection of Sensor & Actuator.

UNIT 2: Block Diagram Representation (08 Hrs)
Introduction to Mechatronic System Design; Identification of key elements of Mechatronics systems and represent into Block Diagram; Open and Closed loop Control System; Concept of Transfer Function; Block Diagram & Reduction principles; Applications of Mechatronic systems: Household, Automotive, Industrial shop floor.

UNIT 3: Data Acquisition (08 Hrs)
Introduction to Signal Communication & Types-Synchronous, Asynchronous, Serial, Parallel; Bit width, Sampling theorem, Aliasing, Sample and hold circuit, Sampling frequency; Interfacing of Sensors / Actuators to Data Acquisition system; 4 bit Successive Approximation type ADC; 4 bit R- 2R type DAC; Current and Voltage Amplifier.

UNIT 4: Programmable Logic Control (08 Hrs)
Introduction to PLC; Architecture of PLC; Selection of PLC; Ladder

Logic programming for different types of logic gates; Latching; Timers, Counter; Practical examples of Ladder Programming.

UNIT 5: Frequency Domain Modelling and Analysis (08 Hrs)
Transfer Function based modeling of Mechanical, Thermal and Fluid system; concept of Poles & Zeros; Stability Analysis using Routh Hurwitz Criterion; Bode Plots: Introduction to Bode Plot, Gain Margin, Phase Margin, Relative Stability Analysis, Frequency Domain Parameters-Natural Frequency, Damping Frequency and Damping Factor; Mapping of Pole Zero plot with damping factor, natural frequency and unit step response.

UNIT VI: Control System (08 Hrs)
Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems in parallel form; Unit step Response analysis via Transient response specifications: Percentage overshoot, Rise time, Delay time, Steady state error; Manual tuning of PID control; Linear Quadratic Control (LQR).

Books:
Text:

• K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
• Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall, 2009.

References:

• Alciatore & Histand, Introduction to Mechatronics and Measurement system, 4th Edition, Mc-Graw Hill publication, 2011
• Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006
• Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi
• C. D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi