MAHATMA GANDHI INSTITUTE OF TECHNOLOGY (Autonomous)
B. Tech. in Metallurgical and Materials Engineering
Scheme of Instruction and Examination
(Choice Based Credit System)
Applicable from AY 2022-23 Batch

V SEMESTER

S. No.	Course Code	Course Title	Instruction			Examination		Duration of SEE in hours	Credits
			Hours per week			Max. Marks			
			L	T	P	CIE	SEE		
1.	MS501HS	Business Economics & Financial Analysis	3	0	0	40	60	3	3
2.	MM501PC	Transport Phenomena	3	1	0	40	60	3	4
3.	MM502PC	Mechanical Working of Metals	3	1	0	40	60	3	4
4.	MM503PC	Metal Casting	3	0	0	40	60	3	3
5.	MM504PC	Nonferrous Extractive Metallurgy	3	0	0	40	60	3	3
6.	MM551PC	Metal Casting Lab	0	0	2	40	60	3	1
7.	MM552PC	Mechanical Working of Metals Lab	0	0	2	40	60	3	1
8.	MM553PC	Modelling and Simulations Lab	0	0	2	40	60	3	1
9	MC502ES	Artificial Intelligence	3	0	0	40	60	3	0
Total Hours/Marks/Credits			**18**	**2**	**6**	**360**	**540**		**20**

L: Lecture **T: Tutorial** **P: Practical**

CIE: Continuous Internal Evaluation **SEE: Semester End Examination**

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VI SEMESTER

S. No.	Course Code	Course Title	Instruction Hours per week			Examination Max. Marks		Duration of SEE in hours	Credits
			L	T	P	CIE	SEE		
1.	MM601PC	Environmental Degradation of Materials	3	0	0	40	60	3	3
2.	MM602PC	Materials Characterization Techniques	3	0	0	40	60	3	3
3.	MM603PC	Welding Metallurgy	3	0	0	40	60	3	3
4.	**Professional Elective – I**								
	MM611PE	1. Powder Metallurgy and Nanomaterials	3	0	0	40	60	3	3
	MM612PE	2. Computational Materials Engineering							
	MM613PE	3. Fracture Mechanics and Failure Analysis							
5.	**Open Elective – I**								
	MM621OE	1.Selection of Materials for Engineering Applications	3	0	0	40	60	3	3
	MM622OE	3. Metallurgy for Non-Metallurgists							
6.	MM651PC	Environmental Degradation of Materials Lab	0	0	2	40	60	3	1
7.	MM652PC	Metal Joining Lab	0	0	2	40	60	3	1
8.	EN651HS	Advanced English Communication Skills Laboratory	0	0	2	40	60	3	1
9.	MM653PC	Industry Oriented Mini Project/ Internship	0	0	4	-	100	3	2
10.	MC601HS	Intellectual property Rights	3	0	0	40	60	3	0
11	MC602ES	Cyber Security	3	0	0	40	60	3	0
12	MC601BS	Environmental Science	3	0	0	40	60	3	0
		Total Hours/Marks/Credits	**24**	**0**	**10**	**440**	**760**		**20**

***MC – Satisfactory / Unsatisfactory**

Environmental Science in III Yr. I Sem Should be Registered by Lateral Entry Students only.

L: Lecture T: Tutorial P: Practical

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VII SEMESTER

S. No.	Course Code	Course Title	Instructions Hours Per week			Examinations Max. Marks		Duration of SEE in hours	Credits
			L	T	P	CIE	SEE		
1.	ME732PC	Introduction to Instrumentation	2	0	0	40	60	3	2
2.	MM701PC	Non-Destructive Testing	2	0	0	40	60	3	2
3.	**Professional Elective – II**								
	MM711PE	1.Additive Manufacturing of Materials	3	0	0	40	60	3	3
	MM712PE	2. Design and Selection of Engineering Materials							
	MM713PE	3.Materials Data Science and Informatics							
4.	**Professional Elective – III**								
	MM714PE	1. Introduction to Numerical Analysis	3	0	0	40	60	3	3
	MM715PE	2. Automotive Materials							
	MM716PE	3. Structural Ceramics and Composites							
5.	**Professional Elective – IV**								
	MM717PE	1.Aerospace Materials	3	0	0	40	60	3	3
	MM718PE	2.Artificial Intelligence in Materials Engineering							
	MM719PE	3.Radar and Stealth Materials							
6.	**Open Elective – II**								
	MM721OE	1. Testing of Materials	3	0	0	40	60	3	3
	MM722OE	2.Corrosion Engineering							
8.	MM751PC	Project Stage - I	0	0	6	100	0	-	3
9.	MM752PC	Designing of Engineering Components Laboratory	0	0	2	40	60	3	1
Total Hours/Marks/Credits			**16**	**0**	**8**	**380**	**420**		**20**

L: Lecture T: Tutorial P: Practical

CIE: Continuous Internal Evaluation SEE: Semester End Examination

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VIII SEMESTER

S. No.	Course Code	Course Title	Instructions Hours per week			Examinations Max. Marks		Duration of SEE in hours	Credits
			L	T	P	CIE	SEE		
1.	**Professional Elective – V**								
	MM811PE	1.Advanced Materials	3	0	0	40	60	3	3
	MM812PE	2.Advanced Manufacturing Technologies							
	MM813PE	3. Energy Materials							
2.	**Professional Elective – VI**								
	MM814PE	1.Materials for high Temperature Applications	3	0	0	40	60	3	3
	MM815PE	2. Electronic and Magnetic Materials							
	MM816PE	3.Advances in Surface Engineering							
	Open Elective – III								
3	MM821OE	1.Materials for aerospace applications	3	0	0	40	60	3	3
	MM822OE	3. Characterization of Materials							
4.	MM851PC	Project Stage – II including seminar	0	0	22	40	60	-	11
Total Hours/Marks/Credits			**9**	**0**	**22**	**160**	**240**		**20**

L: Lecture T: Tutorial P: Practical

CIE: Continuous Internal Evaluation SEE: Semester End Examination

L	T	P	C
3	0	0	3

MS501HS: Business Economics and Financial Analysis

V Semester Syllabus

(Common to CIVIL, EEE, MEC, ECE, MCT, MME & CSE (AI & ML))

Course Objectives: The Objective of the course are:

- Students will understand various forms of Business and the impact of economic variables on the business, concepts of Business Economics and its significance.
- Gain the knowledge on various market dynamics namely Demand, elasticity of demand, and demand forecasting.
- To disseminate the knowledge on production function, Laws of production, Market structures, while dealing with the concept of cost and breakeven analysis.
- To acquaint the students regarding Accounting and various books of accounts.
- To enable the students to analyze a company‟s financial statements through ratios and come to a reasoned conclusion about the financial situation of the company.

Course Outcomes: After completion of the course the students will be able to:

- Select a suitable business organization with available resources.
- Analyze various aspects of Demand, Elasticity of demand and Demand Forecasting.
- Gain knowledge on different market structures, production theories, cost variables and pricing methods.
- Prepare Books of accounts and Financial Statements.
- Analyze financial well-being of the business while using ratios.

UNIT – I: INTRODUCTION TO BUSINESS AND ECONOMICS

Economics: Significance of Economics, Micro and Macro Economic Concepts, National Income - Concepts and Importance, Inflation, Business Cycle - Features and Phases.

Business: Structure of Business Firm, Types of Business Entities – Sole Proprietorship – Partnership – Cooperative Societies - Limited Liability Companies, Sources of Capital – Conventional sources and Non - Conventional Sources of Finance.

Business Economics: Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

UNIT – II: DEMAND AND SUPPLY ANALYSIS

Demand Analysis: Demand - Meaning, Determinants of Demand, Law of Demand, Exceptions of Law of Demand, Demand Function, Changes in Demand – Increase and decrease in Demand - Extension and Contraction in Demand.

Elasticity of Demand: Elasticity – Meaning, Types of Elasticity – Price Elasticity – Income Elasticity – Cross Elasticity–Advertising Elasticity of Demand, Factors affecting Elasticity of Demand, Measurement and Significance of Elasticity of Demand, Elasticity of Demand in decision making.

Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting – Survey methods, Statistical methods.

Supply Analysis: Supply – Meaning, Determinants of Supply, Supply Function & Law of Supply.

Unit III: PRODUCTION, COST, MARKET STRUCTURES & PRICING

Production Analysis: Production – Meaning, Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Cobb-Douglas production function.

Cost analysis: Cost–Meaning, Types of Costs, Short run and Long run Cost Functions.
Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition.
Pricing: Pricing -Meaning, Objectives of pricing, pricing methods – Cost based pricing methods – Demand based pricing methods – Competition based pricing methods – Strategy based pricing methods - Product Life Cycle based Pricing, Break Even Analysis (simple problems), Cost Volume Profit Analysis.

Unit IV: FINANCIAL ACCOUNTING

Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts along with adjustments– Trading account – Profit and loss account – Balance sheet (simple problems).

UNIT – V: FINANCIAL ANALYSIS THROUGH RATIOS

Concept of Ratio Analysis, Importance, Liquidity Ratios- Current Ratio – Quick Ratio – Absolute Liquid Ratio, Profitability Ratios – Gross Profit Ratio – Net Profit Ratio – Operating Ratio, Turnover Ratios – Stock Turnover Ratio – Debtors Turnover Ratio – Creditors Turnover Ratio, Leverage Ratios – Debt-to-Assets Ratio - Debt-Equity Ratio - Proprietary Ratios and interpretation (simple problems).

TEXT BOOKS:

1. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury,"Managerial Economics", 2e, Tata McGraw Hill Education Pvt. Ltd. 2012.
2. Dhanesh K Khatri, "Financial Accounting", Tata McGraw Hill, 2011.
3. Ramachandra Aryasri. A, "Business Economics and Financial Analysis", McGraw Hill Education India Pvt. Ltd. 2020.

REFERENCE BOOKS:

1. P. L. Mehta, Managerial Economics, Analysis, Problems & Cases, 8th Edition, Sultan Chand & Sons, 2001.
2. S.N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.
3. D.D. Chaturvedi, S.L. Gupta, "Business Economics - Theory and Applications", International Book House Pvt. Ltd. 2013.

L	T	P	C
3	1	0	4

MM501PC: Transport Phenomenon
V Semester Syllabus

Course objectives:

- This course will introduce the concepts of fluid flow, heat transfer and mass transfer with processing of engineering materials as the focus.

Course outcomes:
At the end of this course, the student should be able to

- Pose a problem in transport phenomena as a balance equation
- Identify suitable boundary conditions for the problem
- Solve simple partial differential equations relevant to transport phenomena
- Plot different parameters
- Design a pilot plant

UNIT – I: Introduction to Transport phenomena

Properties of fluids, Units and Dimensional Analysis. Molecular theory of viscosity of gas/liquid, Newton's law of viscosity, Reynolds experiments, Types of fluid flow, Types of transport

UNIT – II: Momentum transfer

Equation of continuity and motion, Shell momentum balance and velocity profile, concept of velocity boundary layer, Navier-Stokes equation, and its applications, Bernoulli‟s equation, Friction factor, Fluid flow in packed bed, Darcy's law

UNIT-III: Heat transfer

Fundamentals of heat conduction, convection, radiation, and their combined effect. Fourier‟s law of heat conduction, Steady state and unsteady state conduction in solids, Natural convection, forced convection, concept of heat transfer coefficient and thermal boundary layer, heat transfer through a composite wall, Radiation heat transfer

UNIT – IV: Mass transfer

Diffusivity and steady state diffusion, Fick‟s laws, Unsteady state mass transfer, concept of mass transfer coefficient, concentration boundary layer.

UNIT – V: Dimensionless numbers

Similarities of momentum, mass, and energy transfer. Dimensionless numbers, their physical meaning, the relations between them and their applications. Similarity criteria and introduction to pilot plant studies

TEXT BOOKS:

1. Introduction to Transport Phenomena in Materials Engineering, David R Gaskell, Momentum Press 2nd Edition 2012

REFERENCE BOOKS:

1. Transport Phenomena in Materials Processing: D.R. Poirier and G.H. Geiger, TMS
2. Transport phenomena, 2nd Edition: R. Byron Bird, Warren E. Stewart, and Edwin N Lightfoot. John Wiley & Sons

L	T	P	C
3	1	0	4

B. Tech. in Metallurgical and Materials Engineering

V Semester Syllabus

MM502PC: Mechanical Working of Metals

Course Objectives:

- To introduce students to the consequences of the application of loads on metals
- To analyse stress and strain at an inclined plane from the given three-dimensional stresses.
- To impart knowledge about principles and criteria of yielding during forming of metals
- To impart knowledge on analysis of different bulk metal forming processes.
- To understand the role of different controlling process parameters in metal forming processes

Course Outcomes: At the end of course, the student will be able to

- Use the Mohr‟s circle to graphically analyse stresses.
- Appreciate the consequences of application of loads on metals
- Analyze, compare, and finally gain theoretical experience for the advantages and limitations of different manufacturing processes
- To practically appreciate the utilization of bulk forming processes in industrial manufacturing processes.
- To analyse metallurgical and mechanical aspects of forming of metals into useful shapes and properties.

UNIT-I: Stress-Strain Relationship-Elastic Behavior

Concept of stress and types of stresses. Concept of strain and types of strains. Description of stress at a point, Plane stress, State of stress in two dimensions: Construction of Mohr‟s circle of stress for two-dimensional state of stress. State of stress in three dimensions: Construction of Mohr‟s circle of stress for three-dimensional state of stress. Hydrostatic and Deviator components of stress. Elastic stress strain relations. Calculation of stresses from elastic strains.Plane strain. Strain energy.

UNIT-II: Elements of Theory of Plasticity

Basics of the theories of plasticity. The flow curve. Idealized flow curves. True stress and true strain. Relationship between engineering stress and true stress, engineering strain and true strain. Constancy of volume relationship. Advantage for true strain in metal working. Yielding criteria for ductile metals. Von Mises distortion energy criterion Maximum shear stress or Tresca criterion. The yield locus. Octahedral shear stress and shear strain. Plastic stress strain relations, Levy- Mises equations.

UNIT- III: Fundamentals of Metal Working

Classification of forming processes: High energy rate forming process, Explosive forming. Mechanics of metal working: slab method. Flow stress determination, Plane strain compression test. Mean flow stress, Cold working, Recovery, recrystallisation and grain growth, Hot working Strain-Rate effects Work of plastic deformation. Stresses acting on an

element during drawing of a wide sheet. Dynamic recovery and Dynamic recrystallisation. Friction and lubrication. Deformation zone geometry. Hydrostatic pressure.

