Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus of Engineering 4th Year

Semester-II

SUBJECT TYPE	SUBJECT CODE	SUBJECT NAME	L-T	P	C
Elective-III	MM4505	Transmission Electron Microscopy	4	-	3
Free Elective-II	BM4501	FOUNDATIONS OF MANAGEMENT	4	-	3
Free Elective-II	BM4502	ENTREPRENEURSHIP AND NEW VENTURES	4	-	3
Free Elective-II	BM4503	INTELLECTUAL PROPERTY RIGHTS	4	-	3
Free Elective-II	BSBE4501	SUSTAINABLE TECHNOLOGY	4	-	3
Free Elective-II	BSBE4502	PHARMACEUTICAL TECHNOLOGY	4	-	3
Free Elective-II	BSBE4503	BIO MATERIALS	4	-	3
Free Elective-II	MM4501	Fatigue Creep Fracture	4	-	3
Free Elective-II	CH4504	Computational Fluid Dynamics	4	-	3
Compulsory	MM4800	Project			12
Compulsory	MM4000	Comprehensive Viva-II			1

MM4505 TRANSMISSION ELECTRON MICROSCOPE

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **3-1-0-3**

Objectives:

- To study and understand the working principle of electron microscopy
- To understand the mechanism of electrons transmission through the materials.
- To analyse the images obtained from TEM.

UNIT-I

Introduction , scattering and diffraction ,elastic scattering, inelastic scattering and Beam damage, electron sourcesm lenses, apertures and resolution, electron detectors

UNIT-II

Vaccum pumps and specimen holders, TEM instruments, forming images in TEM, alignment and stigmatism, calibration and imaging, specimen preparation and its examination in TEM, diffraction in TEM, reciprocal space, different beams

UNIT-III

Bloch waves, dispersion surfaces, diffraction from crystals, diffraction from small volumes, parallel beam diffraction patterns, kikuchi pattern, CBED patterns, using convergent beam techniques.

UNIT-IV

Contrast in TEM images: Amplitude contrast, mass thickness contrast, and Z contrast phase contrast images, thickness and bending effects, planar defects and imaging characterizing their fields.

UNIT-V

Weak beam dark field microscopy, high resolution TEM.

Suggested References:

1. **Transmission electron microscopy D B Williams and B.Barry carter Spinger,2009.**

BM4501 **FOUNDATIONS OF MANAGEMENT**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-3**

Course Objective:

- This course enables the students to learn wide range of managerial concepts and equip them to handle the management assignment in the future.

Course Contents:

1. **Development of Management Thought:** Learning objectives, Concept of management, Scientific Management-Taylor, Henry Fayol contributions, Human Relations approach-Hawthorne experiments, Approaches to Management, Ethics in management.
2.
2. **Functions of Management:** Management Processes and function: Nature and description of management process, Managerial functions: Planning, Organizing, Directing, Coordinating and Controlling. Communication process, Theories of motivation and leadership, (14 Modules)

3. Human Resource Management: Nature and Scope of Human Resource Management, Functions of HRM, Industrial Relations. (7 Modules)

4. **Marketing Management:** Marketing Environment, Consumer Markets and Buyer Behaviour, Segmentation, NPD, PLC, Marketing Mix (4Ps), Channels of Distribution. Advertising and Sales Promotion, Personal selling, Public relations. (8 Modules)

5. **Production/Operation Management:** Planning and Design of Production and Operation Systems, Facilities Planning, Location, Layout and Movement of Materials, Materials Management and Inventory Control, Maintenance management, Statistical Quality Control, TQM and ISO Certification. (7 Modules)

Suggested Reference Books:

1. Weirich, Koontz & Aryasri, *Principles of Management,* TMH, New Delhi, (2004).
2. Paul Heresy & Ken Blanchard, *Management and Organizational behavior,* PHI, New Delhi, (1995)
3. Kotler Philip, *Marketing Management*, Prentice Hall of India (1997).
4. Luthans Fred, *Human Resource Management*, McGraw Hill, (1997).
5. Stephen Robbins, O*rganizational Behaviour Concepts, Controversies and Applications*.

BM4502 ENTREPRENEURSHIP AND NEW VENTURES

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-3**

Course Objective:

- This course enables the students to learn wide range of managerial concepts and equip them to handle the management assignment in the future.

Course Objective: This course has two basic objectives. The first is to teach effective entrepreneurial and general management practice from the perspective of the founder and stakeholders. The second is to apply the entrepreneurial perspective in order to approach business problems from a value creation framework.

