MEC-601 NC and CNC Machine tools

UNIT - I :

Introduction: Fundamentals of numerical control, advantages limitations of N.C systems - classification of N.C systems. **Computer Numerical Control:** Nomenclature, types and features of CNC machine tools, machine control unit, position control and its significance, engineering analysis of NC positioning systems, open loop and closed loop systems, precision in NC positioning systems-control resolution, accuracy and repeatability. Actuators: servomotors, stepper motors, transducers and feedback elements.

UNIT - II

Features of N.C. Machine tools: Design consideration of N.C machine tools - increasing productivity with N.C machines, tooling for CNC machine. **System Device:** Feed back system-counting devices digital analog converters. **Interpolations:** DDA integrators, simple and symmetrical DD reference word CNC interpolators.

UNIT - III

Part Programming: Process planning and flow chart for part programming, systems nomenclature and tool geometries, Tool presetting & modular tooling. Selection of tools based on machining capacity, accuracy and surface finish, elements of programming for turning and milling, part programming. Preparatory codes G, miscellaneous functions M, Interpolation, tool compensations, cycles for simplifying programming, typical part programming **Control Loops for N C Systems:** Introduction-control loops for point and counting systems.

UNIT - IV

Computerized Numerical Control: CNC concepts-advantage of CNC reference planes, sampled data techniques, microcomputers in CNC. **Adaptive Control Systems:** Adaptive control with optimization and constraints-variable gains AC systems.

UNIT - V

Modern CNC machines: CNC lathes, turning centers, machining centres, automatic pallet changers, automatic tool changers, direct numerical control and applications, CNC machine design features.

REFERENCE BOOKS:-

1. Numerical control of machine tool – Koren & Ben Uri – Khanna Publisher,Delhi
2. Automation, Production Systems and Computer Integrated Manufacturing - Groover – PHI.
3. CNC Programming - S.K. Sinha - Galgotia
4. Mechatronics - HMT –TMH,Delhi
5. Numerical Control and Computer Aided Manufacturing -Tewari, Rao, Kundra- TMH, Delhi
6. Machine Tool Design and Numerical Control – N.K.Mehta – TMH Delhi
7. Fundamentals of Computer Numerical Control – NIIT – Prentice Hall, Delhi

List of Experiment (Pl. expand it):

Designing and sketching of components contained in the syllabus.

MEC-602 IC Engines

UNIT I

Internal Combustion Engine: S.I. and C.I. engines of two and four stroke cycles, real cycle analysis of SI and CI engines, determination of engine dimensions, speed, fuel consumption, output, mean effective pressure, efficiency, factors effecting volumetric efficiency, heat balance, performance characteristics of SI and CI engines, cylinder arrangement, firing order, power balance for multi-cylinder engines, valve timing.

UNIT 2

Combustion in SI engines: Flame development and propagation, ignition lag, effect of air density, temperature, engine speed, turbulence and ignition timings, physical and chemical aspects of detonation, effect of engine and fuel variables on knocking tendency, knock rating of volatile fuels, octane number, H.U.C.R., action of dopes, pre-ignition, its causes and remedy, salient features of various type combustion chambers, valve timing and firing order.

UNIT 3

Combustion in C.I. Engines: Times base indicator diagrams and their study, various stages of combustion, delay period, diesel knock, octane number, knock inhibitors, salient features of various types of combustion chambers, fuel, ignition, cooling, exhaust and lubrication systems; Simple problems on fuel injection, various types of engines, their classification and salient features. Rotary I. C. engines, their principles of working.

UNIT 4

I.C. Engine System: Fuels, ignition systems, cooling, exhaust/scavenging and lubrication system. Fuel metering in SI engine: Fuel injection in SI engine (MPFI & TBI), Theory of carburetion, simple problems on carburetion. Fuel metering in CI engines: Fuel injection in CI engine and simple problems, various types of engines, their classification and salient features. Fuels: Conventional fuels and alternate fuels, engine exhaust emission, carbon monoxide, unburnt hydro carbon, oxides of nitrogen, smoke, density, measurement and control, hydrogen as alternate fuel.

UNIT 5

Supercharging: Effect of attitude on mixture strength and output of S.I. engines, low and high pressure super charging, exhaust, gas turbo-charging, supercharging of two stroke engines.

