MEE0001: BASICS OF MATERIALS ENGINEERING [3 0 0 3]

NPTEL – 12 weeks

Course Outcomes: On completion of this course student shall be able to –

1. Distinguish and elaborate the chemistry of crystals and solids imperfection.
2. Analyse the materials properties based on testing's.
3. Remember the various industry-based heat treatment processes.
4. Describe the material failure theories.

Introduction, Crystal Structure Imperfections in solids, Mechanical properties of materials, Failure of Materials, Basics of Fracture Mechanics, Fatigue failure theories, Phase diagrams, Thermal Processing and Heat Treatment of Steels.

Reference Books:

1. William D Callister Jr. and David G. Rethwisch, *Materials Science and Engineering: An Introduction*, John Wiley, 8th Edition (2009).
2. Robert L Norton, *Machine Design: An Integrated approach*, latest edition.

MEE0002: BIOMATERIALS [3 0 0 3]

Course Outcomes: On completion of this course student shall be able to –

1. Explain the suitability of a material to be used as a biomaterial in terms of desired biological response.
2. Compare the structures, properties, and morphology of biomaterials.
3. Evaluate the performance of different biomaterials.
4. Interpret interactions between biomaterial and tissue for short term and long-term implantations.
5. Develop a strategy for modification of biomaterials for a specific application to enhance employability.

Importance and classification of biomaterials, Natural and synthetic biomaterials, nano-biomaterials for long-term biomedical applications. Product Testing, physical, mechanical, chemical and biological properties of Biomaterials, regulatory approvals, ethical issues. Tissue engineering, wound healing and the foreign body response, degradation of biomaterials in biological environment. Methods of manufacturing soft and hard tissue implants, hydrogels, organ-on a chip, scaffolds: design and fabrication, 3D printing, bioprinting. Applications of Biomaterials including cardiovascular, neurological, orthopaedic, dental, drug delivery, sutures and biosensors.

Reference books:

1. Ratner, Hoffman, Schoen & Lemons, Burlington, *Biomaterials Science: An introduction to Materials in Medicine*, Eds, Academic Press, 2nd Edition:
2. Jonathan Black, *Biological Performance of Materials: Fundamentals of Biocompatibility*, 4th edition, CRC Press, USA.
3. W. R. Wagner, Shelly E. et al, *An Introduction to Materials in Medicine,* Academic Press, USA.
4. Naznin Sultana, Sanchita Bandyopadhyay-Ghosh and Soon Chin Fhong, *Tissue Engineering Strategies for Organ Regenerations*, Eds:, CRC Press, US.

MEE0003: PRODUCT DESIGN AND MANUFACTURING [3 0 0 3]

NPTEL – 12 weeks

Course Outcomes: On completion of this course student shall be able to –

1. Define the concepts of product design and manufacturing based on industry 4.0
2. Analyse the design theories of product design and manufacturing.
3. Design the plant layout using reverse engineering and quality tools.
4. Explain the concept of reverse engineering.

Introduction to Product Design and Manufacturing, Product Design Morphology, Visual Design, and Quality Function Deployment, Value Engineering, Material, and Manufacturing process selection, Design for Manufacturing, Assembly, and Maintenance, Design for Environment, and Quality Control, Patenting, and Creativity, Rapid Prototyping, Plant Layout Design, Computer Integrated Manufacturing, Reverse Engineering, and Managing Competitiveness.

Reference Books:

1. Eppinger, Ulrich, *Product design and development*. McGraw-Hill Higher Education, 2015.
2. Magrab, Gupta, McCluskey, and Sandborn, *2009*. Integrated product and process design and development: the product realization process. CRC Press, 2015.
3. Boothroyd, G., *Product design for manufacture and assembly*. *Computer-Aided Design*, 26(7), pp505-520, 1994.

MEE0004: JOINING TECHNOLOGY FOR METALS [3 0 0 3]

NPTEL 8 weeks

Course Outcomes: On completion of this course student shall be able to –

1. Remember the various joining processes and electrodes used in industries.
2. Design the weldment for precision manufacturing.
3. Distinguish the weldability theory and solidification of welds.
4. Identify the welding defects.

Classification of joining processes, Heat generation and power density concept in welding Fundamentals of welding: type of weld, types of joint, welding position, arc heat generation, arc initiation, maintenance, shielded metal arc welding Electrode melting rate, effect of electrode polarity and welding parameters Gas tungsten arc welding, Gas metal arc welding, Submerged arc welding, Electro-slag and Electro-gas welding processes, Laser beam welding, Brazing Soldering and Braze welding, Resistance welding, Adhesive joining, Ultrasonic joining, Diffusion bonding, Explosive welding, Magnetic pulse welding, Weld thermal cycle, Heat affected zone and weld thermal cycle, Solidification of weld metal, Weldability of carbon & alloy steels: Fe-C, CCT, Weldability of stainless steels, Solidification cracking and their control, Residual stresses in weld joints, Cracking of welded joints.