Course Contents:

1. **Introduction to Entrepreneurship:** Learning objectives, Entrepreneurship in Indian Scenario and Future prospects, Emerging economies, Entrepreneurial traits, motivation and leadership (7Modules)

2. **Entrepreneurial Process:** Opportunity Identification, Idea Generation and Evaluation. (6 Modules)

3. **Business Model:** Business Plan, Business Models (Creating a business model with technology differentiators) (5 Modules)

4. **Financing Venture**: Funding, Valuation of a new company, Marketing, Company Growth, Acquisitions and Exit Strategies. (6 Modules)

5. **Building the Team and IPR:** Launching and managing venture, Human resource aspects. Intellectual Property and Corporate Law. (12 Modules)

Suggested Reference Books:

1. Kuratko & Hodgetts, *Entrepreneurship-Theory, Process Practice*, Thompson South-Western Publication, (2008).
2. Holt, *Entrepreneurship – New Venture Creation*, PHI Publication, (1992).
3. Kawasaki, *The Art of the Start*, Portfolio Publication, (2004).
4. Lusk & Harrison, *The Mouse Driver Chronicles: The True-Life Adventures of Two First-Time Entrepreneurs*, Perseus Books Group, (2002).
5. Dorf & Byers, *Technology Ventures: From Idea to Enterprise*, McGraw Hill Publication, (2010).
6. Kaplan, Startup: *A Silicon Valley Adventure*, Penguin Books, (2001).

BM4503 **INTELLECTUAL PROPERTY RIGHTS**

Externals: 60Marks **L-T-P-C***

Internals: 40Marks **4-0-0-3**

Course Objective:

- This course enables the students to learn wide range of managerial concepts and equip them to handle the management assignment in the future.

Course Objective: This course aims at helping the students to learn legalities of intellectual property to avoid plagiarism and other IPR relates crimes like copyright infringements.

Course Contents:

1. **Introduction to IPR:** Meaning of Intellectual Property, Nature of I.P, Protection of IP Rights, Kinds of I.P rights, International Conventions on Intellectual Property Rights-patent treaty 1970, GATT1994, TRIPS &TRIMS, International Organisation for Protection of IPR-WTO, WIPRO, UNESCO.

2. **Patent Rights:** Meaning of patent, commercial significance, Obtaining patent, patentable subject, rights and obligations of patentee, Registration of patents, compulsory licensing and licenses of rights, revocation.

3. **Industrial designs**: Definitions of Designs, Registration of Designs, rights and duties of proprietor of designs, piracy of registered designs.

4. **Introduction and significance of Trademarks**: Meaning of Trademark, purpose of protecting Trademarks, Registered Trademarks, procedure, passing off, assignment and licensing of Trademarks, Infringement of Trademarks.

5. **Nature of scope of Copy Right**: Subject matter of Copy Right, Right conferred by copyright publication, Board- Casting and telecasting, Computer programme, database right, Assignment and Transmission of Copyright, Infringement of copy right.

Suggested Readings:

1. Cornish.W.R, "Intellectual Property Patents", Copy Right and Trademarks and Allied rights, Sweet&Maxwell 1993.
2. P. Narayanan: Intellectual Property Law, Eastern Law House, 2nd edn 1997.
3. Roy Chowdhary, S.K. & Other:Law of Trademark, Copyrights, Patents and Designs, Kamal Law House, 1999.
4. Dr. G.B. Reddy,Intellectual Property Rights and the Law 5th Ed. 2005 GogiaLaw Agency.
5. B.L. Wadhera: Intellectual Property Law, Universal Publishers, 2nd Ed. 2000.

BSBE 4501 SUSTAINABLE TECHNOLOGIES

Externals: 60 Marks	L-T-P-C
Internals: 40 Marks	3-0-0-3

Learning objectives: To give an overview of existing technologies and their associated problems. The main objective of the course is to stress on the need of innovation in development of sustainable technologies.

Learning outcome: This paper sets out to discuss the commonalities that can be found for sustainable development. The commonalities include systemic or holistic thinking, the integration of different perspectives, skills such as critical thinking, diverse attitudes and values. Student will get the knowledge to resolve the environmental problems of the planet, work towards community-oriented problems with coherent and inferential problem solving skills.

UNIT 1: DRAW BACKS OF CURRENT TECHNOLOGIES

Environmental degradation, financial constraints, social issues with automation in technology, extinction of fossil fuels, risks involved in operations. Global environmental issues- Resource degradation, Climate change (Carbon credits and carbon trading, carbon foot print), Global warming, Ozone layer depletion, Regional and Local Environmental Issues.

