DEPARTMENT OF MECHANICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA, BILASPUR (C.G.), 495009

EVALUATION SCHEME OF Pre-Ph. D COURSE WORK

EFFECTIVE FROM SESSION 2021-22

SN.	Name of the Subject	Subject Code	Periods / Week L – T – P	ESE Duration	ESE MARKS		Credits
					Max.	Min.	
1	Research Methodology in Engineering	ETPHDT00	3 – 1 – 0	3 Hrs.	100	40	4
2	Elective - I	**	3 – 1 – 0	3 Hrs.	100	40	4
3	Elective - II	**	3 – 1 – 0	3 Hrs	100	40	4
4	Seminar	ETPHDS00	-	-	Qualified/Not qualified		---
Total			**9 – 3 – 0**	**-**	**300**	**165***	**12**

Duration of the semester will be 6 months.
*Candidate has to score minimum 55% of the aggregate marks to qualify in ESE.
Two core subjects as Electives (4 credits each) to be decided by the DRC.

LIST OF ELECTIVES		**	LIST OF ELECTIVES		**
SN	Name of the Subject	Subject Code	SN	Name of the subject	Subject Code
1	Mechatronic System Design	MEPHDT01	9	Finite Element Methods in Engineering	MEPHDT09
2	Reliability and Maintenance Engineering	MEPHDT02	10	Fracture, Fatigue and Failure Analysis	MEPHDT10
3	Composite Materials	MEPHDT03	11	Physics of Manufacturing Processes	MEPHDT11
4	Material Characterization Techniques	MEPHDT04	12	Energy Conservation and Waste Heat Recovery	MEPHDT12
5	Advanced Machining Processes	MEPHDT05	13	Supply Chain and Logistic Performance Management	MEPHDT13
6	Micro and Precision Manufacturing	MEPHDT06	14	Production and Operations Management	MEPHDT14
7	Industrial Automation	MEPHDT07	15	Design Of Solar Thermal Systems and Applications	MEPHDT15
8	Engineering Design Methodology	MEPHDT08	17	Modeling and Analysis of Solar Systems	MEPHDT16

L : Lecture, T: Theory, P: Practical, Max.: Maximum Marks in ESE; Min.: Minimum Pass Marks in each subject as 40

Department of Mechanical Engineering, School of Engineering & Technology, GGV, Bilaspur (C.G.)

ETPHDT00-RESEARCH METHODOLOGY IN ENGINEERING

Introduction and Design of research: Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

Data and Methods of Data Collection: Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability.

Data Analysis and Interpretation: Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, Testing of hypothesis, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution analysis of variance: one way, two-way, chi square test, z test and its application, student's 'T' distribution, Univariate and Bivariate analysis, regression analysis.

Report writing and presentation: Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references.

Research ethics, IPR and scholarly publishing: Ethics: Definition, moral philosophy, nature of moral judgments and reactions, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP). Redundant publication duplicates and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance, Publication's misconduct: definition, concept, problems that lead to unethical behavior and vice versa, Patents, Designs, Trade and Copyright. Process of Patenting and Development.

Reference Books:

1. Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon.
2. Research Methodology – Methods and Techniques, C K Kothari, New Age International.
3. Design and Analysis of Experiments, D C Montgomery, Wiley.
4. Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley.
5. Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education.
6. Research Methodology - Methods & Techniques, CR Kothri CR (1990), VishvaPrakashan, NewDelhi.
7. Research Methodology & Statistical Techniques, S Gupta (1999) Deep & Deep Publications, NewDelhi.
8. Research Methodology for Biological Sciences, N Gurumani (2007), MJP Publishers, Chennai.

9. Research Design:Qualitative, Quantitative &Mixed Method Approaches, JohnW. Creswell (2009), Sage Publication, USA

MEPHDT01-MECHATRONIC SYSTEM DESIGN

Mechatronics System design:

Introduction to Mechatronics-Integrated design issues- Key elements and design processes-Physical system modelling - Electrical systems-Micro processor based controller and micro electronics- Mechanical translation and rotational systems-Electromechanical coupling-Fluid system

Actuating devices:

Direct current motor, Permanent magnet stepper motor, Mechanical actuation, Hydraulic and pneumatic power actuation devices, Linearand latching linear actuators, Rotatory actuators, Piezoelectric actuators, Actuator parameters and characteristics.