References:

1. Ganeshan V; Internal Combusion engines; TMH
2. Mathur ML & Sharma RP; A. Course in IC engines; DhanpatRai
3. Gupta HN; Fundamentals of IC Engines; PHI
4. Srinivasan S; Automotive Engines; TMH
5. Halderman JD and Mitchell CD; Automotive Engines theory and servicing; Pearson
6. DomKundwar; Internal Combustion Engines ; Dhanpat Rai Publications
7. Taylor GF; Internal Combustion Engines Theory & Practice; MIT Press
8. Richard Stone; Introduction to IC Engines; Society of Automotive Engr (Palgrave Mc Millan)

List of Experiments (Pl. expand it):

1. Determination of Valve timing diagram
2. Load test on Petrol Engine
3. Heat Balance of SI engine
4. Heat Balance of CI Engine
5. Study of Battery Ignition system and Electronic Ignition System
6. Study of Diesel fuel pump
7. Study of Diesel fuel injectors
8. Study of a Carburetors
9. Study of Fuel Injection system in SI Engine
10. Study of lubricating system in CI Engines

MEC – 603 Heat and Mass Transfer

Unit-1

Basic Concepts: Modes of heat transfer, Fourier's law, Newton's law, Stefan Boltzman law; thermal resistance and conductance, analogy between flow of heat and electricity,combined heat transfer process; **Conduction:** Fourier heat conduction equation, its form in rectangular, cylindrical and spherical coordinates, thermal diffusivity, linear one dimensional steady state conduction through a slab, tubes, spherical shells and composite structures, electrical analogies, critical-insulation-thickness for pipes, effect of variable thermal conductivity.

Unit 2

Extended surfaces (fins): Heat transfer from a straight and annular fin (plate) for a uniform cross section; error in measurement of temperature in a thermometer well, fin efficiency, fin effectiveness, applications; **Unsteady heat conduction:** Transient and periodic conduction, heating and cooling of bodies with known temperatures distribution, systems with infinite thermal conductivity, response of thermocouples.

Unit 3

Convection: Introduction, free and forced convection; principle of dimensional analysis,Buckingham 'pie' theorem, application of dimensional analysis of free and forced convection,empirical correlations for laminar and turbulent flow over flat plate and tubular geometry; calculation of convective heat transfer coefficient using data book.

Unit 4

Heat exchangers: Types- parallel flow, counter flow; evaporator and condensers, overall heat transfers coefficient, fouling factors, log-mean temperature difference (LMTD), method of heat exchanger analysis, effectiveness of heat exchanger, NTU method;

Mass transfer: Fick's law, equi-molar diffusion, diffusion coefficient, analogy with heat transfer, diffusion of vapour in a stationary medium.

Unit 5

Thermal radiation: Nature of radiation, emissive power, absorption, transmission, reflection and emission of radiation, Planck's distribution law, radiation from real surfaces; radiation heat exchange between black and gray surfaces, shape factor, analogical electrical network, radiation shields. **Boiling and condensation:** Film wise and drop wise condensation; Nusselt theory for film wise condensation on a vertical plate and its modification for horizontal tubes; boiling heat transfer phenomenon, regimes of boiling, boiling correlations.

References:

1. Sukhatme SP; Heat and mass transfer; University Press Hyderabad
2. Holman JP; Heat transfer; TMH
3. Nag PK; heat and Mass Transfer; TMH
4. Dutta BK; Heat Transfer Principles And App; PHI Learning
5. Mills AF and Ganesan V; Heat transfer; Pearson
6. Cengel Yunus A; Heat and Mass transfer;TMH
7. Yadav R; Heat and Mass Transfer; Central India pub-Allahabad

8. Baehr HD;Stephan K; Heat and Mass Transfer; MacMillan Pub
9. Incropera FP and Dewitt DP; Heat and Mass transfer; Wiley

List of Experiments (Pl. expand it):

1 Conduction through a rod to determine thermal conductivity of material
2 Forced and free convection over circular cylinder
3 Free convection from extended surfaces
4 Parallel flow and counter flow heat exchanger effectiveness and heat transfer rate
5 Calibration of thermocouple
6 Experimental determination of Stefen-Boltzman constant

MEC- 604(A) – Power Plant Engineering

UNIT I

Introduction to methods of converting various energy sources to electric power, direct conversion methods renewable energy sources, solar, wind, tidal, geothermal, bio-thermal, biogas and hybrid energy systems, fuel cells, thermoelectric modules, MHD-Converter.