UNIT-IV: Forging and Rolling of Metals

Forging: Classification of forging processes: Open-die, closed-die, impression die and isothermal forging. Forging operations: Swaging, fullering, edging, cogging, coining, drawing out, upsetting. Forging equipment. Forging of a rectangular slab in plane strain, Forging of a cylinder in plane-strain, Forging defects.
Rolling of Metals: Classification of rolling process, rolling mills, Classification of rolling mills, Hot rolling, cold rolling, Rolling of bars and shapes, Geometrical relationships in rolling, Simplified analysis of rolling load, rolling variables. Front tension and back tension, effect of strip tension on distribution of roll pressure, Rolling mill control. Problems and defects in rolled products. Theories of cold and hot rolling, torque and horsepower

UNIT-V: Extrusion and Drawing

Extrusion: Classification of extrusion processes-Direct extrusion, Indirect extrusion, Hydrostatic extrusion, and Impact extrusion. Extrusion equipment. Typical extrusion dies-Flat and conical dies. Patterns of metal flow in extrusion. Hot extrusion Deformation and defects in extrusion. Analysis of the extrusion process Cold extrusion of tubing and production of seamless pipe and tubing, Spider dies, Mannesmann mill process.
Drawing of Rods, Wires and Tube: rod, wire, and tube drawing processes. Drawing die. Analysis of wire drawing, Analysis of tube drawing. Maximum possible reduction in drawing, Defects in drawing, Residual stresses in rod, wire and tubes. Deep drawing of sheets.

TEXT BOOKS:

1. Mechanical Metallurgy by GE Dieter (3rd edition)
2. Metal forming mechanics of metallurgy, William F.Hosford, Robert M.Caddell. Cambridge, 3.Edition.
3. Technology of Metal Forming Processes – Surender Kumar PHI 2008 Reference Books:

REFERENCE BOOKS:

1. Mechanical Working of Metals - Avitzur.
2. Mechanical Properties and Working of Metals and Alloys, AmitBhaduri, Springer

L	T	P	C
3	0	0	3

B. Tech. in Metallurgical and Materials Engineering

V Semester Syllabus

MM503PC: Metal Casting

Course Objectives:

- This course is mainly intended to introduce and explain various moulding, casting techniques and equipment used
- This course is mainly intended to introduce and explain various moulding, casting equipment used
- Principles of Solidification of castings
- Defects in castings and their remedies are also dealt in detail

Course Outcomes:

- This course paved a platform for students to develop a thorough understanding on the,
- Casting technologies and Different Moulding process
- Solidification of metals and alloys
- Gating and Riser system
- Cupola, Induction furnace
- Identified the casting Defects and found the suitable remedies

UNIT- I: Introduction to Foundry–Types of Foundries and Patterns

Materials for patterns, types of patterns, properties of pattern materials; functions and pattern allowance. Cores, core prints and core making, Moulding materials; moulding sands, properties and selection of binding materials and additives.

Moulding Processes: Green and dry sand moulding; shell moulding, CO_2 moulding, Plaster moulding, Investment casting

UNIT-II: Casting Methods

Permanent and Expendable moulding, pressure die-casting, Gravity die casting, Vacuum die casting, Horizontal, Vertical and Semi centrifugal casting, Squeeze casting and Composite Casting

UNIT-III: Melting and Solidification

Solidification, Nucleation, and growth. Freezing of metals and alloys. Dendritic freezing. Progressive and Directional Solidification. Gating, Risering and their design

UNIT-IV: Modern Developments

Recently developed processes-V-Forming Full Mould Process, Furon-No-Bake Sand Moulds and Cores, Cold Setting, and Self Setting Processes. Cupola furnace, construction of cupola furnace, Melting of Gray Iron in cupola and Induction furnace Melting,

UNIT-V: Casting Defects and Remedial Measures

Casting defects arising due to moulding, cores, melting and pouring practice. Introduction to NDT Inspection of castings

TEXTBOOKS:

1. Principles of Metal casting by Heine – Loper and Rosenthal, Tata McGraw Hill, 2nd Edition.
2. Castings – John Campbell – Second Edition – Elsevier

REFERENCES:

1. Foundry Technology – Dharmendra Kumar & S. K. Jain, CBS Publisher, 2007
2. Fundamentals of metals casting, P. C. Mukherjee, Oxford & IBH Pub. Co., 1988
3. Casting Technology and Cast Alloys – AK Chakrabarti – PHI 2011 Edition
4. Metal Casting : Principles and practice – T.V. RamanaRao, New Age, International, 2007.

L	T	P	C
3	0	0	3

B. Tech. in Metallurgical and Materials Engineering

V Semester Syllabus

MM504PC: Non-Ferrous Extractive Metallurgy

Course objectives:

- To explain the various methods of extraction of non-ferrous metals.
- To describe the procedure and equipment used for production of nonferrous metals from their ores.

Course outcomes:

At the end of the course, student would be able to recommend

- Describe and explain non-ferrous sulphide and oxide ore treatment techniques
- Explain extractive processes based on thermodynamic perspective for sulphide and oxide ores
- Describe and explain material and energy flows related to extraction of non-ferrous metals of chloride and carbonate ores
- Describe and explain processes and reactors for extraction and refining of non-ferrous precious and radio-active metals
- The students get an idea of energy saving methods and environment controlling methods in extractive units.

UNIT -I: Principal Ore and Minerals

General and Engineering Applications of Cu, **Pyrometallurgical Extraction of Cu:** Ores of Cu, Copper Matte smelting – Blast furnace, Reverberatory, Electric furnace, Flash; Converting; Continuous production of blister Copper; Fire refining; Electrolytic refining
Hydro- Metallurgical copper extraction of Cu: Leaching processes, Recovery of copper from leach solutions; Electro- winning.

UNIT –II: Zinc and Lead Extraction

General and Engineering Applications of Zn and Pb, **Pyrometallurgical Extraction of Zinc:** Ores of Zn General Principles, Horizontal and vertical retort processes: Production in a Blast furnace:
Hydrometallurgical Extraction of Zn: Leaching- purification: Electrolysis, Refining.
Pyrometallurgical Extraction of Lead: Ores of Pb, Blast furnace smelting, Refining of lead bullion.

UNIT – III: Aluminum Extraction

General and Engineering Applications of Aluminum, Ores of Al, Aluminum: Bayer process: Hall - Heroult process: Anode effect: Efficiency of the process: Refining of Al, Alternative processes of aluminum production. Recovery and Recycling of Aluminum

UNIT – IV: Magnesium and Titanium

General and Engineering Applications of Mg and Ti, **Magnesium:** Ores; Production of a hydrous Magnesium chloride from seawater and magnesite. Electro- winning practice and

problem, refining, Pidgeon and Hansgrig processes. **Titanium:** Ores; Upgrading of ilmenite, chlorination of titanium, Kroll's process. Refining.

UNIT – V: Extraction of Nuclear Material – U and Zr

Nuclear Applications of U and Zr, **Uranium:** Ores of Uranium, Processing of Uranium ores; Recovery of Uranium from solution, **Zirconium:** Ores of Zr, Treatment of Zr – Methods for separation of Hafnium from Zr; Reduction of Zr compound to Metal.

TEXTBOOKS:

1. Extraction of Non-Ferrous Metals - HS Ray, KP Abraham and R.Sridhar
2. Non-Ferrous Extractive Metallurgy – G B Gill John Wiley & Sons1980

REFERENCE BOOKS:

1. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics, Alain Vignes (ISTELtd.,)
2. Extractive Metallurgy 2: Metallurgical Reaction Processes, Alain Vignes (ISTELtd.,)
3. Extractive Metallurgy 3: Processing Operations and Routes, Alain Vignes (ISTELtd.)
4. Topics in non-ferrous extractive metallurgy, Burkin, Wiley-Blackwell(1980)

L	T	P	C
0	0	2	1

B. Tech. in Metallurgical and Materials Engineering

V Semester Syllabus

MM551PC: Metal Casting Lab

Objective:

- This Laboratory course is designed to make the student to understand and demonstrate
- This lab course is mainly designed to provide hands on practice on the various foundry testing methods for evaluation of moulding sand properties

Course Outcomes:

Upon successful completion of this course, the student will be able to:

- Determine moulding sand dry, hot and green strength
- Understand the preparation of moulding sand
- Determine moulding sand properties by varying additives
- Understanding the gating and riser system
- Understand the Melting of Al alloys

LIST OF EXPERIMENTS:

1. Preparation of gating system using green moulding sand.
2. Study of particle size distribution of the sand.
3. Study of the variation of permeability of the green sand with clay and water.
4. Determination of the variation of sand properties like green hardness, green compact strength with additives in sands.
5. Determination of the variation of hot compact hardness and hot shear strength with additives in sands.
6. Determination of clay content in sand.
7. Determination of the shatter index of green sand.
8. Melting of Al alloys in a pit furnace and casting into light components.
9. Study of Charge calculations and melting practice of cast iron in cupola.
10. Preparation of a shell-by-shell moulding process.

Equipment:

1. Mould Boxes, Patterns, Core Boxes, Tool Boxes.
2. Sieve Shaker with Sieves
3. Permeability Apparatus.
4. Universal Sand Testing Machine with Accessories.
5. Sand Hardness tester.
6. Clay Content Apparatus
7. Shatter Index test.
8. Shell Moulding Machine
9. Centrifugal Casting Machine
10. Ladles, Crucibles and other Accessories
11. Melting Furnace 1000^0c

L	T	P	C
0	0	2	1

B. Tech. in Metallurgical and Materials Engineering

V Semester Syllabus

MM552PC: Mechanical Working of Metals Lab

Course Objectives:

- This lab course is designed to know the various testing methods for evaluation of metal forming techniques.

Course outcomes: Upon successful completion of this course, the student will be able to

- Determine strain hardening exponent from the stress-strain diagram.
- Understand the difference between simple, progressive and compound dies.
- Understand the effect of cold working and annealing on microstructure.
- Illustrate the effect of friction and semi die –angle on metal flow in extrusion.
- Practice various deformation processes like extrusion, deep drawing and redrawing

.

LIST OF EXPERIMENTS:

1. To determine the formability of given materials by Erichson cup test
2. To manufacture washer components using fly press (progressive dies /compound dies)
3. Deep drawing of a cup with / without blank holder by hydraulic press
4. Redrawing of a cup with / without blank holder by hydraulic press
5. To determine the friction factor by ring compression test
6. Determination of strain hardening exponent „n“ and strength coefficient „k“
7. To verify Hall-Petch relation in MS specimen.
8. To determine the effects of cold working on the microstructure and mechanical properties of given metal.
9. To demonstrate the effect of friction and height-to-diameter ratio in the axi-Symmetric compression of a cylinder.
10. To demonstrate the metal flow in extrusion with different semi- die angles.

List of Equipment:

1. UTM, 2. Hydraulic press, 3. Fly press, 4. Erichson cup Tester

L	T	P	C
0	0	2	1

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V Semester Syllabus

MM553PC: Modelling & Simulation

List of Experiments:

1. Understanding programming & plotting using MATLAB
2. Program to calculate and plot yield strength as a function of grain size
3. Program to plot and fit the Hall Petch equation to determine friction stress & locking parameter
4. Program to Plot hardness data with error bar
5. Program to calculate & plot diffusion distance of carbon in bcc Fe and fcc Fe as a function of time
6. Program to calculate & plot the isomorphous phase diagram
7. Program to calculate & plot the liquidus of the binary eutectic phase diagram
8. Program to compute electrode potential under non-standard conditions
9. Program to compute riser dimensions using shrinkage and cooling characteristics
10. Program to compute and plot the E-pH diagram for Aluminum in water at 25^{o}C

REFERENCES:

1. Getting Started with MATLAB® Mathworks^{TM}.

L	T	P	C
3	0	0	0

B. Tech. in Metallurgical and Materials Engineering

MC502ES: Artificial Intelligence

V Semester Syllabus

(Common to all branches except CSE, IT, CSBS, CSE(AI&ML))

Course Objectives:

- To train the students to understand different types of AI agents, various AI search algorithms, fundamentals of knowledge representation, building of simple knowledge-based systems and to apply knowledge representation, reasoning.
- Study of Markov Models enable the student readyto step into applied AI.

UNIT - I

Introduction: AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents **Basic Search Strategies**: Problem Spaces, Uninformed Search (Breadth-First, Depth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), ConstraintSatisfaction (Backtracking, Local Search)

UNIT - II

Advanced Search: Constructing Search Trees, Stochastic Search, A* Search Implementation,Minimax Search, Alpha-Beta Pruning

Basic Knowledge Representation and Reasoning: Propositional Logic, First-Order Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem

UNIT - III

Advanced Knowledge Representation and Reasoning: Knowledge Representation Issues, Non-monotonic Reasoning, Other Knowledge Representation Schemes

Reasoning Under Uncertainty: Basic probability, Acting Under Uncertainty, Bayes‟ Rule, Representing Knowledge in an Uncertain Domain, Bayesian Networks

UNIT - IV

Learning: What Is Learning? Rote Learning, Learning by Taking Advice, Learning in Problem Solving,Learning from Examples, Winston‟s Learning Program, Decision Trees.

UNIT - V

Expert Systems: Representing and Using Domain Knowledge, Shell, Explanation, KnowledgeAcquisition.

TEXT BOOK:

1. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivasankar B. Nair, The McGraw Hillpublications, Third Edition, 2009

REFERENCE BOOKS:

1. Russell, S. and Norvig, P, Artificial Intelligence: A Modern Approach, Third Edition, Prentice-Hall, 2010.
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving,Pearson Education, 6th ed., 2009.

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM601PC: Environmental Degradation of Materials

Course objectives

- To familiarize the student with the extent and importance of material degradation.
- To study various aspects of corrosion of materials and its control.

Course outcomes

After completing this course, the student should be able:

- To apply the principles of electrochemistry to the corrosion concepts.
- To apply the concepts of thermodynamics and kinetics to the corrosion phenomenon.
- To differentiate the corrosion mechanisms based on corrosion failure pattern.
- To adapt suitable corrosion preventive measures based on the failure mechanism.
- To apply the corrosion mechanism to understand the degradation of materials.

Unit – I: Fundamentals of electrochemistry and corrosion

Introduction to Environmental Degradation of Materials, Classification of Corrosion processes. Forms of environmental degradation, Importance of corrosion studies, cost of corrosion, Electrochemical aspects of Corrosion. **Review of electrochemical Principles** – Theory of Electrolytes, Faraday‟s Laws of Electrolysis. Electrode Potential and its determination. Primary and Secondary electrodes. Reversible and Irreversible electrode potentials, EMF series – its applications and limitations.

Unit – II: Thermodynamic and Kinetic Concepts of corrosion

Thermodynamic concepts of Corrosion: Nernst Equation – Derivation and its application to the concepts of Corrosion. and Free Energy relation. Construction and application of the Pourbaix diagrams.

Kinetics of corrosion: Concept of Exchange current density, polarization, over potential – Hydrogen over potential and Oxygen over Potential. Classification of polarization – Activation Polarization, Concentration Polarization, Resistance Polarization and combined Polarization. Mixed Potential Theory and Tafel equations. Passivity – concepts and Mechanism.

Electrochemical Measuring Techniques:

Potentiostatic and potentiodynamic measurements, EIS – interpretation of Nyquest an Bode plots

Corrosion rate measurement:

Weight loss methods, Tafel‟s extrapolation method, and Linear Polarization resistance (LPR).

Unit – III: Forms of Corrosion

ASM Classification, Characteristic features, Mechanism, Factors influencing, and remedial measures of Uniform corrosion, Galvanic Corrosion, Crevice Corrosion, Pitting Corrosion, Intergranular Corrosion, Erosion Corrosion, Selective leaching, Stress Corrosion Cracking, Hydrogen Embrittlement. Microbial Corrosion Processes.