Sensors and Transducers:

An introduction to sensors and transducers, sensors for motion and position, Force torque and tactile sensors, Flow sensors, Temperature sensing devices, Ultrasonic sensors, Range sensors, Active vibration control using magneto structive transducers, Lasers and Opto mechatronics

based devices.

Software and Hardware components in Mechatronics systems:

Signals , system and controls, system representation, Signal conditioning and devices, PLC, system representation, linearization of nonlinear systems, Time delays and measurement of system performance, Elements of Data acquisition and control systems, real time interfacing.

MEMS and Microsystems:

Microsystems and miniaturization- lithography technique- Microactuators- actuation using shape memory alloys, piezo electric crystals and electrostatic forces- micro valves and pumps- micro sensors-Overview on applications of Robotics in automobiles and other industries.

Text books:

[1] W. Bolton, Mechatronics, Pearson publications (ISBN 978-81-3176253-3)
[2] DevdasShett, Richard A. Kolk, Mechatronics System Design,Brooks/Cole, Thomson learning(ISBN 0-534-95285-2).

Reference Books:

[1] John Watton, Fundamentals of Fluid power and control, Cambridgeuniversity press (ISBN 9780521762502)
[2] AndrejzM.Pawlak, Sensor and Actuators in Mechatronics Design,Taylor and Francis (ISBN-13:978-0-8493-9013-5)

[3] Tai-Ran Hsu, MEMS and Microsystems design and manufacture,Tata McGraw-Hill(ISBN0-07-048709-X)
[4] Stephen A.Campbell, The Science and Engineering ofmicroelectronic fabrication, Oxford university press(ISBN 0-19-568144-4)

MEPHDT02- RELIABILITY AND MAINTENANCE ENGINEERING

Fundamentals of reliability: Scope of reliability engineering, concept of bath tub curve, types of failure data, reliability estimations, constant failure rate models, time dependent failure rate models, concept of failure on demand, reliability estimation of series/parallel/mixed/complex system configuration, concepts of availability and maintainability.

Design for Reliability: Capturing user's reliability requirements, reliability and/or redundancy allocation/optimization, design methods, FMEA/FMECA, reliability testing (burn-in testing,
reliability assurance testing, reliability growth testing, accelerated life testing), fault tree analysis.

Availability Assessment: Markov modelling approach for availability estimation.

Maintenance Management: Corrective, preventive and predictive maintenance. Age and time based preventive maintenance, opportunistic maintenance, concepts of imperfect maintenance, concept of TPM and RCM, maintenance optimization.

Remaining useful life prediction of equipments subject to condition monitoring: ANN models, ARMA models, Markovmodels, proportional hazard models**.**

Suggested Books

[1] CharlesEbeling, An Introduction To Reliability andMaintainability Engineering, Waveland PrInc; 2 Har/Cdredition, 2009.
[2] Igor Bazovsky, Reliability Theory and Practice, DoverPublications (October, 2004).
[3] Patrick O'Connor, Practical Reliability Engineering, JohnWiley & Sons Inc.2002.
[4] Gregg K. Hobbs, Accelerated Reliability Engineering: HALTand HASS, Wiley, 2000.
[5] G. Vachtsevanos, F.L. Lewis, M. Roemer, A. Hess and B. Wu,Intelligent Fault Diagnosis and Prognosis for EngineeringSystems. John Wiley & Sons, 2006.

MEPHDT03-COMPOSITE MATERIALS

Introduction: classifications, terminologies, manufacturing processes.

Macro-mechanical analysis of lamina: Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials–2D Unidirectional and angle ply lamina –

Strength theories of lamina.

Micro-mechanical analysis of lamina: Volume and mass fraction, density and void content – Evaluation of Elastic module, Ultimate strength of unidirectional lamina.