Unit II

Fossil fuel steam stations: Basic principles of sitting and station design, effect of climatic factors on station and equipment design, choice of steam cycle and main equipment, recent trends in turbine and boiler sizes and steam conditions, plant design and layout, outdoor and indoor plant, system components, fuel handling, burning systems, element of feed water treatment plant, condensing plant and circulating water systems, cooling towers, turbine room and auxiliary plant equipment., instrumentation, testing and plant heat balance.

UNIT III

Nuclear Power Station: Importance of nuclear power development in the world and Indian context, Review of atomic structure and radio activity, binding energy concept, fission and fusion reaction, fissionable and fertile materials, thermal neutron fission, important nuclear fuels, moderators and coolants, their relative merits, thermal and fast breeder reactors, principles of reactor control, safety and reliability features.

Unit IV

Hydro-Power Station: Elements of Hydrological computations, rainfall run off, flow and power duration curves, mass curves, storage capacity, salient features of various types of hydro stations, component such as dams, spillways, intake systems, head works, pressure tunnels, penstocks, reservoir, balancing reservoirs, Micro and pico hydro machines, selection of hydraulic turbines for power stations, selection of site.

Unit V

Power Station Economics: Estimation and prediction of load. Maximum demand, load factor, diversity factor, plant factor and their influence on plant design, operation and economics; comparison of hydro and nuclear power plants typical cost structures, simple problems on cost analysis, economic performance and tariffs, interconnected system and their advantages, elements of load dispatch in interconnected systems.

References:

1- Nag PK; Power plant Engg; TMH
2- Al-Wakil MM; Power plant Technology; TMH
3- Sharma PC; Power plant Engg; Kataria and sons, Delhi
4- Domkundwar; Power Plant Engg; Dhanpatrai & sons.
5- Rajput RK; A text book of Power plant Engg.; Laxmi Publications.
6- Yadav R; Steam and gas turbine and power plant engg by

MEC-604(B) Lean Manufacturing Engineering

UNIT 1

Lean Production: Introduction, background, and lean thinking, importance of philosophy, strategy, culture, alignment, focus and systems view. Discussion of Toyota Production System.

UNIT 2

Lean Production Preparation: System assessment, process and Value-stream mapping, sources of waste. **Lean Production Processes, Approaches and Techniques:** importance of focusing upon flow. Tools include: Workplace organization – 5S, Stability, Just-In-Time – One piece flow – Pull, Cellular systems, Quick change and set-up reduction methods, Total productive maintenance, Poka-Yoke– mistake proofing, quality improvement, Standards, Leveling and Visual management, Six Sigma.

UNIT 3

SMED: Single minute exchange of dies – theory and practice of the SMED system, the structure of production, Set-up operations, Fundamentals of SMED, Techniques for applying SMED, Basic examples of SMED.

UNIT 4

Employee Involvement: Teams, Training, Supporting and encouraging involvement – Involving people in the change process; communication; importance of culture.

UNIT 5

Concurrent Engineering: Obeya in Toyota's new product development process, cross-functional teams, use of computer technology, information management for simultaneous engineering.

Reference Books:

1. Liker, J, The Toyota Way, McGraw-Hill (2004).
2. Liker, J and Meier, D., The Toyota Way Fieldbook, McGraw-Hill (2006).
3. Womack, J and Jones, D, Lean Thinking, Free Press (2003).
4. Womack, J and Jones, D and Roos, D., The Machine that Changed the World, Rawson Associates (1990).
5. Dennis, P., Lean Production Simplified, Productivity Press (2007).
6. Shingo, S., A Revolution in Manufacturing: The SMED System, Productivity Press (1985).

MEC-604(C) Reverse Engineering & Rapid Prototyping

UNIT 1

Introduction: Introduction to rapid prototyping (RP), Need of RP in context of modern production methods. **Review of solid modelling techniques**: product design by curves, surfaces and solids.