Unit – IV: Corrosion Prevention
Materials selection, Alteration of Environment, Design Aspects, Inhibitors, Cathodic and anodic protection, Coatings - Organic and Inorganic Coatings

Unit – V: Degradation of Non-Metallic Materials:
Introduction to composite and polymer materials. Mechanism of degradation of polymeric materials and composite materials and preventive measures

Suggested Readings:

1. Corrosion Engineering, Mars. G. Fontana, McGraw Hill Education, 2017
2. Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R. Scully,D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

Reference Books:

1. Corrosion: Metal / Environment Reactions, Volume 1, L.L. Shreir, R.A. Jarman, G.T. Burstein, Butterworth-Heinemann, 1994.
2. Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM602PC: Materials Characterization Techniques

Course Objectives:

1. To obtain knowledge on various structural and micro structural characterization techniques of materials.
2. To study the principles, theory, and practice of various characterization techniques.
3. The latest advancement in microscopy for structural and elemental analysis of materials.

Course Outcomes:

1. To analyze microstructure of the materials by operating Optical Microscope and quantitative metallography.
2. To make out the basic operational modes of a Scanning Electron Microscope.
3. To identify the basic operational modes of a Transmission Electron Microscope and the diffraction patterns.
4. To comprehend the production of x-rays and the principles of diffraction (Bragg‟s Law) and realize the applications of X-ray diffraction.

UNIT-I: Optical Microscopy

Optical Principle – Image formation, Resolution, Numerical aperture, Magnification, Components of Optical microscope, Illumination System – Electric Lamps Optical microscope, Important lens defects and their corrections, Specimen Preparation – Sectioning, Mounting, Grinding and Polishing and Etching, Imaging Modes – Bright and Dark Field, Principle of Phase Contrast, Polarized light microscopy, Differential Interference Contrast and Confocal Microscopy, Elements of quantitative Metallography.

UNIT-II: Scanning Electron Microscopy

Principle – Construction and Working principle SEM, Electron Sources – Thermionic Emission Gun and Field Emission Gun, Electromagnetic Lenses, Working Distance, Depth of field, Depth of focus, Signal Detection, Contrast Formation - Interaction of electron beams with matter, Topographic Contrast, and Compositional Contrast, Different types of modes used in SEM (SE and BSE) and their applications, Specimen preparation for SEM, Advantages, limitations and applications of SEM.

UNIT-III: Transmission Electron Microscopy

Principle – Construction and Working principle of TEM, Resolving power and Magnification, Depth of field and Depth of focus Image, Specimen Stage, Specimen preparation for the TEM – Pre-Thinning, and Final Thinning – Electrolytic Thinning, Ion Milling, and Ultramicrotomy, Modes: Bright and Dark field, Mass – Density Contrast and Diffraction Contrast – Selected Area Diffraction, Applications of TEM, Advantage and Limitations of TEM.

UNIT-IV: X-Ray Diffraction

Introduction of X-rays, Production – Filament tube method and properties of x-rays – Continuous and Characteristic Spectrum, Bragg‟s law of diffraction, Diffraction under non-ideal conditions, Experimental Methods of Diffraction – Transmission and Back-Reflection Laue method, Powder method, Diffractometer,Intensity of Diffracted beams – Scattering by an electron, by an atom, by a unit cell, Structure-factor calculations – Simplest unit cell, Base,

Body and Face-Centered and Hexagonal unit cells, Examples of NaCl, Factors affecting Diffraction Intensities – Multiplicity and Absorption factors, Temperature factor, Lorentz factor.

UNIT-V: Application of XRD

Orientation of single crystals – Schultz methods, Effect of plastic deformation; The structure of Polycrystalline Aggregates-Crystal size: Grain size and Particle size, Crystal Perfection: Quality, Crystal Orientations: Texture of Wire and Sheet, Determination of crystal structure – Indexing pattern of Cubic and Non-Cubic crystals, Determination of No. of Atoms in a unit cell and Atom Position, Precise lattice parameter measurements - Cubic and Non-Cubic crystals, Stress measurement: Principle and Experimental Technique: Diffractometer, Order-disorder transformation – Long range ordering in $AuCu_3$, AuCu.

TEXT BOOKS:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Leng – John Wiley & Sons (Asia) Pvt. Ltd. 2008
2. Elements of X-ray diffraction – Bernard Dennis Cullity & Stuart R Stocks, Prentice Hall, 2001 – Science
3. Materials Characterization (Vol. 10), George M. Crankovic, Kathleen Mills, Ruth E. Whan, ASM Handbook Committee

REFERENCES:

1. Microstructural Characterization of Materials – David Brandon, Wayne D Kalpan, John Wiley & Sons Ltd., 2008.
2. The Principles of Metallographic Laboratory and Practices (Metallurgy) – George L. Khel- McGraw-Hill, 1949.
3. Experimental Techniques in Materials and Mechanics – C. Suryanarayana, CRC Press, Taylor & Francis Group, 2011.
4. Metallography: Principles and Practices – George F. Vander Voort, ASM International, 1984 – Technology & Engineering
5. X-ray diffraction: A Practical Approach – C. Suryanarayana and M Grant Norton, Springer ScienceBusiness Media, LLC, 1998.

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM603PC: Welding Metallurgy

Course Objectives:

- To impart knowledge on various welding processes so that the students can apply them in engineering industry applications.
- Gain knowledge of the concepts, operating procedures, applications, advantages and limitations of various welding processes
- knowledge about the thermal and residual stresses associated with welding processes
- Gain knowledge of process, difficulties, and microstructures formed during welding of high carbon steels, cast irons, Stainless steels and Aluminum alloys and the remedial measures to minimize or eliminate the occurrence of weld defects
- To develop the knowledge on the quality control of weldments.

Course Outcomes:

- Understand the basics of various metal joining processes
- Describe the development of the fusion and heat-affected zones during welding
- Correlate the solidification behaviour and structure of weld zone with the welding parameters
- Understand the metallurgical compatibility in joining dissimilar metals and apply the suitable methods.
- Apply remedial measures to minimize defects in welding of steels and other alloys.

UNIT-I: Welding Processes

Introduction to the process of welding and applications. Classification of welding processes, Principles, advantages disadvantages and fields of application of the following welding processes: Gas Welding, MMAW, GTAW, GMAW, SAW, ESW, Plasma arc welding and resistance welding. Adhesive bonding. Principle, Advantages Disadvantages and Applications of Brazing & Soldering

UNIT-II: Solid-State welding and high energy density welding processes

Working principle. Advantages limitations and applications of Friction welding, Friction stir welding, Explosive welding, Diffusion welding and ultrasonic welding**.**

High energy density welding processes: Principle. Advantages limitations and applications of electron beam and laser beam welding processes

UNIT-III: Weldability concepts of ferrous and non-ferrous alloys

Weldability, Microstructure of fusion zone and heat affected zone, effect of heat input on microstructure and mechanical properties. Thermal and residual stresses, Weldability of carbon steel, cast irons, stainless steels. Importance of Schaffler and Delong diagrams. Welding of non-ferrous alloys -Typical welding problems in Aluminium alloys, weldability of Al-Cu alloys and weldability of copper-based alloys.

UNIT-IV: Dissimilar metal welding and Joining of Ceramics

Importance and applications of dissimilar metal welding, Challenges in welding of dissimilar metals, metallurgical compatibility, Heating process during dissimilar joining, weld dilution in dissimilar metal welding. Joining of ceramics: Properties of ceramics, Problems in joining ceramics, Metal/ceramic joining techniques-Active metal Brazing, Metallisation.

UNIT-V Defects and Quality testing of weldments:

Defects in weldments their causes, effects and remedies. Weld decay /sensitisation and knife line attack in Austenitic stainless steel, stress corrosion cracking, causes, effects and remedial measures. Hot cracking and cold cracking causes and remedies. Introduction to quality testing of weldments: Principle of dye penetrant test and Radiography.

Text Books:

1. Principles of welding ,Robert W. Messler,Jr. Wiley-VCH
2. Metallurgy of Welding, J. F. Lancaster
3. Parmer . R. S. " Welding Engineering and Technology", Khanna Publications

Reference Books:

1. R.S. Parmer: Welding Processes and Technology, Khanna Publishers
2. G. den Ouden M.J.M. Hermans,VSSD
3. Nadkarni S.V., "Modern Arc Welding Technology", Oxford IBH Publishers

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM611PE: Powder Metallurgy and Nanomaterials

Course Objectives:

- This course is designed to impart various principles of metal powder processing applied to fabrication of structural and commercial products.
- It is also intended to elucidate the process variables in powder metallurgy technology and develop concepts of intellectual thinking for future applications

Course Outcomes: This course creates a platform for students to develop a thorough understanding on
(At the conclusion of the course, the student will be able to have thorough understanding on)

- Powder Manufacturing techniques
- Powder characterization
- Powder consolidation
- Zero,oneand two dimensional nano structure
- Concepts of CVD and PVD

UNIT-I: Introduction

Importance and emergence of powder metallurgy Metal powder technology, comparison of powder metallurgy with other manufacturing techniques. Merits, limitations, and applications. Introduction, Importance of Nano-technology, Emergence of Nano-Technology
Powder Production methods: chemical reduction (tungsten, iron), carbonyl decomposition (iron, nickel, Evaporation and condensation growth), atomization (pure metal and multicomponent alloy powders), milling (oxides), and electrolysis (elemental powders of one dimensional nano powders). Micro emulsions and Aerosol

Homogeneous Nucleation & Growth and Heterogeneous nucleation and growth:

Powder Characterization

Determining powder characteristics: particle shape, size, size distribution (Sieve analysis, Fisher Sub sieve), specific surface area, apparent and tap density (Hall Flow meter), angle of repose, compressibility/compactibility. Influence of the manufacturing process on powder characteristics.

UNIT-II: Consolidation of Metal Powders-Compaction

Introduction and importance of Compaction**,** Die compaction, Single die and double die compaction. Theory of compaction: Pressure transmission in powders. Pressure dependence of densification. Green strength, Green Density.

UNIT-III: Consolidation of Metal Powders-Sintering

Introduction to Sintering, Mechanisms of solid state and liquid phase sintering. Effect of powder characteristics on compaction and sintering. Hot Pressing, Sinter forging. Cold isostatic pressing, Hot isostatic pressing.

UNIT-IV: Powder Metallurgy Products

I. Porous Parts: Filters, Self-lubricating bearings (CuSn). II.Dispersion strengthened materials: (Al_2O_3,Ni-ThO_2). III. Electrical materials - Tungsten lamp filaments, IV. Magnetic materials: Fe-Ni soft magnets, ALNICO and $SmCo_5$ permanent magnets. V. Cutting Tools: Cemented carbides (WC-Co). VI. Special Products: Heavy alloys (W-Ni-Fe).

UNIT-V: Nanomaterials:
Nano Wires, vapor-liquid-solid growth, Electro-phoretic deposition. Two dimensional Nano-Structures, Fundamentals of film growth. Physical vapour Deposition (PVD):Chemical Vapour Deposition (CVD):Thin films, Atomic layer deposition (ALD), Electrochemical deposition (ECD), Sol-Gel films

TEXTBOOK:

1. Powder metallurgy – Anil Kumar Sinha, Dhanpat Rai & Sons, NaiSarak, 110006, 1981
2. Nano structures and Nano materials: Synthesis, properties and applications - Guozhong CaoImperial College press in 2004, 2nd edition.
3. Text book of Nano Science and Technology, B S Murthy, Universities press-IIM series in Metallurgy and Material Science

REFERENCES:

1. Powder Metallurgy Science- Randall M German , Metal Powder Industries Federation, 1994 - Technology & Engineering ,USA,1994
2. Powder Metallurgy Science, Technology and Materials, Anish Upadhaya, GS Upadhaya, University Press, IIM, 2011
3. Introduction to powder metallurgy – J.S. HirshhornAmerican *Powder Metallurgy* Institute, Princeton NJ, 1969
4. Treatise on Powder metallurgy – Claus Guenther Goetzel Vol 1& II Interscience Publishers, 1950
5. Powder Metallurgy principles – Fritz V. Lenel , Princeton, 1986
6. ASM Handbook on Powder Metallurgy, Metals Park, Ohio, USA

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM612PE: Computational Materials Engineering

Course objectives:

- **Know the techniques used in Materials modeling**

Course Outcomes:

At the end of the course the student should be able to

- Know thermodynamic modelling and its role in Materials Genome
- Know phase field models and how they can be used
- Know the application of Python in Artificial Intelligence
- Know ML and apply it to predict materials property
- Know Artificial Neural Networks and apply it to predict constitutive behavior of metals

UNIT-I: Thermodynamic modelling

Materials Genome, Methodology of CALPHAD, Thermodynamic and properties databases, Properties that can be calculated, demo using The Open CALPHAD

UNIT-II: Phase field modelling

Fourier Transformation, Cahn-Hilliard equation, Diffuse interface, simulation of spinodal decomposition, demo using open source MicroSim software stack (https://github.com/ICME-India/MicroSim)

UNIT-III: Python for AI

Introduction to Python: strings, statements, functions; Arrays, NumPy, Pandas (numpy vs pandas), Crisp methodology, EDA Exploratory data analysis and visualizations(demo using cyclic oxidation as example), PCA

UNIT-IV:AI-Machine learning

Intro to ML, ML algorithms: Classification, Regression, Clustering; Decision trees and Ensemble models (bagging and boosting), Cross Validation, demo using ML for yield strength of HEAs

UNIT-V:AI-Artificial neural networks

Neuron, Activation functions, Feed forward back propagation, Multilayer networks, MATLAB for ANN, demo using ANN for constitutive behavior of metals,

Textbook, Web resources

1. https://thermocalc.com/about-us/methodology/the-calphad-methodology/
2. Qin and Bhadeshia, Materials Science and Technology, 26(2010) 803-811
3. Neural Networks and Learning Machines, S. Haykin, Prentice Hall Indian Pvt. Ltd.

References

1. Scikit-learn.org
2. https://thermocalc.com/about-us/methodology/the-calphad-methodology/

3. Materials Genomics: From CALPHAD to Flight, G.B. Olden and C.J. Kuehmann, Scripta Mater 2014https://doi.org/10.1016/j.scriptamat.2013.08.032
4. Sylvie Chatain, Jean-Louis Flèche, The CALPHAD approach applied to the fluorides compounds, COMO 2015

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM613PE: Fracture Mechanics and Failure Analysis

Course objectives:

-
- Gain an understanding of fundamentals of fracture mechanics, Griffith crack theory.
- Analyze the crack behavior in various conditions.
- Obtain a working knowledge of failure analysis.

Course Outcomes:

- Fundamental understanding of fracture mechanics.
- Awareness about crack formation and crack growth in materials under various conditions.
- Able to analyze and take remedial steps in case of failure by fracture.
- Gaining theoretical knowledge on different techniques to find properties of failure.
- Designing a material to withstand different loading and service conditions.

UNIT-I Introduction :

Stress and strain tensor; Principal stress and strain hypothesis, strain energy hypothesis; Fracture criteria, theoretical strength, stress-concentration factor;Effect of material properties on fracture, fractures mechanisms, modes of fracture,ductile to brittle transition, stress-corrosion cracking, fatigue, creep.

UNIT-II Energy Principles and Crack Behaviour :

Elastic crack tip stress field: the airy stress function, complex stress function, the effect of finite size crack, elliptical cracks; Crack tip deformation and plastic zone size, effective crack length: Energy release rate, criterion for crack growth, crack resistance (R); Dynamics and Crack arrest: crack speed and kinetic energy, dynamic stress intensity and elastic strain energy release rate, crack branching, principle and practice of crack arrest, dynamic fracture toughness.