Macro-mechanical analysis of laminates: Laminate code, Stress strain relations – In-plane and Flexural modulus, Hydro thermal effects.

Failure Analysis and Design: Special cases of laminates, symmetric, cross ply, angle ply and anti symmetric laminates, failure criteria and failure modes

Suggested Books

[1] Jones, R M, Mechanics of Composite Materials, Scripta BookCo.

[2] Agarwal, B D and Broutman, J. D, Analysis and Performance of Fiber Composites, New York, John Willey and Sons, 1990

[3] Mallik, P. K, Fiber reinforced composites : materials, manufacturing and design, New York- Marcel and Dekker,1993 (2ndedition)

[4] Arthur, K Kaw, Mechanics of Composite Materials, CRC Press, 1997.

[5] Reddy J N, Mechanics of Laminated Composite Plates, CRC Press

[6] Mallik, P. K, Composite Engineering Hand Book, New York, Marcel and Dekker, 1997 (2nd edition)

MEPHDT04-MATERIAL CHARACTERIZATION TECHNIQUES

Introduction: Requirement of different techniques of material characterization for different situations. Mechanical and physical characterization.

Optical Metallographic Techniques: Observation of microstructure. Preparation of samples (polishing, etching etc.)

Mechanical Characterization Processes: Measurement of hardness. Measurement of fracture toughness through nano indentation. Adhesion test. Surface profilometry. Tribological studies of materials.

Physical Characterization Processes: Introduction to different methods and their applications. Diffraction methods for phase, residual stresses, texture analysis etc.; Electro-optical and related techniques like SEM, TEM, EDS, WDS/EPMA etc.; Surface analysis and related techniques like XPS, AFM etc.; Spectroscopic techniques.

Suggested Books

[1] C. R. Brundle, Charles A. Evans, Shaun Wilson, Encyclopedia of materials characterization: surfaces, interfaces, thin films, Material Characterization Series, Surfaces, Interfaces, Thin Films, Butterworth-Heinemann.

[2] B.D. Cullity, Elements of X-Ray Diffraction (3rd Edition),Prentice Hall

[3] Said Jahanmir, Friction and Wear of Ceramics, CRC Press

[4] P J Goodhew, J Humphreys, R Beanland, Electron Microscopy and Analysis, 3rd edition, Taylor and Francis,London

MEPHDT05-ADVANCED MACHINING PROCESSES

Introduction: Types of advanced machining processes (AMPs); evolution, and need.
Mechanical Type AMPs: process principle and elements; Mechanism of material removal, parametric analysis; Shape and material applications; Operational characteristics; Limitations of USM, AJM, WJM, AWJM processes.

Advanced Fine Finishing Process: Process principle, processequipment, parametric analysis, Applications of Abrasive FlowMachining (AFM); Magnetic Abrasive Finishing; MagnetoRheological Abrasive Finishing (MRF) processes.

Chemical Type AMPs: Process principle and details of Chemical Machining (CHM); Photo-Chemical Machining (PCM), and Bio-Chemical Machining processes (BCM).

Electro Chemical Type AMPs: ECM-Process principle, mechanism of material removal; Kinematics and dynamics and dynamics of ECM; Tooling design; Choice and analysis of process parameters; Surface finish and accuracy.

Thermal Type AMPs: Working principle; Power circuits; Mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy, Shape and materials applications, limitations of EDM, LBM, EBM, IBM,PAM processes.

Derived and Hybrid AMPs: Introduction of processes like rotary ultra sonic machining (RUM), electro stream drilling(ESD), shaped tube electro machining (STEM), wire electro discharge machining (WEDM), electro chemical grinding (ECG),electro chemical honing (ECH), electro chemical debarring(ECD), and electro-chemical spark machining (ECSM).

Suggested Books

[1] G.F. Benedict, Non traditional Manufacturing Processes, Marcel Dekker, Inc. New York, 1987.

[2] V.K. Jain Advanced Machining Processes, Allied Publishers, New Delhi, 2002.