UNIT 2

Basic Principles: Basic Principles of RP, Steps in RP, Process chain in RP, RP integrated CAD-CAM environment, Advantages of RP. **Classification of RP processes**: Based on raw material, Based on energy sources

UNIT 3

Rapid Prototyping Systems: Sterolithography, Solid Ground Curing, Ballistic particle manufacture, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, 3D Printing, Laser Engineered Net Shaping etc., **Process planning for rapid prototyping**: STL file generation, Defects in STL files and repairing algorithms, Slicing and various slicing procedures.

UNIT 4

Problem areas of Rapid Prototyping: Accuracy issues in RP, Strength issues of RP Parts, Surface roughness problem in RP, Part deposition orientation issues of RP Parts and other issues like build time, support structure, cost etc.,

UNIT 5

Rapid tooling techniques: RTV Silicone Rubber Mold, Spray Metal Tooling, Vacuum Casting, Cast Resin Tooling, Electroforming, Direct AIM Tooling, Direct Metal Laser Sintering, Laminated Tooling, Laser Engineered Net Shaping. **Reverse Engineering**: Introduction to reverse engineering and its integration with rapid prototyping.

Reference Books:

1. Chua, C.K., Leong, K.F., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons Inc., (2000).

2. Pham, D.T., Demov, S.S., Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited, (2001).

3. Noorani, R., Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., New Jersey, (2006).

4. Zeid, I., Mastering CAD/CAM, Tata McCraw Hill, (2006).

5. Patri, K. V., Weiyin, Ma, Rapid Prototyping - Laser-based and Other Technologies, Kluwer Academic Publishers, U.S.A., (2003).

6. Hague, R.J.M., Reeves, P.E., Rapid Prototyping, Tooling and Manufacturing, iSmithers Rapra Publishing, (2000).

7. Saxena, A., Sahay, B., Computer Aided Engineering Design, Anamaya Publishers, New Dehi, (2005).

8. Hopkinson, N., Hague, R.J.M., Dickens, P.M., Rapid Manufacturing- An Industrial Revolution for the Digital Age, John Wiley & Sons Ltd., U.K., (2006).

MEC-605(A) Renewable Energy System

UNIT-I

Solar Radiation: Extra-terrestrial and terrestrial, radiation measuring instrument, radiation measurement and predictions. **Solar thermal conversion**: Basics, Flat plate collectors-liquid and air type. Theory of flat plate collectors, selective coating, advanced collectors, Concentrators: optical design of concentrators, solar water heater, solar dryers, solar stills, solar cooling and refrigeration. **Solar photovoltaic**: Principle of photovoltaic conversion of solar energy; Technology for fabrication of photovoltaic devices; Applications of solar cells in PV generation systems; Organic PV cells.

UNIT-II

Wind energy characteristics and measurement: Metrology of wind speed distribution, wind speed statistics, Weibull, Rayleigh and Normal distribution, Measurement of wind data, Energy estimation of wind regimes; **Wind Energy Conversion**: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics; power curve of wind turbine, capacity factor, matching wind turbine with wind regimes; Application of wind energy.

UNIT-III

Production of biomass, photosynthesis-C3 & C4 plants on biomass production; Biomass resources assessment; Co2 fixation potential of biomass; Classification of biomass; Physicochemical characteristics of biomass as fuel **Biomass conversion** routes: biochemical, chemical and thermo chemical Biochemical conversion of biomass to energy: anaerobic digestion, biogas production mechanism, technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas plant manure-utilization and manure values. Biomass Gasification: Different types, power generation from gasification, cost benefit analysis of power generation by gasification.

UNIT-IV

Small Hydropower Systems: Overview of micro, mini and small hydro system; hydrology; Elements of turbine; Assessment of hydro power; selection and design criteria ofturbines; site selection and civil works; speed and voltage regulation; Investment issue load management and tariff collection; Distribution and marketing issues. **Ocean Energy:** Ocean energy resources, ocean energy routs; Principle of ocean thermal energy conversion system, ocean thermal power plants. Principles of ocean wave energy and Tidal energy conversion.