References Books:

1. *Metals Handbook-Welding, Brazing and Soldering, American Society for Metals*, 10th edition, Volume 6, USA, 1993.
2. Richard Little, *Welding and Welding Technology*, McGraw Hill, 2001, 1st edition.
3. H Cary, *Welding Technology,* Prentice Hall, 1988, 2nd edition.
4. S V Nadkarni, *Modern Arc Welding Technology,* Ador Welding Limited, 2010, New Delhi.

5. R S Parmar, *Welding process and technology*, Khanna Publisher, New Delhi
6. *Welding handbook, American Welding Society*, 1987, 8th edition, volume 1 & 2, USA

MEE0005: OPERATIONS MANAGEMENT [3 0 0 3]

- **NPTEL: 12 weeks**

Course Outcomes: On completion of this course student shall be able to –

1. Understand Role and Importance of Operation Manager in an Organization.
2. Apply Analytical Techniques for Forecasting and Scheduling of jobs and services.
3. Understand Quality Standards and Statistical control Charts.
4. Design and plan models for the firm for materials management.

Introduction to Operations Management, Types of Production Systems, Operations Strategy. Product Life Cycle, Value Engineering, Design for X (DFX), Ergonomics in Product Design, Rapid Prototyping, Sales Forecasting, Forecasting System, Facility Planning, Case Study, Material Flow Patterns, Production Planning and Control, Process Planning, Capacity Planning, Project Scheduling, Network Diagrams, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Production Control, Sequencing, Production Scheduling (MPS), Total Quality Management (TQM), Total Productive Maintenance (TPM), Statistical Quality Control (SQC), Six Sigma. Materials Management, Just in Time (JIT), Kanban System, Materials Requirement Planning (MRP)-I, Materials Requirement Planning (MRP)-II, Enterprise Resource Planning (ERP).

References Books

1. K. N. Dervitsiotis, *Operation Management*, McGraw-Hill International Company.
2. R.S. Russell, and B.W. Taylor, *Operations Management*, Pearson Education
3. M. Telsang, *Industrial Engineering and Production Management*, S. Chand & Company Ltd.

MEE0006: ADDITIVE MANUFACTURING [3 0 0 3]

Course Outcomes: After completion of this course student shall be able to -

1. Describe additive manufacturing and its advantages & disadvantages.
2. Explain the processes used in additive manufacturing for a range of materials and applications.
3. Select appropriate additive manufacturing processes for a given application to enhance employability skills.
4. Interpret the effects of surface finish and microstructure on performance of additively manufactured components.

Additive Manufacturing (AM) - Reverse engineering, Different AM processes and relevant process physics, AM process chain, Application, Rapid Manufacturing, Materials science for AM - multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship, AM technologies - Powder-based, droplet based, extrusion based, stereolithography, Bio-printing, Micro- and nano-additive processes, Mathematical models for AM, Selection of AM technologies using decision methods, AM process plan, Monitoring and control of defects, transformation.

Reference Books:

1. Ian Gibson, David W. Rosen and Brent Stucker, *Additive manufacturing technologies: rapid prototyping to direct digital manufacturing*, Springer, Latest Ed.
2. C.K. Chua, K.F. Leong and C.S. Lim, *Rapid prototyping: Principles and applications*, 3rd Edition, World Scientific, Latest Ed.
3. Andreas Gebhardt, *Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing*, Hanser Publishers, Latest Ed.
4. J.D. Majumdar and I. Manna, *Laser-assisted fabrication of materials*, Springer Series in Material Science, Latest Ed.

MEE0007: RENEWABLE ENERGY [3 0 0 3]

Course Outcomes: On completion of this course student shall be able to –

1. Develop an understanding of the current and future worldwide energy scenario.
2. Identify alternate energy type for a given application for employability enhancement.
3. Analyze Solar and Wind energy technologies for given application.
4. Estimate feasibility of Biomass, Ocean, and Geothermal energy as alternative.

Energy demand growth and supply: Fossil fuels: Environmental Impacts of Burning of Fossil fuels; Sustainable Development and Role of Renewable Energy, Solar geometry; Primary and Secondary Solar energy and Utilization of Solar Energy. Characteristic advantages and disadvantages, applications. Solar concentrators and tracking device, power generation in a PV cell; Storage and Balance of system. Wind energy, Potential, Applications, turbines, CAES. Energy from Biomass & Biogas, Gasifier, Tidal power plants: single basin and two basis plants, Ocean Thermal Electricity Conversion (OTEC); Electricity generation from Waves: Geothermal energy, Conversion technologies- Steam and Binary systems.

References:

1. Twidell J and Weir T., *Renewable Energy Resources*, Taylor & Francis, Latest Ed.
2. Godfrey Boyle, *Renewable energy,* Oxford Press, Latest Ed.
3. V.V.N. Kishore, *Renewable Energy engineering and Technology: Principles and Practice*, TERI Press, Latest Ed.
4. S. P. Sukhatme, J.P. Nayak, *Solar Energy: Principles of Thermal Collection and Storage*, (3e), McGraw Hill India, 2009.