[3] A. Ghosh, and A.K. Mallik, Manufacturing Science, Affiliated East-West Press Ltd, New Delhi, 1985.

[4] P.C. Pandey, and H.S. Shan, Modern Machining Processes, Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 1980.

[5] J.A. Mc Geough, Advance Methods of Machining, Chapman and Hall, London, 1988.

MEPHDT06-MICRO AND PRECISION MANUFACTURING

Micro-manufacturing: Introduction to different mili-machining, micromachining, Nano-machining processes, Micro and nano finishing processes, Micro-forming, Micro-joining techniques, nanotechnology processes, the related process mechanism, process parameters of these processes and their applications to production of miniaturized components.

Micro-machines: - Introduction, Mesoscopic domain, Biological systems, cells as machines, Role of proteins, Physics of micromechanism, Future prospects.

Precision manufacturing: Introduction, concept of accuracy, tolerance and fits, influence of different factors on the maintainability of accuracy of the machine tools and the product, compensation of thermal errors and location errors, effects of vibration and tool wear, dimensioning and dimensional chains.

Metrology and Characterization Techniques for Micro and Precision Manufactured Products: Profilometric, Microscopic, diffractometric, and electron beam based techniques.

Suggested Books

[1] I. Fujimasa, "Micromachines: A New Era in Mechanical Engineering", Oxford Science Publications.

[2] J. Paulo Davim, Mark J. Jackson, “Nano and Micromachining”, Wiley-ISTE

[3] N.P. Mahalik, “Micromanufacturing and Nanotechnology",Springer

[4] P.C. Pandey and H.S. Shan, "Modern MachiningProcesses", Tata McGraw Hill Publication.

[5] V. K. Jain (Ed.), Introduction to Micromachining, Narosa Publishing House, New Delhi, 2010.

[6] Yi Qin, Micromanufacturing Engineering and Technology, Elsevier, 2010 (ISBN 13: 978-0-8155-1545-6)

[7] R.L. Murty, "Precision Engineering in Manufacturing", New Age International Publishers.

[8] C. R. Brundle, Charles A. Evans, Shaun Wilson,Encyclopedia of materials characterization: surfaces, interfaces, thin films, Material Characterization Series, Surfaces, Interfaces, Thin Films, Butterworth-Heinemann.

MEPHDT07-INDUSTRIAL AUTOMATION

Basic Concepts: Introduction of Mechanization and Automation, Classification and Strategies of Automation, Reasons for and Arguments against Automation. Mechanical, Electrical, Hydraulic, and Pneumatic Devices and Controls

High Volume Manufacturing or Hard Automation: Automated Flow Lines, Types of Automatic Transfer Mechanisms, Design and Fabrication Considerations, Analysis of Automated Flow Lines.

Assembly Automation: Assembly Systems and their Types, Manual Assembly Lines and Line Balancing, Automated Assembly Lines and their Types, Automatic Assembly Transfer Systems, Automatic Feeding and Orienting Devices:- Vibratory and Mechanical Feeders and their types, Orientation of Parts, Performance and Economics of Assembly Systems, Feasibility Study for Assembly Automation.

Design for Assembly: Design for Manual Assembly, Design for High-Speed Automatic Assembly, Design for Robotic Assembly

Programmable Automation: Brief Introduction of Numerical Control (NC), Computer Numerical Control (CNC), Machining Centers, Programmable Robots, Direct Numerical Control(DNC), and Adaptive Control.

Flexible Automation: Introduction of Group Technology (GT),Steps in Implementing GT, Part Families and Machine Cell Formation, Introduction of Flexible Manufacturing Systems (FMS).

Suggested Books

[1] M. P. Groover, “Automation, Production systems and Computer Integrated Manufacturing”, Prentice-Hall Inc. Englewood Cliffs, 1987. [Indian Edition from Prentice Hall of India, New Delhi].

[2] G. Boothroyd "Assembly Automation and Product Design", Marcel Dekker, New York, 1992.