UNIT-V

Geothermal energy: Origin of geothermal resources, type of geothermal energy deposits, site selection geothermal power plants; **Hydrogen Energy**: Hydrogen as a source of energy, Hydrogen production and storage. **Fuel Cells**: Types of fuel cell, fuel cell system and sub-system, Principle of working, basic thermodynamics

References:

1. Kothari, Singal & Rajan; Renewable Energy Sources and Emerging Technologies, PHI Learn
2. Khan, B H, Non Conventional Energy, TMH.
3. Sukhatme and Nayak, Solar Energy, Principles of Thermal Collection and Storage, TMH.
4. Tiwari and Ghosal, Renewable Energy Resources: basic principle & application, Narosa Publ
5. Koteswara Rao, Energy Resources, Conventional & Non-Conventional, BSP Publication.
6. Chetan Singh Solanki, Solar Photovoltaics: Fundamental, technologies and Application,PHI L

7. Abbasi Tanseem and Abbasi SA; Renewable Energy Sources; PHI Learning
8. Ravindranath NH and Hall DO, Biomass, Energy and Environment, Oxford University Press.
9. Duffie and Beckman, Solar Engineering of Thermal Process, Wiley
10. Nikolai, Khartchenko; Green Power; Tech Book International
11. Tester, Sustainable Energy-Choosing Among Options, PHI Learning.
12. Godfrey Boyle, Renewable Energy: Power for a sustainable future, Oxford OUP.

MEC-605 (B) Measurement Techniques

UNIT 1

Mechanical Measurement: Need of mechanical measurement, Basic definitions: Hysteresis, Linearity, Resolution of measuring instruments, Threshold, Drift, Zero stability, loading effect and system response. Measurement methods, Generalized Measurement system, Static performance characteristics, Errors and their classification. **Linear and angular measurements:** Linear Measurement Instruments, Vernier calliper, Micrometer, Interval measurements: Slip gauges, Checking of slip gauges for surface quality, Optical flat, Limit gauges, Problems on measurements with gauge.

UNIT 2

Measurement of Force, Torque and Strain: Force measurement: load cells, cantilever beams, proving rings, differential transformers. Measurement of torque: Torsion bar dynamometer, servo controlled dynamometer, absorption dynamometers. Power Measurements. Measurement of strain: Mechanical strain gauges, electrical strain gauges, strain gauge: materials, gauge factors, theory of strain gauges and method of measurement, bridge arrangement, temperature compensation. **Displacement, Velocity/Speed, and Acceleration, Measurement:** Working principal of Resistive Potentiometer, Linear variable differential transducers, Electro Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer.

UNIT 3

Temperature measurement: Temperature Measuring Devices: Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices, Numerical Examples on Flow Measurement. **Metrology:** Basics of Metrology, Need for Inspection, Accuracy and Precision, Objectives, Standards of measurements.

UNIT 4

Metrology of Gears and screw threads: Gear tooth terminology, Sources of errors in manufacturing of gears, Measurement of tooth thickness: Gear tooth vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement of tooth profile: Tool maker's microscope or projector, Involute tester, Measurement of pitch, Measurement of run out, Lead and Backlash checking. Measurement of concentricity, Alignment of gears. **Screw Thread Measurement:** Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread calliper gauges.

UNIT 5

Metrology of Surface finish: Surface Metrology Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, and Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, Wave length, frequency and cut off, other methods for measuring surface roughness: Pneumatic method, Light Interference microscopes, Mecrin Instruments. **Comparators:** Functional Requirements, Classification, Mechanical Comparators, Mechanical Optical Comparators, Electrical Comparators, Pneumatic Comparators.

Reference Books:

1. Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press,
2. Engineering Metrology and Measurements, Bentley, Pearson Education
3. Theory and Design for Mechanical Measurements, 3rd Edition, Richard S Figliola, Donald E Beasley, Wiley India
4. Metrology and Measurement, Anand Bewoor & Vinay Kulkarni McGraw-Hill
5. Doebelin's Measurement Systems Ernest Doebelin, Dhanesh Manik McGraw-Hill
6. Instrumentation, Measurement and Analysis, B.C. Nakra, K.K. Chaudhry McGraw-Hill
7. A Text book of Engineering Metrology, I C Gupta, Dhanpat Rai Publications
8. A course in Mechanical Measurements and Instrumentation, A K Sawhney, Dhanpat Rai Publications
9. Mechanical Measurements and Instrumentations, Er. R K Rajput, Kataria Publication(KATSON)
10. Mechanical Measurement and Metrology by R K Jain, Khanna PublisherMechanical Measurement & Control by D.S. Kumar.
11. Industrial Instrumentation & Control by S K Singh, McGrawHill
12. Mechanical Measurements by Beckwith & Buck, Narosa publishing House

MEC-605(C) Welding Technology

UNIT 1

Metal Joining Processes: Introduction, classification of welding processes as per AWS, commonly welded base metals, advantages and disadvantages of welding. Welding as compared to riveting and casting. Soldering, brazing, adhesive bonding processes, welding of dissimilar metals.