UNIT-III Linear Elastic Fracture Mechanics:

Crack tip 2D and 3D fields, atomic view of fracture, Griffith theory, plane stress vs plane strain conditions; Stress intensity factor and stress concentration factor, energy release during crack propagation, compliance, stress and displacement field in isotropic elastic materials; Small scale yielding: Irwin plastic zone correction; Crack initiation at cavities and notches.

UNIT-IV Elastic-Plastic Fracture Mechanics:

Dugdale approach, Cohesive zone models, effect of plate thickness;J integral: concept, uses, measurement, limitations; Crack Tip Opening Displacement (CTOD), Relationship between CTOD, K and G, Equivalence between CTOD and J, Determination of CTOD

UNIT-V Fractography and Testing :

Fracture in materials: effect of alloying, processing, temperature, service conditions, anisotropy; Fractography: fracture surface characterization methods;Damage tolerance; Case studies

Text books:

1. Fracture Mechanics: Fundamentals and Applications, T.L. Anderson, CRC Press, Inc., 1995.
2. Fracture Mechanics, Dietmar Gross, Thomas Seelig, Springer, 2nd Edition, 2011.
3. Elementary Engineering Fracture Mechanics, David Broek, Scjtoff&Noordhoff, 1978.

Reference Books:

1. ASM Handbook: Fatigue and Fracture, S.R. Lampman, (Rechnical Ed.), ASM International, 1996.
2. Failure Analysis – R.W. Hertzberg, Deformation of Fracture Mechanics of Engineering Materials – John Wiley & Sons Publications, 1995.

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM621OE: Selection of Materials for Engineering Applications

Course Objectives:

This course aims at making student to understand and design a material for a given application considering the composition, manufacturing process and properties that are required in service.

- Knowledge of selection of materials and factors affecting them in design
- Role of microstructure processing and properties in design and selection of materials
- Design of and selection materials for high temperature applications based on mechanical properties
- Knowledge of materials selection for Nuclear applications
- Knowledge of special materials for specific applications

Course Outcomes: Student is able to

- Gain knowledge in different materials and factors affecting in selection of materials
- Analyse and co relate the structure, processing and properties of the components
- Select the materials for high temperature applications
- Select the materials for Nuclear applications
- Design and select smart materials for any applications

UNIT-I:

Introduction to Roles & Responsibilities of Materials Engineer; Introduction to Materials Selection, Criteria for selection of materials; Factors affecting the selection of materials; Introduction to Engineering Materials

UNIT-II:

Effect of composition, processing and structure on materials properties: Concepts in the Selection of industrial components

UNIT-III:

Properties vs Performance of materials: Aerospace, Space and defense applications: Selection based on LCF, TMF, Creep fatigue interaction, hot corrosion resistance, role of DBTT for Naval applications

UNIT-IV:

Nuclear Materials: Materials for fission and fusion reactors.
Nuclear applications: Radiation damage, effect of radiation damage on YS, UTS

UNIT-V:

Special Materials: Selection of ceramics, polymers and composites for aerospace and electronic applications

TEXT BOOKS

1. M.F. Ashby, Materials Selection in Mechanical Design, Pergamon Press, 1992
2. G.E. Dieter, Engineering Design, A Materials and Processing Approach, 2nd ed. McGraw-Hill, 1991
3. Material Selection and Design, Vol 20, ASM Hand Book, ASM International.

REFERENCES

1. T.H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 1990
2. J.R. Dixon and C. Poli, Engineering Design and Design for Manufacturing, Field Stone Publishers, 1995.

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B. Tech. in Metallurgical and Materials Engineering
VI Semester Syllabus
MM622OE: Metallurgy for Non Metallurgists

Course Objectives:

- To describe the basic principles of metallurgy and the importance of metallurgy in various disciplines of engineering.
- Gain thorough knowledge about heat treatment of steels.
- Gain knowledge about properties and uses of cast irons and non ferrous metals.
- Gain working knowledge of basic testing methods for metals.

Course Outcomes:

At the end of the course student will be able to:

- Classify steels and understand the different crystal structures of metals and defects.
- Establish heat treatment process – structure – properties correlation.
- Know the metallurgical and mechanical properties of various cast iron and their applications.
- Justify the choice of light metals and super alloys based on their properties.
- Evaluate the various mechanical properties in materials by different methods.
- Able to understand the areas and domains of metallurgy and materials.

UNIT-I:

Introduction: Crystal structure and defects, Crystal structure of metals, Classification of steels, Carbon steels.

UNIT-II:

Heat Treatment of Steels: The Iron carbon systems, Common phases in steels, Annealing, Normalizing, Hardening and tempering.

UNIT-III:

Cast irons: Properties and applications of Ductile irons, Malleable irons, Compacted graphite iron.

UNIT-IV:

Non Ferrous Metals: Properties and applications of Light Metals (Al, Be, Mg, Ti), Super alloys.

UNIT-V:

Testing of Metals: Hardness testing, Tensile Testing, Impact Testing, Fatigue Testing.

TEXT BOOKS:

1. Materials Science and Engineering: An introduction, 9th edition - William D. Callister Jr.,David G. Rethwisch, published by John Wiley, 2013.
2. Introduction to Physical Metallurgy, 2nd edition – Sidney H Avner, published by Tata McGraw-Hill ,1997.

Reference Books:

1. Engineering Physical Metallurgy, 1st Edition – Y Lakhtin, published by CBS Publishers &Distributors, 2005.
2. Experimental Techniques in Materials and Mechanics - C. Suryanarayana, CRC Press,2011.
3. Foundations of Materials Science and Engineering, 5th edition – William F. Smith Professor, Javad Hashemi Prof., published by Mc-Graw Hill, 2009.
4. Physical Metallurgy for Engineers, 2nd Edition - Donald Sherman Clark and Wilbur Richmond Varney, CBS Publishers, 1962.
5. Mechanical Metallurgy, 3rd Edition – George E. Dieter Published by Mc Graw Hill Education,2017.

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM651PC: Environmental Degradation of Materials Lab

Course Objectives

- Is to understand the Thermodynamic aspects of corrosion
- Is to understand the cathodic electrometallurgical processes through electroplating
- Is to understand various
- Is to understand principles of through different corrosion experiments

Course Outcomes

- To understand the influence of the process variables, Current Density, on current Efficiency
- To apply the concepts of Thermodynamics in corrosion process
- To gain hands on experience and principles on different corrosion processes
- To understand the influence of Environmental factors on corrosion process
- To gain knowledge on different methods to estimate the rate of corrosion

LIST OF EXPERIMENTS:

1. Study the effect of concentration and temperature on conductivity of an aqueous electrolyte.
2. Verification of Faraday‟s laws of electrolysis.
3. Determine the influence of cathodic current density on current efficiency by electroplating (Cu and Ni electroplating).
4. Determination of EMF of Common metals.
5. Determination of corrosion rate of common metals through weight loss technique.
6. Study the galvanic corrosion by constructing different galvanic couples.
7. To study the intergranular corrosion of Austenitic stainless steels.
8. Study the influence of coating on rate corrosion on steel samples.
9. Study the influence of Environmental effect (pH, Temperature, oxidizers, velocity) on rate of corrosion

List of equipment:

1. Rectifier
2. Ammeters
3. Rheostats
4. D C Regulated Power Supply instrument
5. Multimeters
6. Conductometers
7. Digital weighing balance
8. Potentiometers

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM652PC: Metal Joining Lab

Course Objective:

- This Laboratory course is designed to make the student to understand and demonstrate the various types Welding processes and its variables, testing methods and correlation between microstructure and Mechanical properties of the Welded joints.

Course Outcomes:

- Select process parameters by bead on plate trial.
- Gain knowledge in practical aspects of SMAW, GMAW and SAW
- Gain knowledge on welding of carbon steel,
- To carryout characterization and testing techniques for welded joints.

List of Experiments:

1. Study of gas welding equipment and process. Identification of flames, making Butt joint with gas welding.
2. Study of Arc welding process, comparison of the bead geometry with DCSP, DCRP and A.C.
3. Study of resistance spot welding process and plot the variation of spot area with time and current variation
4. Study of Tungsten Inert Gas (TIG) welding process and measurement of temperature during TIG welding process.
5. Study of fundamental aspects of Submerged Arc Welding (SAW) process and finding out deposition efficiency of the process.
6. Study of fundamental aspects of MIG welding process
7. To conduct tests on weld joints to evaluate the mechanical properties of the joints, like bend test and ram tensile test.
8. To evaluate the microstructure of welded joint and understand the structural difference in Weld zone, Heat Affected Zone and Base metal.

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EN651HS: Advanced English Communication Skills Laboratory

VI Semester Syllabus

(Common to CE, ECE, EEE, ME, MCT & MME)

Introduction:

The introduction of the Advanced English Communication Skills Lab is considered essential at the B.Tech 3rd year level. At this stage, the students need to prepare themselves for their career which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalized context.

The proposed course should be a laboratory course to enable students to use appropriate English and perform the following:

1. Gathering ideas and information to organize ideas relevantly and coherently.
2. Making oral presentations.
3. Writing formal letters.
4. Transferring information from non-verbal to verbal texts and vice-versa.
5. Writing project/research reports/technical reports.
6. Participating in group discussions.
7. Engaging in debates.
8. Facing interviews.
9. Taking part in social and professional communication.

Course Objectives:

This Lab focuses on using multi-media instruction for language development to meet the following targets:

1. Improve the students‟ fluency in English, with a focus on vocabulary.
2. Enable them to listen to English spoken at normal conversational speed by educated English speakers.
3. Respond appropriately in different socio-cultural and professional contexts.
4. Communicate their ideas relevantly and coherently in writing.
5. Prepare the students for placements.

Course Outcomes:

Students will be able to:

1. Enhance listening proficiency and reading comprehension and cultivate critical thinking ability.
2. Acquire essential vocabulary and develop strategic planning skills for effective technical writing and gain expertise in E-Correspondence and (N) etiquette.
3. Understand the nuances of oral skills (Speaking skills), gain competence in delivering effective presentations, employing suitable language and body language.
4. Communicate confidently in group discussions and enhance the employability skills of students.
5. Apply effective techniques and strategies for successful job interviews.

Syllabus:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Listening and Reading Comprehension:** Active Listening – Development of Listening Skills Through Audio clips - Benefits of Reading – Methods and Techniques of Reading – Basic Steps to Effective Reading – Common Obstacles – Discourse Markers or Linkers - Sub-skills of reading - Reading for facts, negative facts and Specific Details- Guessing Meanings from Context, Inferring Meaning - Critical Reading — Reading Comprehension – Exercises for Practice.
2. **Activities on Writing Skills**: Vocabulary for Competitive Examinations - Planning for Writing – Improving Writing Skills - Structure and presentation of different types of writing – Free Writing and Structured Writing - Letter Writing –Writing a Letter of Application –Resume vs. Curriculum Vitae – Writing a Résumé **–** Styles of Résumé - e-Correspondence – Emails – Blog Writing - (N)etiquette – Report Writing – Importance of Reports – Types and Formats of Reports– Technical Report Writing– Exercises for Practice.
3. **Activities on Presentation Skills –** Dealing with Glossophobia or stage fear, starting a conversation – responding appropriately and relevantly – using the right language and body language – Role Play in different situations including Seeking Clarification, Making a Request, Asking for and Refusing Permission, Participating in a Small Talk – Oral presentations (individual and group) through JAM sessions- PPTs – Importance of Presentation Skills – Planning, Preparing, Rehearsing and Making a Presentation - Understanding Nuances of Delivery - Presentations through Posters/Projects/Reports – Checklist for Making a Presentation and Rubrics of Evaluation.
4. **Activities on Group Discussion (GD):** Types of GD and GD as a part of a Selection Procedure - Dynamics of Group Discussion - myths and facts (Dos and Don‟ts) of GD - Intervention, Summarizing - Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas - GD Strategies – Exercises for Practice.
5. **Activities on Interview Skills**: Concept and Process - Interview Preparation Techniques - Types of Interview Questions – Pre-interview Planning, Opening Strategies, Answering Strategies - Interview Through Tele-conference & Video-conference - Mock Interviews.

Suggested Books:

1. Effective Technical Communication by M Ashraf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition.
2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

Reference Books:

1. Rizvi, M. Ashraf (2018). *Effective Technical Communication*. (2nded). McGraw Hill Education (India) Pvt. Ltd.
2. Suresh Kumar, E. (2015). *Engineering English.* Orient BlackSwan Pvt. Ltd.
3. Bailey, Stephen. (2018). Academic *Writing: A Handbook for International Students.* (5th Edition). Routledge.
4. Koneru, Aruna. (2016). *Professional Communication.* McGraw Hill Education (India) Pvt. Ltd.
5. Raman, Meenakshi & Sharma, Sangeeta. (2015). *Technical Communication, 3E: Principles and Practice.*Oxford University Press.
6. Anderson, Paul V. (2007). *Technical Communication***.** Cengage Learning Pvt. Ltd. New Delhi.
7. McCarthy, Michael; O‟Dell, Felicity & Redman, Stuart. (2017). *English Vocabulary in Use* Series. Cambridge University Press.
8. Sen, Leela. (2009). *Communication Skills.* PHI Learning Pvt Ltd., New Delhi.
9. Elbow, Peter. (1998). *Writing with Power.* Oxford University Press.
10. Goleman, Daniel. (2013). *Emotional Intelligence*: *Why it can matter more than IQ.* Bloomsbury Publishing.
11. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
12. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
13. How to Write and Speak Better, Reader‟s Digest, 2003.
14. TOEFL Reading & Writing Workout, The Princeton Review.
15. How to prepare for Group Discussions and Interviews by Harimohan Prasad and Rajneesh Prasad,TataMcgrawHill.
16. Keep Talking, Frederick Klippel, Cambridge University Press, South Asian edition (6 May 2010).
17. Objective English, Edgar Thorpe & Showick Thorpe, Pearson; 5th edition (1 August 2013).
18. Communication Skills for Engineers, Sunitha Mishra, C.Murali Krishna, Pearson; 4th Edition.

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MC601HS: Intellectual Property Rights

VI Semester Syllabus

(Common to CIVIL, MECH, ECE, MCT & MME)

Course Objectives: The objectives of the course are:

- To enable the students to have an overview of Intellectual Property Rights.
- To provide comprehensive knowledge to the students regarding Trademarks Registration process and law related to it.
- To disseminate knowledge on Copyrights, its related rights and recent developments.
- To make the students understand Patent Regime in India and abroad.
- To understand the framework of Trade secrets.

Course Outcomes: By the end of the course students shall:

- Gain knowledge on Intellectual property rights and their importance.
- Understand Indian and International Trademark Law and procedure for registration of Trademarks.
- Acquire knowledge on Copyright Law, and the privileges awarded to the copyright owners.
- Familiarized with the process of acquiring the patent and relevant laws.
- Learn the importance of trade secrets for business sustainability.