[3] G. Boothroyd, P. Dewhurst, and W. Knight "Product Design for Manufacture and Assembly (2nd Edition)", Marcel Dekker, New York, 2002.

[4] G. Boothroyd, C. Poli, and L. E. Murch, "Automatic Assembly", Marcel Dekker Inc. New York, 1982.

[5] G. Boothroyd, and A. H. Redford, "Mechanized Assembly: Fundamentals of Parts Feeding, Orientation and Mechanized Assembly", McGraw Hill Publishing Co. Ltd., London, 1968

MEPHDT08 ENGINEERING DESIGN METHODOLOGY

Fundamentals: principles of design, systematic approach, need analysis and design of specification; Conceptual design: developing function structure, developing concepts by systematic search with physical principles, classifying schemes; Concept selection: matrix methods, necessity methods, probability methods, fuzzy set based methods, case study on consumer product; Embodiment design: basic rules, system modelling, preliminary design calculations and material selection, design considerations like force alignment, vibration etc., failure modes and effects analysis, design for manufacturability and assembly, case studies on design of machines; Optimal and robust design: design problem formulation for analytical and numerical solution, design of experiments, Taguchi's method; Reverse engineering; Physical prototyping; Lab: conceptual design, reverse engineering, design of simple sensors and actuators, hydraulic and pneumatic systems, motors and controller, product teardown and redesign, embodiment design, CAE analysis, prototyping, design project.

Textbooks:

[1] Yousef Haik, Engineering Design Process, Vikas Publishing house, New Delhi, 2003.

[2] G. Pahl, and W. Beitz, Engineering Design – A Systematic Approach, Springer – Verlag, 1996

Reference books:

[3] K. Otto and K. wood, Product Design – techniques in reverse engineering and new product development, Pearson Education, New Delhi, 2004.

[4] A. Ertas and J. C. Jones, The Engineering Design Process, 2nd ed., John Wiley and Sons, 1996.

[5] A. Kusiak, Engineering Design – Products, Processes and Systems, Academic Press, 1999.

[6] C. L. Dym and P. Little, Engineering Design – A Project based Introduction, John Wiley, 2000.

[7] G. E. Dieter, Engineering Design – A Materials and Processing Approach, 3rd ed., McGraw-Hill International, 2000.

[8] E. Kroll, S. S. Condoor and D. G. Jonsson, Innovative Conceptual Design – Theory and Application of Parameter Analysis, Cambridge Univ. Press, 2001

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MEPHDT09 FINITE ELEMENT METHODS IN ENGINEERING

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method; Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post processing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame. Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages.

Text books:

[1] J N Reddy, An introduction to the Finite Element Method, McGraw-Hill, New York, 1993.

[2] R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3d ed., John Wiley, New York, 1989.

[3] K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, 1982.

[4] T J T Hughes, The Finite Element Method, Prentice-Hall, Englewood Cliffs, NJ, 1986

[5] O C Zienkiewicz and R L Taylor, The Finite Element Method, 3d ed. McGraw-Hill, 1989.

MEPHDT10-FRACTURE, FATIGUE AND FAILURE ANALYSIS

Griffith's theory of brittle failures; Irwin's stress intensity factors; Linear elastic fracture mechanics: The stress analysis of crack tips, Macroscopic theories in crack extension, Instability and R-curves, Crack tip plasticity, K as a failure criterion, Mixed mode of fracture, Analytical and Experimental methods of determining K; Elastic plastic fracture mechanics: Crack tip opening displacement, J Integrals, Crack growth resistance curves, Crack tip constraint under large scale yielding, creep crack growth; Microscopic theories of fracture: Ductile and cleavage fracture, ductile-brittle transition, inter-granular fracture; Fatigue crack propagation: Fatigue crack growth theories, crack closure, Microscopic theories of fatigue crack growth; Application of theories of fracture mechanics in design and materials development

Text books:

[1] T. L. Anderson, Fracture Mechanics Fundamentals and Applications, CRC Press, 1994

[2] D. Brock, Elementary Engineering Fracture Mechanics, Maritinus Nijhoff Publishers, 1982.