UNIT 2

Gas Welding Processes: Introduction, oxy-acetylene welding, oxy-hydrogen, air-acetylene welding. Principle of operation, types of welding flames, Lighting the torch, flame adjustment, gas welding techniques .welding techniques- leftward & rightward. Filler metals and fluxes, gas welding equipments, applications.

UNIT 3

Arc Welding Processes: Introduction, Principle, Working, Specifications, Equipments, Merits and demerits, applications of Carbon arc welding, Flux Shielded Metal arc Welding, Gravity Welding, Sub Merged Arc Welding, GTAW Welding, GMAW Welding, CO2 Welding, Flux Cored Arc Welding(FCAW),Electro Slag welding, Electro Gas welding, Plasma Arc Welding. Source of Power Supply: AC/DC & their characteristics

UNIT 4

Resistance Welding Processes: Introduction, Principle, Working, Specifications, Equipments, Merits and demerits, applications of Spot welding, Seam welding, Projection Welding, Upset welding, Flash Butt welding, Percussion Welding.

UNIT 5

Solid State and Thermo chemical and Processes: Introduction, Principle, Working, Specifications, Equipments, Merits and demerits, applications of Solid State welding Processes like Cold (or pressure welding), Diffusion(Bonding), Explosive welding, Friction ,Inertia and forged welding. Thermo chemical welding processes like thermit welding, atomic hydrogen welding. Weld Defects & Tests :Introduction, type of defects in weldments, causes and remedies of defects. Repair of defective welds, Visual examination of welding, Fabrication Weldability tests , Hydrostatic Pressure testing and Hydraulic or Gas Pressure testing for leakage, Use of NDT for weldments, Pre and post weld heat treatment, safety standards

References:

1. The Metallurgy of Welding, 6th Edition , Lancaster, William Andrew Publishing, NY.
2. Principles of Welding (Processes, Physics, Chemistry and Metallurgy), Robert and Messler, Wiley Interscience Publishers.
3. Welding Hand Book Vol. 5; 7th edition, AWS, 1984.
4. Welding METALLURGY, S Kou, John Wiley, USA, 2003.

MEC-606 (A) Operation Research

UNIT 1

Linear system and distribution models: Mathematical formulation of linear systems by LP, solution of LP for two variables only, special cases of transportation and assignment and its solution, Vogel's forward looking penalty method, cell evaluation degeneracy, use of SW Lindo, Tora, Excell.

UNIT 2

Supply chain (SCM): Definition, importance, expenditure and opportunities in SCM; integration of inbound, outbound logistics and manufacturing to SCM, flow of material money and information, difficulties in SCM due to local v/s system wide (global) optimization and uncertainties in demand and transportation; Bull-whip effect; customer value; IT, info-sharing and strategic partnerships; plant and warehouse-network configuration; supply contracts and revenue sharing; outsourcing; transportation, cross docking and distribution, forecasting models in SCM; coordination and leadership issues; change of purchasing role and vendor rating, variability from multiple suppliers.

UNIT 3

Inventory models: Necessity of inventory in process and safety stock, problem of excess inventory and cycle time (=WIP/ Throughput), JIT/ lean mfg; basic EOQ/ EPQ models for constant review Q-system(S,s); periodic review, base stock P-system; service level, lead time variance and safety stock;; ABC, VED and other analysis based on shelf life, movement, size, MRP technique and calculations, lot sizing in MRP, linking MRP with JIT; evolution of MRP to ERP to SCM and e-business.

UNIT 4

Waiting Line Models Introduction, Input process, service mechanism, Queue discipline, single server (M/M/1) average length and times by Little□s formula, optimum service rate; basic multiple server models (M/M/s) (b) **Competitive strategy**: concept and terminology, assumptions, pure and mixed strategies, zero sum games, saddle point, dominance, graphical, algebraic and LP methods for solving game theory problems.