UNIT – I: INTRODUCTION TO INTELLECTUAL PROPERTY

Introduction of IPR-Meaning of intellectual property, types of intellectual property-trademarks, copyrights, patents, trade secrets, importance of intellectual property rights, International organizations-WTO-WIPO-USPTO-INTA, International Conventions, agencies and treaties- Paris Convention-Berne Convention- Madrid Protocol-NAFTA-PCT-GATT-TRIPS.

UNIT – II: TRADEMARKS

Trademarks: Purpose and functions of Trademarks-Categories of marks, acquisition of trademark rights - Protectable matter - Selecting and evaluating Trademark- Trademark registration process – Trademark Infringement - Remedies for infringement of Trademarks-New developments in Trademark Law- International Trademarks Law.

UNIT III: COPYRIGHT

Copyrights-Fundamentals of Copyright Law - Requirements of Copyrightability - Originality of material, fixation of material, Authorship works, exclusions from copyright protection-Rights of Copyright Owner-Right of reproduction of copyrighted work, right to do derivative works ,right to distribute copies of the copyrighted work, right to perform the work publicly, right to display the copyrighted work, – Copyright Ownership issues – Joint Works, Works made for Hire, Specially commissioned works, Copyright Registration - Notice of Copyright – Copyright Infringement - Remedies for infringement in Copyrights- New developments in Copyright Law- International Copyright Law.

UNIT IV: PATENTS

Concept of Patent - Classification – Utility Patents – Design Patents and Plant Patents, Patent searching process-Types of Patent Applications-Patent Registration Process, Ownership, Transfer, Assignment and Licensing of Patent-Patent Infringement, Remedies for Infringement of Patents, New developments in Patent Law- International Patent Law.

UNIT – V: TRADE SECRETS & LAW OF UNFAIR COMPETITION

Trade Secrets: Trade secret law, determination of trade secret status, measures for protecting trade secret - Liability for misappropriation of trade secrets, protection for submissions, trade secret litigation. New developments in Trade secrets Law - International Trade Secret law.

Law of Unfair Competition: Passing off, Misappropriation, Right of publicity, Dilution of trademarks, Product disparagement, False advertising, Internet Piracy.

TEXT BOOKS:

1. Deborah. E.Bouchoux, Intellectual property, Cengage learning India Pvt.Ltd., 4th edition, 2013.
2. Prabuddha Ganguli, Intellectual Property Right, Tata McGraw Hill Publishing Company, 8th edition, 2016.

REFERENCES

1. Richard Stim, Intellectual Property, Cengage learning India Pvt. Ltd. 3rd edition, 2017.
2. Vinod.V. Sope, Managing Intellectual Property, Asoka K. Ghosh, 2nd edition, 2010.

MC602ES – Cyber Security

VI Semester Syllabus

(Common to all branches except CSE, IT, CSBS)

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Course objectives:

- To familiarize various types of cyber-attacks and cyber-crimes
- To give an overview of the cyber laws
- To study the defensive techniques against these attacks

Course Outcomes:

- The students will be able to understand cyber-attacks, types of cybercrimes, cyber laws and how to protect them self and ultimately the entire Internet community from such attacks.

UNIT - I

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defence, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT - II

Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT - III

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

UNIT- IV

Cyber Security: Organizational Implications: Introduction cost of cybercrimes and IPR issues, web Threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.

Cybercrime and Cyber terrorism: Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

UNIT - V

Privacy Issues: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.

Cybercrime: Examples and Mini-Cases Examples: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket, e-mail spoofing instances.

Mini-Cases: The Indian Case of online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in Cyber Domain.

TEXT BOOKS:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer
   Forensics and Legal Perspectives, Wiley
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

REFERENCES:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.

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MC601BS: Environmental Science

VI - Semester Syllabus

(Common to all branches**)**

Course objectives:

- To understand the natural resources and their conservation.
- To understand the importance of ecosystem, biodiversity and ecological balance for sustainable development.
- To gain knowledge about environmental pollution, effects and controlling measures.
- To study about global environmental problems and global issues.
- To understand the environmental policies, regulations and sustainable development.

Course Outcomes:

After completing the course, the student will be able to:

- Learn about different types of natural resources and take up the measures to protect the resources.
- Get the information about ecosystem, biodiversity and their usage and conservation.
- Get the information about the types of pollution, understand their effects and controlling measures.
- Gain the knowledge about current global environmental issues and initiations to be taken to protect the environment.
- Gain the knowledge about environmental acts, EIA, sustainable development and follow the rules and regulations.

UNIT - I

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity.

UNIT – II Natural Resources:

Classification of Resources: Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and usingmineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

UNIT - III

Biodiversity and Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife

conflicts; conservation of biodiversity: In- Situ and Ex-situ conservation. National Biodiversity act.

UNIT - IV

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, **Air Pollution:** Primary and secondary pollutants, causes and effects, Ambient air quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Global Environmental Issues and Global Efforts: Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-GoI Initiatives.

UNIT - V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, biomedical waste management and handling rules, hazardous waste management and handling rules.

Environmental Impact of Assessment (EIA): structure, methods of baseline data acquisition. Concepts of Environmental Management Plan (EMP).

Towards Sustainable Future: Concept of Sustainable Development Goals, Population and its explosion, Environmental Education, Human health, Environmental Ethics, Concept of Green Building, Green chemistry principles, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

1 Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha forUniversity Grants Commission.
2 Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.

REFERENCE BOOKS:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHLLearning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHILearning Pvt. Ltd.
3. Environmental Studies by R. Rajagopalan, Oxford University Press.
4. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BSPublications.
6. Introduction to Environmental Science by Y. Anjaneyulu, BS. Publications.

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ME732PC: Introduction To Instrumentation
VII Semester Syllabus

Course Objectives:

At the end of this course students are expected to:

- Know the basic principles of Measurements, General measurement system and the working of Electronic Instruments
- Understand the construction, working, advantages, limitations and applications of Instruments used for measurement of Pressure
- Understand the construction, working, advantages, limitations and applications of Instruments used for measurement of Flow.
- Learn the principles of measurement of Vibration, Viscosity, Humidity and Level.
- Understand the working of Analyzers for measuring various parameters.

Course Outcomes:

After successful completion of the course, student will:

- Be familiar with the basic principles of Measurements, and the working of Electronic Instruments
- Be able to demonstrate the use of various measurement systems for the measurement of Pressure
- Be able to demonstrate the use of various measurement systems for the measurement of flow.
- Possess a reasonable level of competence in the use of different sensors/gauges for the measurement of Vibration, Viscosity, Humidity and Level.
- Choose a suitable analyzer for a given physical parameter measurement

UNIT - I

Electronic Instruments: CRO - Storage oscilloscope – Digital voltage meter (DVM) – Digital multi meter – XY recorder, Strip chart recorder – Digital recording- Data logger – Introduction to virtual instrumentation.

UNIT - II

Pressure Measurements: Unit of Pressure – Manometers- Different types, - Elastic type pressure gauges – Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionization gauge.

UNIT - III

Flow Measurements: Flow meters – Variable head type flow meter – Orifice plate – Venture tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rota meter – Mass flow meters.

UNIT - IV

Vibration, Viscosity, Humidity, Level Measurement: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer - Vibrometers – Viscosity – Saybolt viscometer. Humidity – Hot wire electro type hygro meter - Dew cell – Electrolysis type hygrometer.

UNIT - V

Analysers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyser – Sodium analyser – Silica analyser – Turbidity meter – Gas analyser – NOx analyser – H2S analyser – CO andCO2 monitor, Dust & Smoke measurement.

TEXT BOOKS:

1. Alan S. Morrris. Principles of Measurement and Instrumentation, Print ice-Hall of India Pvt.,Ltd. New Delhi, 1999
2. Ernest O Doeblin. Measurement Systems Application & Design, Tata McGraw Hill PublishingCo., New. Delhi, 1999

REFERENCE BOOKS:

1. Murthy, D.V.S. Transducers and Instrument and Instrumentation, Prentice Hall of India Pvt. Ltd. New Delhi.
2. Patranabir, D. Principle of Industrial Instrumentation, Tata McGraw Hill Publishing Co., New Delhi 1999.
3. Jain, R.K. Mechanical and Industrial Measurements, Khanna Publishing, New Delhi, 1999.
4. Liptak B.G. Instrumentation Engineers Hand Book (Measurement), Chilton Book Co., 1994

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B. Tech. in Metallurgical and Materials Engineering

VI Semester Syllabus

MM701PC: Non-Destructive Testing

Course Objectives:

The objective of the course is to introduce various non-destructive evaluation techniques applied to impact and test quality of manufacture products obtained by various manufacturing techniques such as welding, rolling, forging, casting, powder metallurgy etc. This subject also provides certification aspects of commercial products.

Course Outcomes:

This course paved a platform for students to develop a thorough understanding on the

1.Comprehend the basic principles of non-destructive testing (NDT) methods,
2.Identify suitable surface NDE methods for defect detection
3.Identifying the nature and quantifying the defects using radiography and electromagnetic induction
4.Interpret the defects in engineering components using ultra sonic testing
5.Understanding Advanced NDT Techniques

UNIT-I: Introduction

Importance of NDT, visual methods: Optical aids, In-situ metallography, Optical holographic methods, Leak detection.

UNIT-II: Penetrant flaw detection

Principles, Process, Penetrant systems, Liquid-penetrant materials, Emulsifiers, cleaners developers, sensitivity, Advantages, Limitations, Applications. Magnetic methods, Advantages, Limitations, Methods of generating fields, magnetic particles and suspending liquids Magnetography, field sensitive probes, applications. Measurement of metal properties.

UNIT-III: Radiographic methods

Limitations, Principles of radiography, sources of radiation, Ionising radiation - X-rays sources, Gama-rays sources Recording of radiation, Radiographic sensitivity, Fluoroscopic methods, special techniques, Radiation safety.

UNIT-IV: Ultrasonic testing of materials

Advantages, disadvantages, Applications, Generation of. Ultrasonic waves, general characteristics of ultrasonic waves, methods and instruments for ultrasonic materials testing, special techniques.

UNIT-V: Advanced NDT testing

Eddy current methods, Acoustic Emission methods, Infrared thermography, Phased Array Ultrasonic Technique (PAUT), Impact Echo Testing Technique, Remote Visual Inspection (RVI)

TEXT BOOKS:

1. Non-Destructive Testing by P. Halmshaw

2. Practical Non Destructive testing, Baldev Raj, T. Jayakumar, M. Thavasimuthu, Woodhead Publishing, 2002

REFERENCE BOOK:

1. ASM Metals Handbook, Nondestructive inspection and quality control

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM711PE: Additive Manufacturing of Materials

Course Objective

1. The course objective is to given fundamental knowledge on additive manufacturing methods, materials used for additive, and metallurgical aspects in additive manufacturing

Course Outcomes: By the end of the course student will be able to

1. Appreciate the advantages and limitations of additive manufacturing methods over conventional manufacturing methods
2. Gain knowledge on different materials and their properties used for Additive manufacturing along with tooling for additive manufacturing
3. Understand different additive manufacturing techniques
4. Gain knowledge on different necessary post-processing methods
5. Gain knowledge on different metallurgical aspects on Advanced Manufacturing products

Unit I: Introduction to Additive Manufacturing

- Overview of Additive Manufacturing
- Classification and comparison with conventional manufacturing
- Advantages and disadvantages
- Applications and CAD data considerations (STL format, data translation, loss)

Unit II: Materials for Additive Manufacturing

- Material forms: Liquid, Solid, Wire, and Powders
- Types of materials: Polymers, Metals, Non-Metals, Ceramics, Composites
- Preparation, properties, and support materials
- Equipment and tooling
- Process parameters and selection.

Unit III: Additive Manufacturing Techniques

- Binder Jetting: Process, materials, benefits, drawbacks, applications
- Sheet Lamination: Techniques, materials, applications
- Powder Bed Fusion: Process, powder preparation, fusion mechanisms, applications
- Directed Energy Deposition: Process, applications, materials.
- Wire Arc and Electron Beam Additive Manufacturing: Process, parameters, applications

Unit IV: Post-Processing of AM Parts

- Removal of support materials
- Improvements in surface texture, accuracy, aesthetics

- Property enhancements
- Post-Processing Techniques: Shot-peening, Heat treatment, Hot isostatic pressing

Unit V: Materials Science in AM of Metals

- Defects in AM processes
- Dislocations and strengthening mechanisms.
- Grain structure and solidification rate
- Phase transformations, heat treatment, and microstructure development
- Structure-property relationships.

Reference Books

1. "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing," by Ian Gibson, David W Rosen, Brent Stucker
2. "3D Printing and Additive Manufacturing: Principles & Applications," by Chua Chee Kai, Leong Kah Fai
3. "Rapid Prototyping: Laser-based and Other Technologies," by Patri K. Venuvinod and Weiyin Ma
4. "Additive Manufacturing," by AmitBandyopadhyay, Susmita Bose
5. "Additive Manufacturing: Principles, Technologies and Applications," by C.P Paul, A.N Jinoop
6. "Additive Manufacturing of Metals," by J.O. Milewski
7. "Additive Manufacturing Applications for Metals and Composites," by K.R. Balasubramanian, V. Senthilkumar

Online Resources

- National Institute of Standards and Technology on AM: NIST
- Metal AM Magazine: Metal-AM
- Additive Manufacturing Community: AM Basics
- 3D Printing Industry News: 3D Printing Industry
- Thingiverse for 3D Printing Designs: Thingiverse
- RepRap Open Source 3D Printing: RepRap

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM712PE: Design and Selection of Engineering Materials

Course Objectives:

This course aims at making student to understand and design a material for a given application considering the composition, manufacturing process and properties that are required in service.

1. Knowledge of selection of materials and factors affecting them in design
2. Role of microstructure processing and properties in design and selection of materials
3. Design of and selection materials for high temperature applications based on mechanical properties
4. Knowledge of materials selection for Nuclear applications
5. Knowledge of special materials for specific applications

Course Outcomes: Student is able to

- Gain knowledge in different materials and factors affecting in selection of materials
- Analyse and co relate the structure, processing and properties in designing the components
- Select the materials for high temperature applications
- Select the materials for Nuclear applications
- Design and select smart materials for any applications

UNIT-I: Introduction to Roles & Responsibilities of Materials Engineer

Introduction to Materials Selection, Criteria for selection of materials; Factors affecting the selection of materials; Introduction to Engineering Materials.

UNIT-II: Effect of composition, processing and structure on materials properties

Concepts in the design of industrial components

UNIT-III: Properties vs Performance of materials

Aerospace and defense applications: design and alloy Selection based on LCF, TMF, Creep fatigue interaction, hot corrosion resistance, role of DBTT for Naval applications, Intermetallics, Aluminides

UNIT-IV: Nuclear Materials

Design aspects of materials for fission and fusion reactors. Nuclear applications: Radiation damage, effect of radiation damage on YS, UTS, DBTT

UNIT-V: Special Materials

Manufacturing aspects w.r.to design. Selection and design of ceramics composites and polymers for specific applications

TEXTBOOKS

3. M.F. Ashby, Materials Selection in Mechanical Design, Pergamon Press, 1992
4. G.E. Dieter, Engineering Design, A Materials and Processing Approach, 2nd ed. McGraw-Hill, 1991
4. Material Selection and Design, Vol 20, ASM Hand Book, ASM International.

REFERENCES

3. T.H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 1990
4. J.R. Dixon and C. Poli, Engineering Design and Design for Manufacturing, Field Stone Publishers, 1995.