[3] S. T. Rolfe and J. M. Barson, Fracture and Fatigue Control in Structures, PHI, 1977

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MEPHDT11- PHYSICS OF MANUFACTURING PROCESSES

Introduction of manufacturing processes from the point of view of underlying physics. Stresses and Strain: stress and strain behaviour of materials, plastic and tangent modulus, work hardening, plastic instability in tensile test, empirical stress-strain equations, effect of pressure, strain-rate and temperature, analysis of stress tensor, eigen values, decomposition into deviatoric and hydrostatic components, octahedral stresses, analysis of strain and strain-rates, stress equilibrium and virtual work, objective stress rates. Plasticity: the criteria of yielding, isotropic and anisotropic hardening, rules of plastic flow, Levy-Mises and Prandtle-Reuss equations, anisotropic flow rule, Hill's 1948 and 1979 yield criteria for anisotropic yielding. Upper bound theorem and its application in processes like rolling, wire drawing, extrusion, forging and machining. Lower bound theorem with a few applications. Slab method and its application in process like asymmetric rolling, forging, wire drawing and extrusion. Elasto plastic sheet bending. Analysis of auto frettaging. Theory of slipline field and its application in metal forming and machining. Heat transfer analysis in manufacturing. Workability and dynamic materials model.

Text books:

[1] Chakrabarty, J., Theory of plasticity, McGraw Hill Book Company, Singapore, 1998.

[2] Johnson, W. and Mellor P.B., Engineering plasticity, Von NostrandReinhold Company, London, 1972.

[3] Bhattacharyya, A., Metal cutting: theory and practice, New Central Book, Kolkata, 1984.

[4] Incropera, F.P. and DeWiit, D.P., Fundamentals of heat and mass transfer, John Wiley & Sons, Singapore.

[5] Prasad, Y.V.R.K., Sasidhara, S., Hot working guide: a compendium of processing maps, ASM International, Materials Park, OH, 1997

MEPHDT12-ENERGY CONSERVATION AND WASTE HEAT RECOVERY

Energy resources and use. Potential for energy conservation. Optimal utilization of fossil fuels. Total energy approach. Coupled cycles and combined plants. Cogeneration systems. Exergy analysis. Utilization of industrial waste heat. Properties of exhaust gas. Gas-to-gas, gas-to-liquid heat recovery systems. Recuperators and regenerators. Shell and tube heat exchangers. Spiral tube and plate heat exchangers. Waste heat boilers: various types and design aspects. Heat pipes: theory and applications in waste heat recovery. Prime movers: sources and uses of waste heat. Fluidized bed heat recovery systems. Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems. Thermoelectric system to recover waste heat. Heat pump for energy recovery. Heat recovery from incineration plants. Utilization of low grade reject heat from power plants. Need for energy storage: Thermal, electrical, magnetic and chemical storage systems. Thermo-economic optimization.

References Books:

[1] J. H. Harlock, Combined Heat and Power, Pergaman Press, 1987

[2] F. Kreith and R. E. West, Energy Efficiency, CRC handbook, CRC Press,1999

[3] Kays and London, Compact Heat Exchangers, 3rd edition, McGraw-Hill, New York.

MEPHDT13- SUPPLY CHAIN AND LOGISTIC PERFORMANCE MANAGEMENT

UNIT I:

Supply Chain Management and sustainability:

Core of supply chain and management and its components, how supply chain works, Importance of supply chain, Supply chain networks, big data in the supply chain, supply chain analytics and its differentiator. SC sustainability concept, pillars and challenges in current modern organizations.

UNIT II:

Supply chain management strategies:

Introduction of SC strategies, the concept, nature, scope, importance of lean SC strategy-theoretical Models, eights kinds of waste. Sustainable supply chain strategies, Green SC management objective, model and current policy. Agile and Le-Agile strategies to sustainable SC, Resilient strategy contribution to sustainable SC.