UNIT 5

Decision analysis: decision under certainty, risk probability and uncertainty; Hurwicz criteria; AHP- assigning weight and consistency test of AHP **(**b**) Meta-heuristics** Definition of heuristic and meta-heuristic algorithms; introduction to Tabu search, Simulated Annealing and Genetic algorithms and solution of traveling salesman and non linear optimization problems.

References:

1. Hillier FS and Liberman GJ; Introduction to Operations Research concept and cases; TMH
2. Simchi-Levi, Keminsky; Designing and managing the supply chain; TMH.
3. Srinivasan G; Quantitative Models In Operations and SCM; PHI Learning
4. Mohanty RP and Deshmukh SG; Supply Chain Management; Wiley India
5. Taha H; Operations research; PHI
6. Sen RP; Operations Research-Algorithms and Applications; PHI Learning

7. Sharma JK; Operations Research; Macmillan
8. Ravindran , Philips and Solberg; Operations research; Wiley India
9. Vollman, Berry et al; Manufacturing planning and control for SCM; TMH.
10. Bowersox DJ, Closs DJ, Cooper MB; Supply Chain Logisti Mgt; TMH
11. Burt DN, Dobler DW, StarlingSL; World Class SCM; TMH
12. Bronson R ;Theory and problems of OR; Schaum Series; TMH

MEC-606(B) Statistical Quality Control

UNIT I

Introduction: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement).

UNIT II

Modeling Process Quality: Mean, Median, Mode, Standard deviation, Calculating area, The Deming funnel experiment, Normal distribution tables, Finding the Z score, Central limit theorem. **Methods and Philosophy of Statistical Process Control**: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL)

UNIT III

Control Charts for Variables: Control Charts for X-Bar and R charts, Type I and Type II errors**. Process Capability:** The foundation of process capability, Natural Tolerance limits, Cp – process capability index, Cpk, pp – process performance index, summary of process measures.

UNIT IV

Control Charts For Attributes: Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit.

UNIT V

Lot-By-Lot Acceptance Sampling For Attributes: The accepting sampling problem, single sampling plan for attributes, Double, Multiple, and sequential sampling, AOQL, LTPD, OC curves **Cumulative-Sum (CUSUM) & Exponentially Weighted Moving Average (EWMA) Control Charts:** CUSUM Control Chart (basic principles of the chart for monitoring the process mean); EWMA control chart (EWMA control chart for monitoring process mean), design of a EWMA control chart.

Reference Book

1. Statistical Process Control and Quality Improvement by Gerald M. Smith, Pearson Prentice Hall.

2. Statistical Quality Control for Manufacturing Managers by W. S. Messina, Wiley & Sons, Inc., New York, 1987.

MEC-606(C) Ergonomics Engineering

UNIT 1

General: Man in industrial work environments, Ergonomics as multidisciplinary fields, Importance and justification and ergonomics problems, Man-machine-environment system.

UNIT 2

Anthropometry: Significance of human body measurement in design of equipment, Facilities, Work place and operation, Static and dynamic anthropometry, Anthropometric data. **Task Analysis:** Task description, Posture measurement, RULA & REBA analysis and evaluation, Lifting & lowering tasks, Lifting index, Lifting & carrying tasks, NIOSH lifting equation.

UNIT 3

Biomechanics: Introduction to levers of Human Body, Ligaments & Tendons, Joints. Kinetics to include forces producing motion.

UNIT 4

Man-Environment Interface: Environmental factors of temperature, Humidity, Lighting and noise in industry, Effect of environmental factors on human performance, Measurement and mitigation of physical and mental fatigue, Basics of environment design for improved efficiency.

UNIT 5

Design of Display and Control: Need for information display, Elements of information theory, Reaction time, Methods and types of displays, Design of audio and visual displays, Design of hand and foot operated control device, Design of human-computer interface.

References:

1. Bridger, R.S., Introduction to Ergonomics, McGraw Hill (2008).
2. Sanders, M. and McCormick E., Human Factors in Engineering & Design, McGraw Hill (1993).
3. Maynard, H. B., Industrial Engineering Hand Book, McGraw Hill (1992).
4. David, A., Practice & Management of Industrial Ergonomics, Prentice Hall (1986).
5. Singleton, W. T., Introduction to Ergonomics, WHO, Geneva (1972).