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM713PE: Materials Data Science and Informatics

Course objectives:

1. Solve materials and metallurgical problems through data analytics and data science

Course Outcomes:

At the end of the course the student should be able to

1. Understand data and informatics
2. Know the basics of Python language
3. Know the Data science approach and visualize metallurgical data
4. Know data analysis and model development using data
5. Know model evaluation and exploration

UNIT-I:

Introduction to data science, types of data, variables and their types, scale of measurement, Examples with materials data. Materials data science and its needs in industry and materials research perspective. Concept of materials informatics, Material Discovery and Development, History of Materials Development Cycles, Need for accelerated materials development and deployment. Materials Innovation and Ecosystem. Big Data.

UNIT–II:

Getting Python, white space formatting, modules, arithmetic, functions, strings, exceptions, lists, tuples, dictionaries, defaultdist, counter, sets, control flow, truthiness, sorting, list comprehensions, generators and iterators, randomness, regular expressions, object-oriented programming, functional tools, enumerate, zip and argument unpacking, args and kwargs

UNIT-III:

Data Science approach: Terminology and Components of Data Science, Getting and Cleaning Data, Data Statistics, Descriptive and Inferential Statistics, Event Space, Probability, Distributions and Hypothesis Testing Summarizing and Visualizing Data: Example with a material and metallurgical data.

UNIT–IV:

Univariate and Multivariate Exploratory Data Analysis. Feature extraction and feature selection. Simple example with materials data. Model development using data, learning algorithms: supervise, unsupervised and reinforcement learning, tools, and techniques. Functional mapping, Classification, and pattern recognition, rule base model etc.

UNIT–V:

Data Pre-processing, Model Evaluation and Ensembles. Stages of data science approach of problem solving, Descriptive, diagnostic, predictive and prescriptive analytics of materials data. Example with industrial and laboratory data. Structure-Property Linkages using a Data Science Approach, exploring new materials space using data science informatics.

TEXT BOOKS

1. Joel Grus, Data science from scratch, O‟Reilly Media, USA, First edition, 2
2. Krishna Rajan (Ed), Elsevier, Informatics for Materials Science and Engineering. Data-driven Discovery for Accelerated Experimentation and Application, Elsevier, First Edition, 2013.

Reference Books

1. Web resource: https://www.coursera.org/learn/material-informatics
2. AmitKonar, Computational Intelligence: principles, techniques and application, Springer, NY, First Edition 2007.

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM714PE: Introduction to Numerical Analysis

Course objectives:

1. This course introduces the numerical analysis, which is the backbone of Computational Materials Engineering

Course Outcomes:

At the end of the course the student should be able to

1. Understand interpolation and curve fitting
2. Understand numerical differentiation and integration
3. Solve algebraic and transcendental equations
4. Find roots of polynomial equations
5. Find Eigen values and Eigen vectors

UNIT-I:

Approximations and errors in computation, finite differences-divided differences, Newton-Gregory forward and backward interpolation formulae, Newtons divided difference interpolation, Lagrange‟s interpolation, inverse interpolation, curve fitting by the method of least squares, linear and quadratic curve fitting.

UNIT-II:

Numerical differentiation and numerical integration, trapezoidal and Simpsons rules, numerical double integration. Numerical solution of initial value problems in ordinary differential equations by Taylors series method, modified Eulers method, Runge-Kutta methods of second and fourth orders, predictor-corrector method, Adams Bashforth and Adams Moultan methods.

UNIT-III:

Numerical solution of algebraic and transcendental equations, rate of convergence and condition of convergence, Methods of ordinary iteration, Regula-falsi and Newton-Raphson methods

UNIT-IV:

Multiple roots of polynomial equations by generalized Newtons method, Solution of systems of linear equations by Newton-Raphson method. Solution of systems of linear equations, Gauss-Jacobi, Gauss-Seidel and relaxation methods

UNIT-V:

Eigen values and eigenvectors, finding the largest eigen value by power method. Solving difference equations with constant coefficients

TEXT BOOKS:

1. Richard L. Burden and J. Douglas Faires, Numerical Analysis - Theory and Applications, Cengage Learning, Singapore.

2. S.S. Sastry, Introductory Methods of Numerical Analysis, Fourth Edition, Prentice-Hall, India.

References

1. David Kincaid and Ward Cheney, Numerical Analysis - Mathematics of Scientific Computing, American Mathematical Society, Providence, Rhode Island.

2. Kendall E. Atkinson, An Introduction to Numerical Analysis, Wiley India.

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B. Tech. in Metallurgical and Materials Engineering
VII Semester Syllabus

MM715PE: Automotive Materials

Course Objectives:

- Knowledge on properties of engineering materials
- To select suitable materials for design
- Materials selection criteria for engine and transmission systems
- Different materials used for automotive structures.
- Different electronic materials for automotive applications

Course Outcomes: The student will be able to:

- Gain knowledge on Selection criteria of materials based on design charts and functional requirements
- Understand the Selection criteria for various components and importance.
- Understand different materials used for automotive engines and transmission.
- Select proper material for Automobile applications
- Understand different materials used for sensors in a vehicle

UNIT I: Basis for Material Selection for Automotive Applications

Selection strategy, Attribute limits and Material indices, structural index. Selection procedure: understanding material properties using materials selection charts, Design process - types of design, design requirements, Function, Material attributes, Shape and Manufacturing processes. Systematic process selection, Energy consumption for production, Material costs, Availability, Recyclability. Environmental consideration: Materials and the environment-selection of materials.

UNIT II: Materials for Automotive Body

Introduction to nomenclature of automotive body components. Property requirements for different components of automotive body structure. Selection of materials based on required properties for automotive structures – steels, Al alloys, Mg Alloys, Composite materials. Challenges in forming automotive materials.

UNIT III: Materials for Engines and Transmission Systems

Materials selection for IC engines: Material Selection criteria of Piston, piston rings, cylinder, Engine block, connecting rod, Crank shaft, Fly wheels, Gear box, Gears, and Clutches.

UNIT-IV: Materials for Automotive Structures

Materials selection criteria for bearings, leaf springs, chassis & frames, shock absorbers, brake shoes, and Disc.

UNIT-V: Electronic Materials for Automotive Applications

Materials for sensors and electronic devices meant for Engine Speed and Crank Position, Manifold Absolute Pressure, Temperature Sensor, Oxygen Sensor, Piezoelectric Sensor, Ultrasonic Sensor, and Dew Sensor. Sensor Materials and Technologies.

TEXT BOOKS:

1. Gladius Lewis, "Selection of Engineering Materials", Prentice Hall Inc. New Jersey USA, 1995.
2. Hiroshi Yamagata," The Science and Technology of Materials in Automotive Engines", Woodhead Publishing,2005

REFERENCES:

1. ASM Handbook. "Materials Selection and Design", Vol. 20- ASM Metals Park Ohio.USA, 1997.
2. ASM Handbook, "Selection of Materials Vol. 1 and 2", ASM Metals Park, Ohio. USA, 1991.
3. Cantor," Automotive Engineering: Lightweight, Functional, and Novel Materials", Taylor & Francis Group, London, 2006
4. James A. Jacobs, Thomas F. Kilduff., "Engineering Materials Technology: Structure, Processing, Properties & Selection", Prentice Hall, USA, 1996. 5. M F Ashby, "Materials Selection in Mechanical Design", third edition, Butterworth- Heineman, New York, 2005.

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM716PE: Structural Ceramics and Composites

Course Objectives:

1. To provide in depth knowledge on processing ceramic materials including structure, properties, phase transformations, applications, and fabrication methods
2. To describe key processing techniques for producing metal-, ceramic-, and polymer-matrix composites.

Course Outcomes:

1. Knowledge of the structures of a wide range of composite materials.
2. Able to explain how common fibers are produced and how the properties of the fibers are related to the internal structure.
3. Can demonstrate the relationship among synthesis, processing, and properties in composite materials.
4. To compare ceramics and understand their superiority over metals and other materials in some specific and critical applications.
5. Understanding various manufacturing techniques of ceramic materials.

UNIT–I: Introduction and Crystal structures

Definition, Classification of Ceramics, Traditional Ceramics, Structural Ceramics, Ceramic super conductors. Crystal structures in Ceramics, Grouping of ions and Pouling‟s rules, Glass formation, Equilibrium Diagrams of ceramic systems: Two component systems like Al_2O_3 – SiO_2 and BaO – TiO_2; and Three component systems MgO – Al_2O_3 – SiO_2.

UNIT–II: Ceramic Processing Techniques:

Hot Pressing, Hot Isostatic Pressing, (HIP). Spark Plasma Sintering. Sintering, Sinter / HIP, Injection moulding, Slip casting, Tape casting, Gel casting, Extrusion.

UNIT–III: Introduction

Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement and matrix. Types of reinforcements and their properties: Fibers: Carbon, Boron, Glass, Aramid, Al_2O_3, SiC; Nature and manufacture of glass, carbon and aramid fibres, Comparison of fibres. Rule of mixtures.

UNIT–IV: Applications, advantages:

limitations and manufacturing of polymer matrix, ceramic matrix, metal matrix composites. Micromechanics of Composites: Density, Mechanical Properties: Prediction of Elastic constants, Micro mechanical approach, Halpin-Tsai equations, Transverse stresses; Thermal properties: Hydrothermal stresses and Mechanics of Load transfer from matrix to fiber.

UNIT–V: Advanced Ceramics

Graphene, graphite, diamond like carbon, activated carbons, carbides and nitrides for extreme environment (aerospace and nuclear), $BaTiO_3$, transparent conducting oxides ($12CaO.7Al_2O_3$); Advanced Composites: high performance thermoplastic matrices, ballistic composites, non-automotive composites.

TEXTS BOOKS:

1. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt. 1997.
2. Introduction to Ceramics, W.D. Kingery et al, John Wiley
3. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCE BOOKS:

1. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993.
2. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman & Hall, London, 1994.
3. Fundamentals of Ceramics, M W Barsoum
4. Ceramic Science and Technology, Vol. 2 Material Selection and Properties Ed., Ralf Riedeland I, Wei Chen, Wiely, VCH

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B. Tech. in Metallurgical and Materials Engineering
VII Semester Syllabus
MM717PE: Aerospace Materials

Course Objectives:
This course is primarily instructed to make the students

1. understand the significance of aerospace engineering
2. distinguish materials for application in aerospace
3. gain knowledge on the characterization of aerospace materials
4. recommend a specific material for aerospace application
5. formulate design of treatments for various metallic alloys for aerospace applications

Course Outcomes:
At the conclusion of the course, the student will be able to

1. distinguish aerospace materials from the variety of materials
2. understand the failure mechanism of aerospace components
3. recommend the heat treatment to be employed for a particular aerospace material
4. characterize the material for aerospace application

UNIT-I: Introduction to aerospace Materials

Definition, Classification, Functional requirements and selection criteria of aerospace materials, mechanical behavior, characterization, and possible causes for failure of materials in aerospace applications. Detection of defects in aerospace components.

UNIT-II: Nonferrous materials in aerospace

Aluminum and its alloys: Properties and Classification, Heat treatment processes, Surface treatments. Magnesium and its Alloys: Properties, classification, specific applications, fabrication problems, special treatments. Titanium and its alloys: Properties and microstructural features of titanium base alloys for aerospace applications.

UNIT-III: Ferrous Alloys in Aerospace

Steels: Specifications of aircraft steels, classification, corrosion and heat resistant steels, maraging steels: Properties, fabrication, and applications. Welding and heat treatment of steels for structural aerospace applications.

UNIT-IV: Nonmetallic materials in aerospace:

Ceramics and Composites: Conventional ceramic materials, cermets, glass ceramics, Composite Materials: Metal matrix and polymer matrix composite materials, carbon-carbon composite materials, fabrication processes of composite materials.

UNIT-V: Special Materials for aerospace applications:

Superalloys: Introduction and Classification, Properties of Nickel, Iron, and Cobalt base Superalloys. Thermomechanical treatments employed on various superalloys for their applicability in aerospace.

TEXT BOOKS:

1. Aircraft Material and Processes Titterton G F Lienhard V English Book Store, New Delhi 5th Ed.,1998

2. Advanced Aerospace Materials H Buhl Springer, Berlin 1992

Reference Books

1 Aerospace material Balram Gupta S Chand & Co 2009

2 Materials for Missiles and Space ParkerERMcGraw-Hill 1963

3. The Materials of Aircraft Construction HillFT Pitman London 1937

4. Handbook of Aircraft materials C G Krishnadas Nair Interline publishers 1993

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM718PE: Artificial Intelligence in Materials Engineering

Course objectives:

1. Know AI and its application in Materials Engineering

Course Outcomes:

At the end of the course the student should be able to

1. Know Artificial Intelligence
2. Know fundamentals of artificial neural networks
3. Solve a materials problem using artificial neural networks
4. Know genetic algorithms and its application in materials engineering
5. Know data mining and Fuzzy logic its application in materials engineering

UNIT-I: Introduction to artificial intelligence and machine learning

History, Philosophy, and Definitions of AI, The Foundation of AI, correlation between materials structure, properties, phenomena, and process. Scope of solving industrial and research-based materials problem using AI. Role of AI in solving materials science problems. Accelerating Materials Development and Deployment.

UNIT-II: Fundamental of Artificial neural network

Basic elements and principles, types, etc. Supervise unsupervised and reinforcement learning. Back propagation algorithm, hyper parameters loss function transfer function and optimization algorithms, recent development, and deep learning.

UNIT-III

Applications and examples of artificial neural network in solving materials problem

Structure properties linking, process property linking. Artificial neural network in MATLAB, Activation functions, splitting data into train, validation and test data, performance criteria, demo of ANN for constitutive behavior of metals

UNIT–IV: Framing a material problem as optimization search problem

Classical and heuristic search. Local and global search, Genetic Algorithms as AI based search tool, single and multi-criteria search, constraints etc. Example study with solving the blast furnace operation-based problem /coiling temperature in Hot strip mill, design of steel and alloys.

UNIT–V: Reasoning and Association rule mining for solving materials problem

Decision trees, fuzzy logic and reasoning, fuzzy set, fuzziness in materials systems, a fuzzy variable with metallurgical examples, fuzzy inference system case example of fuzzy modelling materials problem solving. Rough set theory and its applications in alloy design. Hybrid system and their application in materials with examples of more complex problems

TEXT BOOKS

1. Dan W. Patterson, Introduction to AI & Expert System, PHI, First Edition, 2015.

2. Russel&Norvig, Artificial Intelligence: A Modern Approach, Pearson Education, by Stuart Russell and Peter Norvig. Cahn, Fourth edition, 2019

3. Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-Graw Hill, 2nd Edition 1991.

4. RajalingappaShanmugamani, Deep learning for Computer Vision, Packt Publication, Mumbai India, First Edition, 2018.

5. S. Haykin, Neural Networks; a comprehensive foundation, Prentice-Hall India Pvt Ltd. 2nd edition 2003.

Reference Books

1. Neuro-Fuzzy and Soft Computing: A computational approach to learning and machine intelligence, Indian Edition, Prentice Hall, USA 1997.