UNIT 2: ENVIRONMENT REMEDIATION

Environment Impact Assessment (EIA) - Procedures of EIA in India, Physical and Chemical technologies for reclamation, Need for ecosystem restoration, Bioremediation.

Alternative Hirarchy Process (AHP), Selection of best technology using AHP, Alternative resources and technologies, resource recovery from waste, energy recovery from waste, Sustainable Development vs Environmental Engineering - Energy Issues.

UNIT 3: SUSTAINABLE TECHNOLOGIES

Sustainability - Introduction, Need and concept of sustainability; People, planet and profit; Social, environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Green technologies.

UNIT 4: BIOMIMICRY

Defining biomimicry, why biomimicry matters? Biomimicry examples - Bioplastics, biomaterials, bioluminescence for LED's, neural networks, swarm intelligence, aerodynamics for automobile engineering, DNA computing.

UNIT 5: BIOLOGICAL RESOURCES FOR SUSTAINABILITY

Organic Farming for sustainable agriculture, Microbial leaching of low grade mineral ores, Bioelectricity (Microbial fuel cells), Biomagnetism (for therapy), Biofuels (for energy), Microbial engineering for cleaning environmental pollution, biosynthesis of industrial products.

Reference:

1. *Perspectives on Sustainable Technology- M. Rafiqul Islam*

2. Sustainable Energy Consumption and Society- David L. Goldblatt

3. Sustainable development (energy, engineering and technologies, manufacturing and environment) - Chaouki Ghenai

4. Sustainability and Environmental Impact of Renewable Energy Sources - R. E. Hester, R. M. Harrison

5. Sustainable Natural Resources Management - Prof. Abiud Kaswamila.

6. Sustainable Communities Design Handbook - Woodrow W. Clark

7. Handbook of Bioplastics and Biocomposites Engineering Applications - Srikanth Pilla

8. Modeling & Imaging of Bioelectrical Activity: Principles and Applications (Bioelectric Engineering) - Bin He

9. Handbook of Swarm Intelligence: Concepts, Principles and Applications – YuhuiShi, Meng-Hiot Lim, Bijaya ketan Panigrahi.

10. DNA Computing and Molecular Programming - DNA 16 – Yasubumi sakkibara, yongli Mi

11. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.

12. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning .

13. Environment Impact Assessment Guidelines, Notification of Government of India, 2006

14. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998 .

15. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System

16. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.

17. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).

18. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios publication.

19. Biomimicry: Innovation Inspired by Nature by Janine Benyus.

BSBE 4502 PHARMACEUTICAL TECHNOLOGY

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **3-0-0-3**

OBJECTIVE:

Pharmaceutical Technology course is designed to educate chemical engineer students and provide them with the skills required to work in the pharmaceutical field, with particular emphasis on the engineering aspects of drug manufacturing, pharmaceutical production, pharmaceutical development, and pharmaceutical operations.

LEARNING OUTCOMES:

Upon completion of the program, students will be able to:

-Apply in-depth knowledge and practical skills for formulation and process manufacturing of chemical and biological drugs into a range of pharmaceutical dosage forms, ranging from tablets to injectables.

-Demonstrate that they have gained practical skills in instrumental analysis, clinical testing and quality control of drugs.

-Evaluate therapeutic management of diseases based on knowledge of drug design, pharmacokinetics and pharmacotherapy.

-Demonstrate their ability to solve problems and suggest pharmological interventions in health issues related to the local community.

-Demonstrate their ability to conduct healthcare related research.

-Demonstrate the acquired skills and knowledge expertise in communication and coordinate activites with other health providers and beneficiaries.

-Integrate the necessary knowledge and skills quickly into the industrial environment and to operate effectively in production processes.

-Understand the regulatory and quality compliance of pharmaceuticals in the process of drug development and manufacturing.

UNIT 1: PREFORMULATION STUDIES

Introduction, Consideration of physicochemical properties of new drug molecules for different dosage forms. Aqueous solubility, organic solubility, intrinsic solubility, methods of enhancement of solubility-surfactants, pH, co-solvency, solid dispersion, complexation.

Techniques for the study of crystal properties and polymorphism - DSC, TGA, PXRD, Optical microscopy, hot stage microscopy.

UNIT 2: PHARMACEUTICAL EXCIPIENTS & POLYMERS

Factors affecting the selection of excipients, drug-excipient interactions, Study of cyclodextrins, ion exchange resins, film coating materials, super-disintegrants, directly compressible vehicles, surfactants and thickeners. Co-processed excipients. Excipient compatibility studies

Polymer classification-biodegradable, synthetic, semi-synthetic and natural polymers. Hydrogels and their applications.