UNIT III:

Performance Measurement and its models:

SC performance measurement, measures, metrics, SC strategic goals, Supply chain performance and SCOR model, Maturity models, Reference models, and Benchmarking model, Application of model towards supply chain. Types of information, Estimation of various types of costs. Application and appraisal of metrics and KPIs.

UNIT IV:

Planning Demand and Supply in SC:
Demand Forecasting in a Supply Chain: The Role of Forecasting in a Supply Chain ,Characteristics of Forecasts, Components of a Forecast and Forecasting Methods ,Basic Approach to Demand Forecast1ng, Time-Series Forecasting Methods ,Measures of Forecast Error, Risk Management in Forecasting , Forecasting in Practice.

UNIT V:

Logistic SC

Logistic Management-Forward and reverse supply chain measures and metrics, Role of transportation in supply chain, modes of transport, transportation in practice, Logistic Equipments, Sourcing Decisions in Supply Chain- role of sourcing, third and fourth party logistics providers, supplier scoring & assessment, Supplier selection -auctions, and negotiations, contracts, procurement process.

Reference books:

1.Supply Chain Management: Janat Shah, Pearson Publications.
2. Supply Chain Management: Sunil Chopra and Mein del, Fourth Edition, PHI.

3. Supply Chain Management: A.S.Altekar PHI Second Ed.
4. Logistics Management: James Stock and Douglas Lambert. McGraw Hill International Ed.
5. Supply Chain Management for Global Competitiveness:Ed.B.S.Sahay McMillan Publication
6. Emerging Trends in Supply Chain Management: Ed.B.S.Sahay McMillan Publication. 7. Logistics Management: Bowersox TMH.

MEPHDT14- PRODUCTION AND OPERATIONS MANAGEMENT

UNIT I: INTRODUCTION TO OPERATIONS MANAGEMENT

History and concept of production and operations management, strategic importance of Operations Management; decisions in operations: products and service, process and technology, Capacity and facilities, human resources, quality, and sourcing. Tools of decision-making decision in operations using excel

UNIT II: PRODUCTION PROCESS DESIGN & MANAGEMENT

Types of processes: Projects, batch production, Mass Production, continuous production; Process Planning: Make or buy Design, Process selection with break-even analysis, Process plans; Process analysis, Process Innovation, Technology Decisions, Job sequencing algorithms-Johnsons rule.

UNIT III: PRODUCT DESIGN

Product Design Process: Idea generation, feasibility study, Form Design, functional Design, final design and process plans; Technology in Design, Design Quality Review, Design for Environment, Metrics for design quality, Design for Manufacture & Assembly (DFMA), Quality Function Deployment.

UNIT IV: PRODUCTION FACILITIES DESIGN

Facility location, Basic Layouts-process, product, fixed position layouts; Designing process layout: block diagramming, relationship diagramming, computerized solutions; Designing a service Layouts, Shared spaces, Designing Product Layouts: Line balancing, computerized line balancing; Hybrid Layouts- Cellular, flexible manufacturing systems, Mixed model assembly lines

UNIT V: QUALITY MANAGEMENT

Evolution of Quality Management System, Quality Management: Statistical Process control, TQM, Cost of Quality, Effect of Quality Management on Productivity, Quality improvement: JIT, Kaizen approach; Work measurements-work study, time study; Forecasting, Inventory management, Human Resource management in operations.

Text books

1. Operations Management by Roberta S. Russell and Bernard W. Taylor (III); Pearson Education, 2003 edition.
2. R. Panneerselvam, Production & Operations Management, PHI
3. S.N. Chary, Production & Operations Management, TMH
4. Shailendra Kale, Production and Operations Management, McGraw Higher Ed.
5. Operations Management, Arun Kumar and N. Meenakshi, Cengage Learning
6. K.C. Jain, Production and Operations Management, Wiley India.

MEPHDT15- DESIGN OF SOLAR THERMAL SYSTEMS AND APPLICATIONS

Solar Radiation Fundamental: Basics of Solar Radiation, instruments for measuring solar radiation, solar radiation geometry, empirical equations, solar radiation on tilted surfaces.