2. David E. Goldberg, Genetic Algorithms in search of optimization and machine Learning, Pearson Education Inc. Fifth Indian Reprint, 2002

3. Luger Artificial Intelligence, Pearson Education India; 5th edition, 2008.

4. S. Rajasekaran, G.A.V. Pai: Neural networks, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice-Hall of India.

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B. Tech. in Metallurgical and Materials Engineering
VII Semester Syllabus
MM719PE: Radar and Stealth Materials

Course Objective: This subject is formulated

1. To introduce fundamentals of radar technology
2. To induct knowledge on radar materials and developments

Course Outcomes: At the end of the course the student will be able to

1. Understand the properties to be considered for radar materials
2. To know the fundamentals of stealth and electronics
3. Understand the concepts in development of radar materials
4. Select the appropriate materials for different radar technologies.
5. Understand physics behind radar and improve the stealth capabilities

UNIT-I Introduction

Introduction, importance of stealth, stealth: radar cross-section reduction (RCS): shape, materials, Radar types: basic elements, continues wave radar, pulsed wave rader, L band surveillance, airborne Interceptor, active missile seeker; Discrimination: range, angle, doppler; radar frequency bands, radar detectors, antennas.

UNIT-II: Physics (Scattering and Absorption)

Electromagnetic waves-matter interactions, wave equations, maxwell equations, waves at boundaries; Scattering regimes: low frequency, resonant region, high frequency optics, Stratton-Chu equations of scattered field, surface waves; Radar absorber measurement techniques: transmission line theory and measurements, free space methods (NRL Arch, RCS), large waveguides, interferometers, admittance tunnel.

UNIT-III: Radar absorbing Materials

Graded interfaces-impedance matching absorbers (Dielectric): pyramidal, tapered loading, matching layer; Resonant and broadband absorbers; Surface wave absorbing materials, structural absorbing materials, Circuit analog radar absorbing materials (RAM), magnetic RAM, adaptive RAM; Carbon nanotubes, metal and metal particles, conducting polymers, polypyrrole, polyaniline, foam, tubules and filaments, chiral materials, shielding, Camouflage nets.

UNIT-IV: Techniques for optimization of radar absorption

The Dallenbach layer, Salisburry screen, Jaumann layers: maximally flat design, Tschebyscheff (Equal-Ripple) design, Gradient methods, genetic algorithm, finite element method, Taguchi method.

UNIT-V: Future

Electrically conducting fabrics, natural fibres, polymer matrix composites, polystyrene-block-polybutadiene-block-polystyrene (SBS), polystyrene-block-poly(ethylene-ran-butylene)-block-polystyrene copolymers (SEBS), ferrites, NiFe particles, Fe_3O_4/Carbon Nanotubes (CNT) in PMMA, interconnected $CoFe_2O_4$/multiwalled carbon nanotubes,

TEXT BOOKS:

1. Radar Absorbing Materials – Mechanisms and Materials, Kevin Gaylor, Published by DSTO Materials Research Laboratory, 1989
2. Fabrication of Organic Radar Absorbing Materials, Paul Saville, Trisha Huber, Darren Makeiff, Defence R&D Canada, 2015
3. Radar Cross Section, EF Knott, JF Shaeffer, MT Tuley, SciTech Publishers, 2nd edition, 2004

REFERENCES:

1. Radar Absorbing Materials, KJ Vinoy, RM Jha, 1st edition, Kluwer Academic Publishers, Springer, 1996.

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B. Tech. in Metallurgical and Materials Engineering

VII Semester Syllabus

MM721OE: Testing of Materials

Course Objectives:

1. To gain an understanding of the response of various metals under the application of stress and/or temperature.
2. To build necessary theoretical background of the role of lattice defects in governing both elastic and plastic properties of metals will be discussed.
3. Obtain a working knowledge of various hardness testing machines
4. Obtain a working knowledge of creep and fatigue and analysis of data.

Course Outcomes:

1. Classify mechanical testing of ferrous and non-ferrous metals and alloys.
2. Recognize the importance of crystal defects including dislocations in plastic deformation.
3. Identify the testing methods for obtaining strength and hardness.
4. Examine the mechanisms of materials failure through fatigue and creep

UNIT-I: Hardness and Impact Test

Introduction, Importance of testing Hardness Test: Methods of hardness testing – Brinell, Vickers, Rockwell hardness tests. The Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, fracture toughness testing - COD and CTOD tests, significance of transition temperature curve, Metallurgical factors affecting Transition Temperature.

UNIT-II: The Tension Test

The Tension Test: Engineering stress-strain and True stress-strain curves. Tensile properties, conditions for necking. Relationship between True stress and Engineering Stress, True Strain and Engineering strain ,Toughness, Resilience, Stress-Strain diagrams for steel, Aluminum and cast iron. Compression Test.

UNIT-III: Fatigue Test

Introduction, Stress cycles, S-N Curve, Effect of mean stress, Fatigue limit, Mechanism of fatigue failure, Effect of stress concentration, size effect, Metallurgical Factors affecting Fatigue life, surface condition and environments on fatigue

UNIT- IV: Creep and Stress Rupture

Introduction, High Temperature problem, The creep curve, Stress-rupture test, Structural changes during creep, Mechanism of creep deformation, Deformation Mechanism Maps, theories of creep. High Temperature alloys, Fracture at elevated temperature.

UNIT-V NDT

Introduction to NDT: Principle, Operation, Advantages and Limitations of Liquid Penetrant, Types of Penetrants, Function of Developer, Steps in Liquid Penetrant Test

Principle, Operation, Advantages and Limitations of Magnetic Particle Test, Methods of magnetisation,LongitudinalMagnetisation,Circularmagnetisation,Demagnetisation methods
Principle, Operation, Advantages and Limitations of Radiography, characteristics of X-Rays and Gamma rays, Radiographic film, Processing of Radiographic film, contrast ,sharpness of Radiographic film
Principle, Operation, Advantages and Limitations of Ultrasonic testing, pulse echo method.

TEXT BOOKS:

1. Mechanical Metallurgy – G. E. Dieter, Third edition, published by New York Mc GrawHill,1986.
2. Mechanical Behaviour of Metals, Meyers and Chawla.
3. Mechanical behavior - Ed. Wulf.

Reference Books:

1. Mechanical Metallurgy – White & Lemay.
2. Testing of Metallic Materials - A.V.K. Suryanarayana

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B. Tech. in Metallurgical and Materials Engineering
VII Semester Syllabus
MM722OE: Corrosion Engineering

Course Objectives:

- Tofamiliarizethestudentwiththeextentandimportanceofmaterialdegradation.
- To study various aspects of corrosion of materials and its control.

Course Outcomes:

After completing this course, the student should be able to

1. To understand the fundamentals of electrometallurgical principles and their application to various electrometallurgical processes
2. Understanding the thermodynamic and Kinetics of Corrosion processes
3. To understand and appreciate different forms of corrosion, characteristic features and their mechanism
4. To understand corrosion preventive measures and apply specific preventive measures based on the cause for the corrosion
5. To understand the effect and mechanism of environment on the degradation of composite and polymeric materials

UNIT-I: Fundamentals of electrochemistry and corrosion

Introduction to Corrosion Engineering, Fundamental Definition of Corrosion, Importance of corrosion studies, cost of corrosion. Review of electrochemical Principles–Classification of electrochemical processes, Characteristics of Electrolytic solutions, Faraday‟s Laws of Electrolysis. Electrode Potential and its determination. Primary and Secondary electrodes, Electrochemical aspects of Corrosion.

Unit-II: Thermodynamic and Kinetic Concepts of corrosion

Thermodynamics of Corrosion: Thermodynamic concepts of Corrosion and Free Energy relation. Reversible and Irreversible electrode potentials, EMF series – its applications and limitations. Nernst Equation – Derivation and its application to the concepts of Corrosion. Study of the Pourbaix diagrams. Concept of Exchange current density.

Kinetics of Corrosion: over potential & polarization–Hydrogen and Oxygen potential. Classification of polarization –Activation Polarization, Concentration Polarization, Resistance Polarization, and combined Polarization. Mixed Potential Theory and Tafel equations. Corrosion rate measurement by weight loss methods, Tafel‟s extrapolation method, and Linear Polarization resistance (LPR). Study the concept of Passivity.

UNIT-III: Forms of Corrosion–I

ASM Classification, Characteristic features, Mechanism, Factors influencing, and remedial measures of Uniform corrosion, Galvanic Corrosion, Crevice Corrosion, Pitting Corrosion.

UNIT-IV: Forms of Corrosion-II

Intergranular Corrosion, Erosion Corrosion, Selective leaching, Stress Corrosion Cracking, Hydrogen Embrittlement.

UNIT-V: Corrosion Prevention:

Materials selection, Alteration of Environment, Design Aspects, Inhibitors, Cathodic and anodic protection, Coatings –Organic and Inorganic Coatings

TEXT BOOKS:

1. Corrosion Engineering, Mars.G.Fontana,McGrawHillEducation,2017

2. Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R. Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

Reference Books:

1. Corrosion: Metal/Environment Reactions, Volume1, L. L. Shreir, R. A. Jarman, G. T. Burstein, Butterworth-Heinemann, 1994.

2. Principles and Prevention of Corrosion, Denny A. Jones, Pearson,1995.

B. Tech. in Metallurgical and Materials Engineering

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VII Semester Syllabus

MM752PC: Designing of Engineering Components Laboratory

Course Objective:

1. This Laboratory course is designed to make the student to understand and demonstrate
2. This lab course is mainly designed to provide hands on practice on the Designing of engineering components using Solid works

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand importance of 3D model software
2. Understand Solidworks 3D software
3. Create solid models
4. Create Casting 3D model
5. Create forging 3D model

LIST OF EXPERIMENTS:

1. Introduction to Solid works software
2. Basic understanding of component drawings
3. Creation of Sketch (2D) using planar face
4. Creation of EXTRUDE, CUTEXTRUDE, SHELL, REVOLVE, HOLE
5. Creation of CHAMFER, FILLET, LOFT, SWEEP, RIB
6. Creation of Rectangle, Square and Hexagon, Ellipse shapes
7. Creation of Angle mate, parallel and perpendicular mates, Coincident mate, ConcentricMate
8. Creation of ConcentricMate, Symmetry mate, Distance mate, Tangent mate
9. Creation of a casting and Forging 3D model.

Equipment:

1. Solid works software
2. Computers

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B. Tech. in Metallurgical and Materials Engineering

VIII Semester Syllabus

MM811PE: Advanced Materials

Course objectives:

1. This course has a prime objective of educating the students in such a way that the student will have an opportunity to study all significant materials under one umbrella. The Classification, manufacture and applications of these materials are dealt in detail.

Course Outcomes:

Through this course, the student will be able

1. Fundamentals of Nano materials, CCC, Cermets
2. Understand the structure, properties and applications of Intermetallic Compounds
3. KnowBiomaterials, Functionally Gradient Materials and Shape Memory Alloys
4. Know the processing and applications of Refractory metals and Cermets
5. Design an advanced system / component with the knowledge acquired through this course.

UNIT-I: Nanomaterials

Introduction–Classification of Nanomaterials, synthesis methods.

Carbon- Carbon Composites: Introduction, Preparation of carbon fibres, Reinforcement performs, knitting, braiding, weaving, filament winding, helical winding, polar winding. Making of carbon-carbon composites advantages and disadvantages, Properties and Application.

UNIT-II: Intermetallic Compounds

Introduction, Types of Intermetallic compounds, Ni-Al, Fe-Al, and Ti-Al system, Preparation, properties and Application of Intermetallic compounds.

UNIT-III: Biomaterials

Properties of Biomaterials, Metallic biomaterials: Stainless steels, Cobalt and Titanium based materials. Polymers and Ceramics.

UNIT-IV: Functionally Gradient Materials (FGM)

Classification of FGMS, Preparations, Properties and Applications of different FGM system.

Shape Memory Alloys (SMA): Introduction, shape memory effect, classification of shape memory alloys, Composition, Properties and Application of SMAs.

UNIT-V: Cermets

Introduction. Classification. Fabrication, techniques, Bonding and microstructure, Oxide cermets, Carbide and Carbonitride cermets, and Steel-bonded cermet: Properties and Applications.

Refractory Metals and Alloys: Introduction, Manufacturing, Preparations, Properties and Application of W,Mo, Nb, Ta, Re

TEXTBOOKS:

1. Materials Science and Technology – RW Cahn.
2. Wiley Interscience : Book Home – Hand Book of Advanced Materials.

REFERENCES:

1. High Temperature Materials-1 E Campbell
2. Advanced materials : Refractory fibres, fibrous metals, composites – Charles Zigniew Carroll-Porczynski.
3. ASM Metals Hand Book Vol 1 & Vol.2
4. Handbook of advanced materials : enabling new designs – James K. Wessel.

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B. Tech. in Metallurgical and Materials Engineering

VIII Semester Syllabus

MM812PE: Advanced Manufacturing Technologies

Course Objective:

1. This course aims at making student to understand and design a material for a given application considering the composition, manufacturing process and properties that are required in service.

Course Outcomes: At the conclusion of this course, the student will be able to

1. Understand various manufacturing technologies for different materials.
2. Correlate between manufacturing technology and the characteristics of Materials.
3. Understand the relationship between materials selection and applications.
4. Understand the relationship between manufacturing process and applications
5. Design the appropriate criteria to facilitate the manufacturing technology suiting to the service environment.

UNIT–I: Introduction

Background of various Manufacturing Technologies; Identification of processing parameters: Dynamic materials modelling and definition, safe processing zones, identification of safe window of processing.

UNIT–II: Advanced Metalworking Processes

A holistic approach on Metalworking processes; Bulk deformation process: Isothermal forging, disc, ring rolling, incremental forging. Severe Plastic Deformation Processes: Introduction, Classification, Principles and procedures involved; Design parameters; necessary equipment; Advantages and Limitations; Applications.

UNIT-III: Advanced Metal Powder Technologies

Significance of metal powder technology in manufacturing engineering; classifications, advances in metal powder techniques: Spray forming, Cold and Hot Isostatic Pressing (HIP), hot pressing; Powder Extrusion. Additive Manufacturing: Introduction, Classification, Principles involved, Process design parameters; Advantages and shortcomings; Applications.

UNIT–IV: Advanced Casting Processes

Introduction; An overview of metal casting processes; recent advances in casting technology; Directional solidification and single crystal component manufacturing, Continuous casting, Rapid solidification of metals- Applications.

UNIT–V: Advanced metal joining processes:

Narrow Gap laser Welding (NGLW) process, Microwave welding, Laser hybrid welding, Magnetic arc welding. Other industrially applied recent welding techniques.

TEXTBOOKS:

1. Advanced Techniques to evaluate hot workability of materials - KP Rao, YVRK Prasad
2. Comprehensive Materials Processing, Elsevier
3. Handbook of Workability and Process Design- G.E. Dieter, SL Semiatin

REFERENCE BOOKS:

1. Rapid protoyping of materials - Marquis FDS
2. Rapid prototyping and manufacturing Fundamentals and Stereo Lithography- PF Jacobs
3. Rapid prototyping: Laser based and Other technologies- PK Venuvinod
4. Hot Working Guide - A compendium of processing Maps -Authors - YVRK Prasad, Sasidhara
5. ASM Handbook Volume -7 Powder Metal Technology & Applications

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B. Tech. in Metallurgical and Materials Engineering

VIII Semester Syllabus

MM813PE: Energy Materials

Course Objectives:

This course is essentially aimed at making the students

- Distinguish the materials applied in energy sector
- Understand the significance of energy materials in Nation‟s growth
- Learn the operating principle of several environmentally friendly energy technologies.
- Identify the material issues relevant to these technologies and to evaluate various operationalaspects associated with these technologies.