UNIT 3: FORMULATION TECHNOLOGY

Tablet technology: Compression, consolidation, decompression, compaction at high loads, forces distribution during compression, compaction profiles, measurement of forces during compression, energy involved in compaction, properties of granules of compression, influence of compression force on the properties of tablets.

Capsule technology: Manufacturing equipment and machinery used in capsule technology. Formulation and evaluation of hard gelatin capsules and soft gelatin capsules.

Parenterals technology: Manufacturing of LVP, SVP, Sterilization and sterility testing of parenterals, GMP & c GMP regulations of parenteral technology.

UNIT 4: STABILITY TESTING - DRUGS AND DOSAGE FORMS

Solid state drug stability, dosage form stability, accelerated stability testing, shelf life calculations, strategies for prolonging shelf life. Effect of packaging materials on dosage form stability. Basic principles of ICH, stability testing of new drug substance and formulations, photostability testing and oxidative stability, role of containers in stability testing. WHO stability guidelines.

UNIT 5: CONCEPTS OF CONTROLLED RELEASE DRUG DELIVERY SYSTEMS

Introduction, concept, advantages & disadvantages. Factors to be considered for designing controlled release dosage forms. Dissolution, Diffusion, Combination of dissolution and diffusion controlled drug delivery systems. Classification of rate-controlled drug delivery systems. Rate-programmed release, activation-modulated and feedback regulated drug delivery systems. Effect of system parameters on controlled drug delivery. Hydrodynamically balanced systems, Osmotic pressure controlled, pH controlled, ion exchange controlled systems

REFERENCE BOOKS

1) Lieberman HA and Lachman L. Pharmaceutical Dosage Forms: Tablets. Vol. I, II and III, Marcel Dekker, New York. Latest Edition.

2). Avis KE, Lachman L and Lieberman HA, Pharmaceutical Dosage Forms: Parenterals. Volume I and II, Marcel Dekker, New York. Latest Edition.

3) Robinson and Lee, Controlled drug delivery: Fundamentals and applications, Marcel Dekker.

4) Carstensen, Pharmaceutical principles of solid dosage forms, CRC.

5) Ray and Weller, Handbook of Pharmaceutical Excipients, Pharmaceutical Press.

BSBE 4503 BIOMATERIALS

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **3-0-0-3**

Learning Objectives:

After successfully completing this course, students will be able to:

1. Understand the fundamental principals in biomedical engineering, material science and chemistry, and how they contribute to biomaterial development and performance.
2. Understand the material selection and structure-function relationships
3. Lists the different strategies to modify and/or design materials that are biocompatible.

Learning Outcomes

On completion of this course students should be able to:

- Demonstrate in-depth knowledge of the mechanical and biological properties of both natural and synthetic biomaterials and thereby implicate its behavior with biological system.

- Describe the role of adsorbed proteins and cells in the tissue response to biomaterials.

- Demonstrate an understanding of the host response to orthopedic biomaterials and be able to compare the responses to different materials.

- Describe the methods of testing for biomaterials biocompatibility.

- Distinguish the events that lead to the degradation of materials in the biological environment.

- Demonstrate an understanding of implant failure from a biological perspective.

-Appreciate the complex mechanical and biological interactions between biomaterials and biological systems

-Demonstrate an in-depth knowledge of the application of biomaterials (both natural and synthetic) in orthopedics, dental, cardiovascular, drug delivery and various system repairing activities of a human body.

UNIT 1. INTRODUCTION TO THE BACKGROUND CONCEPTS OF BIOLOGY, BIOCHEMISTRY AND MEDICINE.

Concepts of cells, proteins and their interaction with the biomaterial, Structure and properties of different classes of biomaterials; Interactions of materials with the human body; Criteria for

selection of biomaterials for specific medical applications, Concepts of Biocompatibility, mechanical properties of biomaterials, corrosion and biodegradation, evaluation of biomaterials.

UNIT 2. METALS AND ITS COMPOSITES.

Surface interaction with the cells; Classes of metals & metal composites; Applications of metals & metal composites; Biocompatibility testing's and evaluation of metals and its composites.

UNIT 3. CERAMICS AND ITS COMPOSITES.

Surface interaction with the host cells; Classes of Ceramics and its composites; Applications of Ceramics and its composites; Biocompatibility testing's and evaluation of Ceramics and its composites.

UNIT 4. POLYMERS AND ITS COMPOSITES.

Surface interaction with the cells, classes of polymers and its composites; Applications of polymers and its composites; Biocompatibility testing's and evaluation of polymers and its composites.

UNIT 5. BIOMEDIACAL APPLICATIONS OF BIO MATERIALS.