Low and Medium temperature solar thermal technology: Flat plate, Evacuated tube collectors and PVT collectors- Basic elements, performance analysis, transmissivity - absorptivity, heat transfer coefficients and correlations, collector efficiency and heat removal factors, effects of various parameters, transient analysis. Energy balance of components, design process and parameters.

High-temperature solar thermal technology: Concentrating Solar Thermal (CST) Technologies, types - Parabolic Trough Collector, Linear Fresnel, Solar Tower, Parabolic Dish, Solar Furnace; general characteristics, geometry, heat transfer correlations, tracking requirements, performance analysis and design process, use of various HTF.

Application of Solar thermal energy: Solar Air heaters, Solar Drying, solar pond, solar refrigeration, Solar cooking, solar still, Solar Distillation-Desalination, Solar thermal power plants, Industrial process heat, etc.

Case studies on Recent Developments in the Solar thermal Collectors: Highlights of the latest heat transfer enhancement techniques such as use of novel selective coatings with nano particles, HTF with nano particles, use of fins and different surface geometry, Artificial surface roughness, Integration of novel Energy storage medium, thermal energy storage – sensible and latent heat etc.

REFERENCE BOOKS:

1. Foster .R, Ghassemi M., Cota A., “Solar Energy”, CRC Press, 2010.
2. Duffie .J.A, Beckman W.A. “Solar Engineering of Thermal Processes”, 3rd ed., Wiley, 2006.
3. De Vos .A, “Thermodynamics of Solar Energy Conversion”, Wiley-VCH, 2008.
4. Garg .H.P, Prakash .J, “Solar Energy Fundamentals and Applications”, Tata McGraw-Hill, 2005.
5. Kalogirou .S, “Solar Energy Engineering”, Processes and Systems, Elsevier, 2009.
6. Tiwari G. N. (2002); Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa.
7. María Isabel Roldán Serrano, “Concentrating Solar Thermal Technologies: Analysis and Optimisation by CFD Modelling”, Springer International, 2017.
8. Brian Norton, “Solar Energy Thermal Technology” Springer, 1992
9. G. Lorenzini, C. Biserni & G. Flacco “Solar Thermal and Biomass Energy” WIT Press 2010.
10. Zhifeng Wang, “Design of Solar Thermal Power Plants”, Elsevier, 2019.
11. Manuel J. Blanco and Lourdes Ramirez Santigosa “Advances in Concentrating Solar Thermal Research and Technology” Woodhead Publishing, 2017

MEPHDT16- MODELING AND ANALYSIS OF SOLAR SYSTEMS

UNIT I - MATHEMATICAL MODELING

Principles of mathematical modelling; systems, models, simulations; definitions of mathematical models; classification of mathematical models.

UNIT II – PHENOMENOLOGICAL MODELS

Elementary statistics; Regression techniques – linear, multiple-linear, non-linear; Neural networks; Design of experiments.

UNIT III – MECHANISTIC MODELS

Ordinary differential equations and Partial differential equations; setting up of differential equations; Closed form solutions; Numerical solutions

UNIT IV –ENERGY MODELLING

Introduction; Energy and climate change; Atmospheric environment and renewable energy; Solar energy models – Solar energy deterministic models

UNIT V – SOLAR ENERGY MODELS

Linear solar energy models; Non linear solar energy models; Solar radiation devices and collectors; Case studies of solar energy modelling and analysis

REFERENCES BOOKS

1. Velten, K, “Mathematical Modelling and Simulation – Introduction for Scientists and Engineers”, Wiley-VCH., 2009.
2. Sen .Z, “Solar Energy: Fundamentals and Modeling Techniques”, Turkey, 2008.
3. Dym .C.L, “Principles of Mathematical Modeling”, Elsevier, 2004.
4. Duffie .J.A, Beckman W.A. “Solar Engineering of Thermal Process”, Wiley, 3rd ed. 2006.
5. Kalogirou .S.A, “Solar Energy Engineering: Processes and Systems”, Academic Press, 2009.