Course Outcomes:

After completing this course, the student should be able to:

- Recommend the requirements of materials for energy concerned applications
- Assess an energy technology for environmental friendliness
- Explain the operating principle of several energy technologies
- Demonstrate the ability to understand the characterization, performance, and failure data related to energy materials

UNIT–I: Introduction to Energy Sector in India

Energy requirements in a global scale and in the Indian context. Global context in terms of reducing greenhouse-gas emissions. Development of the infrastructure to meet the needs of other energy sectors, the scale of India's energy resources and its energy production.

UNIT–II: Energy sources

Evaluation of energy sources from the perspective of clean energy. Carbon equivalent and the carbon footprint of various forms of energy. Renewable energy and carbon Credits

UNIT–III: Energy storage materials

Introduction to different types of energy storage and conversion devices and technologies. Synthesis and characterization of materials used for these technologies, Property requirements in the materials, property evaluation and performance, failure modes and analysis. Impact of environment.

UNIT–IV: Energy storage devices-I

Introduction to Energy storage devices, requirements for devising an Energy Storage device. Technologies and functions of Energy Storage devices, Batteries & Super Capacitors

UNIT–V: Energy storage devices-II

Introduction to Solar energy conversion devices, Industrial applications and advances, Wind energy and mechanical energy storage devices, applications and recent development.

TEXT BOOKS:

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press,2004

REFERENCE BOOKS:

1. Materials Science in Energy Technology 1st Edition by G Libowitz.
2. Advanced Energy materials 1st Edition by Ashutosh Tiwari, Sergiy Valyukh.
3. Energy Storage & Conversion: Materials & Devices by A. Kumar, S. K. Das.

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B. Tech. in Metallurgical and Materials Engineering
VIII Semester Syllabus

MM814PE: Materials for High Temperature Applications

Course Objectives:

1. The prime objective of this industry-oriented course is to introduce the application of high temperature Materials to the undergraduate students.
2. The course will give an insight into the criteria to be followed by the engineering materials to be applied at elevated temperatures.
3. It will focus on the analysis of failures of materials that occur during the in service.
4. The course will throw light on some of the successful engineered conventional alloys that are applied at high temperatures.

Course Outcomes:

At the conclusion of the course, the students will be able to

1. Understand the significance of the alloys for application at elevated temperatures
2. Analyze the factors that influence the behavior of materials at high temperatures
3. Recommend the preventive measures to be adopted to withstand the high temperature
4. failures
5. Design the optimum fabrication process for alloys to be applied successfully at elevated temperature.

UNIT-I: Superalloys

Introduction to high temperature materials, Characteristics of high temperature materials; Super alloys: Fe-Ni base, Ni base super alloys, Cobalt base superalloys;

UNIT-II: Intermetallics and Composites

Intermetallics: Ti-Aluminide systems; High temperature ceramics: refractory silicides and borosilicides; Composites.

UNIT-III: Properties of high temperature materials

Creep properties: Larson–Miller approach for the ranking of creep performance, High temperature Corrosion, LCF, TMF, Creep Fatigue environmental Interaction. Case studies on Structure-property correlation of Super alloys, Intermetallics and Ceramics.

UNIT-IV: Melting and forming methods of Superalloys

Melting Process; Melting of Superalloys; Principles and practices of vacuum Induction Melting and Vacuum Arc melting; Forming Methods; Forming and Fabrication of superalloys; Recent developments in P/M of superalloys Production of components by Hot-Isostatic Pressing

UNIT-V: Casting methods

Improving turbine blade performance by solidification control -the development of single crystal turbine blades. Quality of super alloy castings; Heat Treating of Heat resistant alloys. **Few Case studies:** Case studies on Material selection and design for high temperature Applications: Aero engine components: turbine discs for an aero engine; Nuclear reactors and hypersonic jet engines.

TEXT BOOKS:

1. Superalloys; Source book; Mathew J. Donachie. Jr. editor; 1984.

2. The superalloys; edited by Chester T. Sims and William C Haagel; 1972

3. Material Selection and Design, Vol 20, ASM Handbook, ASM International

Reference Books:

1. J. G. Gerdeen, H. W. Lord and R. A. L. Rorrer, Engineering Design with Polymers and Composites, Taylor & Francis, 2005

2. M. F. Ashby and K. Johnson, Materials and Design, Butterworth Publication, 2002

3. The superalloys: fundamentals and applications, 2005, Roger C. Reed, Cambridge University press

4. V. John, Introduction to Engineering Materials, 3rd ed., Industrial Press, 1992

5. Campbell IE High temperature MATERIALS, John Wiley and sons Inc.; 1956

6. The superalloys: fundamentals and applications By Roger C. Reed

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B. Tech. in Metallurgical and Materials Engineering
VIII Semester Syllabus

MM815PE: Electronic and Magnetic Materials

Course Objective: This subject is formulated

3. To introduce to different electronic and magnetic materials
4. To expose the students to the fundamentals and processing of magnetic and electronic materials.

Course Outcome: At the end of the course the student will be able to

6. Understand the concepts of electro, magnetic properties.
7. Understand the properties to be considered in designing magnetic and electronic materials.
8. To know the manufacturing process of electronic and magnetic materials.
9. Understand the concepts in development of smart materials and devices.
10. Able understand the effects of material micro and atomic structures on electronic and magnetic properties.

UNIT-I: Magnetic Materials

Definition of Magnetic field, Magnetic Induction, Magnetic Field Intensity, Magnetic Susceptibility. Types of Magnetic Materials: Paramagnetic, Diamagnetic, Ferromagnetic, Anti Ferromagnetic, Ferrimagnetic materials.

UNIT-II: Theories of Para, Dia and Ferromagnetism

Curie Temperature, Domain theory of Ferromagnetism, Reversible and Irreversible domains. Bark Haussan Effect.

UNIT-III:

Hysteresis loop, Domain Interpretation of Hysteresis curve, interpretation of hysteresis and hand magnetic Materials, differences in magnetic properties of hard and soft magnetic materials, magnetic anisotropy and magnetostriction. Applications of magnetic materials: soft and hard, high energy hard magnetic materials, magnetic storage, ferrite core memories, bubble memories.

UNIT-IV:

Semiconductors, Band theory and solids, distribution of energy states, classification of semiconductors, intrinsic and extrinsic, n type and p type, variation of carrier concentration with temperature, Hall effect, forward baising and reverse baising semiconductor devices.

UNIT-V:

Production of metallurgical grade silicon, photo lithography pattern transfer, metallization, silicon IC chip, packaging, encapsulation of IC chip, tape automated bonding, smart, intelligent, active materials, piezo electric ceramics, polymers, chemical sensors, electrochemical sensors, shape memory alloys.

TEXT BOOKS:

1. Electronic properties of materials, R E Hummel

2. Ferromagnetic materials structure and properties, RA Macurie

REFERENCES:

1. An introduction to materials science, HL Mancini

2. Magnetic Materials fundamentals and devices, Nicols Spaldin

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3	0	0	3

B. Tech. in Metallurgical and Materials Engineering
VIII Semester Syllabus
MM816PE: Advances in Surface Engineering

Course Objectives:

1. This course primarily focuses on understanding, analyzing and controlling the properties of solid surfaces. It provides knowledge about techniques for altering surface properties. The advancements that have taken place in the recent times will be discussed in detail.

Course Outcomes: At the conclusion of this course, the student will be able to

1. Understand the significance of surfaces and surface characteristics
2. Design a method of surface coating for the given material
3. Evaluate the surface characteristics to correlate with the behavior of the engineering component
4. Altering Surface properties by utilizing proper techniques
5. Recommend the surface engineering technique suiting to the application

UNIT-I: History and background of Surface Engineering

Fundamental approach to surface engineering; scope and emergence; current trends in surface engineering and future scope of surface engineering; factors influencing the surfaces; Types of surface modification treatments; Industry oriented applications of surface engineering; Advantages and Limitations.

UNIT-II: Surface Characterization Techniques

Surface characterization techniques: Principles and procedures involved; Equipment and process design; Classification; Determination of Surface characteristics viz., thickness, continuity, hardness, adhesion, porosity, and bond strength.

UNIT-III: Advances in Surface Coatings-I

Necessity of advances in surface coatings; generation of water repellent surface coatings-techniques to improve wetting and surface characteristics; creation of biocompatible surfaces-techniques, principles and procedures involved.

UNIT-IV: Advances in Surface Coatings-II:

Factors that are responsible for the requirement of thin film coatings; Significance of thin films; Plasma assisted, and Plasma enhanced Chemical Vapor deposition (CVD) and Physical Vapor Deposition (PVD) techniques; Laser supported thin film coating techniques; Liquid phase techniques.

UNIT-V:

Synthesis, processing and Characterization of nanostructured coatings; Applications of advanced surface coatings in medical filed. Polymer coatings; Futuristic view of these advanced surface coating techniques.

TEXTBOOKS:

1. K G Budinski, Surface Engineering for wear resistance, Prentice Hall, New Jersey,1998
2. Surface Engineering, Process fundamentals and applications, Vol I and II, Lecture Notes of SERC school of Surface Engineering
3. Polymer Surfaces, From Physics to Technology, F. Garbassi, M. Morra, E. Occhiello, Wiley, New York, ISBN 0471971006

REFERENCES:

1. Intermolecular and Surface Forces, J.N. Israelachvili, Academic Press 2011, ISBN 9780123751829
2. Electroplating: Basic Principles and Practice - Kanan. N (Elsevier)2004

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B. Tech. in Metallurgical and Materials Engineering

VIII Semester Syllabus

MM821OE: Materials for Aerospace Applications

Course Objectives: The prime aim of this course is to understand and gain

1. Acquire knowledge of different aerospace materials & their properties.
2. Understand the Heat Treatment processes of aircraft metals and alloys
3. Characteristics and Applications of Aluminium alloys, Ceramics, Composites and High Temperature Materials
4. Characteristics and Applications of Ceramics, Composites and High Temperature Materials

Course Outcomes: Upon successful completion of this course, the students will be able to,

1. Apply the knowledge about the mechanical behaviour of different aircraft & aerospace materials.
2. Explain the applications of Aluminium alloys,
3. Evaluate the importance of high temperature materials and their characterization
4. Evaluate the importance of Ceramics and Composites Materials.

UNIT-I: Mechanical Behavior of Engineering Materials

Introduction to aerospace materials and their classification, Linear and non-linear elastic properties - Stress and Strain Curves - Yielding and strain Hardening, Toughness - Modules of resilience -- Bauchinger's effect - Effect of notches - Testing and flaw detection of materials and components, knowledge of various material testing machines

UNIT-II: Non-ferrous materials in aircraft construction

Aluminum and its alloys: Types and identification. Properties; Castings - Heat treatment processes - Surface treatments. Magnesium and its alloys: Cast and Wrought alloys - Aircraft application, features specification, fabrication problems, Special treatments.

UNIT-III: Non-ferrous materials in aircraft construction

Titanium and its alloys, Applications, machining, forming, welding and heat treatment; Be Alloys; Wood and fabric in aircraft construction and specifications - Glues Use of glass, plastics & rubber in aircraft, Introduction to glass & carbon composite.

UNIT-IV: Ferrous materials in aircraft construction

Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications. Maraging Steels: Properties and Applications. Super Alloys: Use - Nickel base - Cobalt base - Iron base - Forging and Casting of Super alloys - Welding, Heat treatment.

UNIT-V: Ceramics and Composites

Introduction, modern ceramic materials, cermets, glass ceramic, production of semi-fabricated forms, Carbon/Carbon composites, Fabrication processes and its aerospace applications involved in metal matrix composites, polymer composites

TEXT BOOKS:

1. Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998, ISBN-13: 978-8175980136

2. H Buhl, Advanced Aerospace Materials, Springer, Berlin 1992, ISBN-13: 978-3540558880.

REFERENCES:

1. Balram Gupta, Aerospace material Vol. 1,2,3,4ARDB, S Chand & Co ,2009, ISBN-13: 978- 8121922005.

2. Parker E R, Materials for Missiles and Space, McGraw-Hill Inc., US, 1963, ISBN-13**:** 978 0070485013

3. Hill E T, The Materials of Aircraft Construction, Pitman London.

4. C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112107086.

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B. Tech. in Metallurgical and Materials Engineering

VIII Semester Syllabus

MM822OE: Characterization of Materials

Course Objectives:

1. To obtain knowledge on various structural and microstructural characterization techniques of materials.
2. To study the principles, theory and practice of various characterization techniques.

Course Outcomes:

After completing this course, the student will be able to:

1. Determine crystal structures of materials
2. Analyse microstructure and morphology of materials at different length scales
3. Analyse atomic scale structures of materials
4. Able to understand elemental analysis and composition of the samples
5. Indicate instrumentation associated with and operating principles of various techniques

UNIT– I: Light Microscopy

Optical Microscopy: principle, image formation, resolving power, depth of field, depth of focus, numerical aperture, magnification, reflection and absorption of light, components of microscope, important lens defects and their corrections, bright field and dark field image contrast; Phase contrast microscopy, Confocal microscopy, Interference and Polarized light microscopy, metallography and image processing.

UNIT–II: X-ray Based Techniques

X-ray Diffraction: introduction, production and properties of X-rays, Bragg‟s law of diffraction, Laue equations of scattering, allowed and forbidden reflections, reciprocal space, experimental methods: single crystal Laue diffraction, rotating single crystal methods, intensity of diffracted beams - scattering by an electron by an atom, by a unit cell, structure-factor calculations, factors affecting diffraction intensities.

UNIT–III: Electron Microscopy

Electron-matter interactions, electron sources/guns, accelerating voltage, probe current, types of contrast, temporal and spatial coherency, magnetic lenses, image rotation and the eucentric plane, apertures, lens aberrations, practical resolution, spot size, electron detectors and displays, vacuum pumps; Scanning electron microscopy: advantages, limitations and applications, construction and working principle, specimen preparation, Modes: SE and BSE, EBSD; Transmission electron microscopy: advantages, limitations and applications, construction and working principle, specimen preparation, bright and dark field imaging, selected area diffraction, STEM, HRTEM.

UNIT–IV: Spectroscopy

Working principles, detectors, applications, advantages, and limitations of Energy dispersive spectroscopy, detectors, wavelength dispersive spectrometers, X-ray photoelectron spectroscopy, auger electron spectroscopy, electron energy loss spectrometers, Secondary ion mass spectroscopy, Raman spectroscopy

UNIT–V: Other Methods

Applications, advantages and limitations of atomic force microscopy, scanning tunnelling microscopy, field ion microscopy, atom probe tomography

TEXT BOOKS:

1. Fundamentals of powder diffraction and structural characterization of materials – VK Pecharsky, PY Zavalij, Springer, 2005.

2. Microstructural characterization of materials – David Brandon, Wayne D Kalpan, John.

REFERENCE BOOKS:

1. Transmission electron microscopy – DB Williams, CB Carter, Springer, 2009.

2. Material characterization: Introduction to microscopic and spectroscopic methods – Yang Leng, 2nd edition, Wiley-VCH, 2013.