Nanostructure biomaterials, Orthopedic implants, dental implants, vascular grafts, ocular materials, drug delivery carriers, introduction to tissue regeneration scaffolds.

.**Texts & References**

- Ratner B, Hoffman A. et al. Biomaterials science: An introduction to materials in medicine, Academic Press, 2004
- Fredrick H. Silver: Biomaterials, Medical Devices & Tissue Engineering: An integrated approach. Chapman & Hall, 1994

MM4501 FATIGUE CREEP AND FRACTURE

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **3-1-0-3**
Objectives:

* To provide an insight into the field of deformation and its dependence on temperature and strain rates
* To understand the fatigue of metals
* To analyze creep and stress rupture
* To study the basics of fracture
* To know and analyze different case studies

Unit 1:

Introduction, basics of deformation, effect of temperature and strain rate on metals and failure theories.

Part 2: Fatigue of metals:

Stress cycles, S-N curve, effect of mean stress on fatigue, cyclic stress-strain curve, low-cycle fatigue, strain-life equation, structural features of fatigue, fatigue crack propagation, effect of stress concentration on fatigue, size and surface effects on fatigue, fatigue under combined stresses, design for fatigue, corrosion fatigue, effect of temperature, sample size and metallurgical factors on fatigue.

Part 3: Creep and stress rupture:

High temperature materials, time-dependent mechanical behavior, the creep-curve, stress-rupture, structural changes during creep, mechanisms of creep deformation, activation energy of creep, superplasticity, creep under combined stresses.

Part 4: Fracture:

Introduction, mechanism of fracture in different stress conditions and mechanical testing procedures, variables effecting fracture process, fracture zones, prediction of the fracture mechanism based on the fractographic analysis.

Part 5: Analyses and case studies:

Macroscopic and microscopic fracture modes in fatigue, creep-fatigue interactions, fracture at elevated temperature, case studies.

.**Suggested References:**

1. Dieter, G, E., Mechanical metallurgy (SI metric edition), McGraw-Hill book company, 1988.
2. Hertzberg, R, W., Deformation and fracture mechanics of engineering materials (3rd edition), John Wiley & sons, 1997
3. Broek, D., Elementary engineering fracture mechanics (3^{rd} edition), Martinus Nijhoff publications, 1982.

CH4504 COMPUTATIONAL FLUID DYNAMICS

Externals: 60 Marks **L-T-P-**

CInternals: 40 Marks **4-0-0-3**

Objective:

- To be able to apply to apply the conservation laws to fluids in motion under different conditions
- To learn modeling of fluid flow under different conditions
- To learn how to convert differential equations to difference equations and to learn grid generation methods
- To simulate the model

Unit-1 Conservation Laws And Turbulence Models

Governing equations of fluid flow and heat transfer –mass conservation, momentum and energy equation, differential and integral forms, conservation and non-conservation form. Characteristics of turbulent flows, time averaged Navier Strokes equations, turbulence models-one and two equation, Reynolds stress, LES and DNS

Unit-2 Finite Differnce Approximation

Mathematical behaviour of PDE, finite difference operators, basic aspects of discretization by FDM, explicit and implicit methods, error and stability analysis

Unit-3 Finite Volume Method

Diffusion problems – explicit and implicit time integration; Convection-diffusion problems – properties of discretisation schemes, central, upwind, hybrid, QUICK schemes; Solution of discretised equations.

Unit-4 Flow Field Computation

Pressure velocity coupling, staggered grid, SIMPLE algorithm, PISO algorithm for steady and unsteady flows

Unit-5 Grid Generation

Physical aspects, simple and multiple connected regions, grid generation by PDE solution, grid generation by algebraic mapping.

Text Books:

1. Computational Fluid Dynamics: The Basics with Applications, Anderson, J. D., McGraw-Hill, 1995.
2. Computational Techniques for Fluid Dynamics, Fletcher, C. A. J., Springer Verlag, 1997.

References:

1. An Introduction to Computational Fluid Dynamics:The Finite Volume Method, Versteeg, H.K. and Malalasekera, W.,Pearson Education Ltd., 2007.
2. Computational Fluid Dynamics, Chung T.J , Cambridge University Press 2003.
3. Computational Fluid Flow and Heat Transfer, Muralidhar, K., and Sundararajan, T., Narosa Publishing House, New Delhi, 2001.
4. Numerical heat transfer fluid flow, Subas, V. Patankar Hemisphere Publishing Corporation, 1980.

MM4800 **PROJECT**

Externals: 60 Marks **L-T-P-C**

Internals: 40 Marks **0-0-0-12**