COURSE STRUCTURE

AND

DETAILED SYLLABUS

R16

Metallurgical and Materials Engineering

For

B.TECH. FOUR YEAR DEGREE COURSE

(Applicable for the students admitted into Academic Year 2016-17)

(I – IV Years Syllabus)

RAJIV GANDHI UNIVERSITY OF KNOWLEDGE TECHNOLOGIES

Basar, Nirmal, Telangana - 504107

COURSE STRUCTURE

FOR

Metallurgical and Materials Engineering

I YEAR
I SEMESTER

Subject Code	Subject Name	L-T-P	Credits	Category
MA1101	Mathematics-I	4-0-0	4	BSC
ME1001	Engineering Mechanics	4-0-0	4	ESC
HS1001	English	4-0-0	3	HSMC
CY1001	Chemistry	4-0-0	4	BSC
CS1101	Programming in C	4-0-0	4	ESC
HS1101	Communication Skills-I	6-0-0	1	HSMC
HS1601	English Lab	0-0-3	2	HSMC
CY1601	Chemistry Lab	0-0-3	2	BSC
CS1701	Programming in C Lab	0-0-3	2	ESC
Total		**26-0-9**	**26**	

L – Lectures, T – Tutorials, P – Practicals, C – Credits

I YEAR
II SEMESTER

Subject Code	Subject Name	L-T-P	Credits	Category
PH1001	Engineering Physics	4-0-0	4	BSC
MA1201	Mathematics-II	4-0-0	4	BSC
CS1201	Scripting Languages	4-0-0	3	ESC
EE1001/2001	Basic Electrical and Electronics Engineering	4-0-0	4	ESC
HS1201	Communication Skills-II	2-0-0	1	HSMC
CE1001	Engineering Drawing	4-0-0	4	ESC
PH1601	Engineering Physics Lab	0-0-3	2	BSC
EE1601/2601	Basic Electrical and Electronics Engineering Lab	0-0-3	2	ESC
ME1601	Workshop	0-0-3	2	ESC
TOTAL		**22-0-9**	**26**	

II YEAR
I SEMESTER

Subject Code	Subject Name	L-T-P	Credits	Category
MM2101	Physical Metallurgy	4-0-0	4	PCC
MM2102	Mineral Processing	4-0-0	4	PCC
MM2103	Metallurgical Thermodynamics	4-0-0	4	PCC
MM2104	Foundry Technology	4-0-0	4	PCC
BSBE2001/3001	Environmental Science	3-0-0	3	
HS2101	Soft Skills-I	2-0-0	1	HSMC
MM2701	Physical Metallurgy Lab	0-0-3	2	PCC
MM2702	Foundry Technology Lab	0-0-3	2	PCC
MM2901	Seminar – I	1-0-0	1	
Total		**22-0-6**	**25**	

II YEAR
II SEMESTER

CODE	SUBJECT	L-T-P	Credits	Category
MM2201	Mechanical Metallurgy	4-0-0	4	PCC
MM2202	Materials Characterization Techniques	4-0-0	4	PCC
MM2203	Iron Making	4-0-0	4	PCC
MM2204	Non Ferrous Extractive Metallurgy	4-0-0	4	PCC
MM2205	Phase Transformations	4-0-0	4	PCC
BM2201	Personality Development-I	2-0-0	1	
MM2801	Mechanical Metallurgy Lab	0-0-3	2	PCC
MM2802	Materials Characterization Lab	0-0-3	2	PCC
MM2803	Non Ferrous Extractive Metallurgy Lab	0-0-3	2	PCC
MM2902	Seminar-II	1-0-0	1	
	TOTAL	**23-0-9**	**28**	

III YEAR
I SEMSESTER

CODE	SUBJECT	L – T - P	Credits	Category
MM3101	Mechanical Working Of Materials	4-0-0	4	PCC
MM3102	Steel Making	4-0-0	4	PCC
MM3103	Heat treatment	4-0-0	4	PCC
MM3104	Polymer Engineering and Technology	4-0-0	4	PCC
MM3105	Composite Materials and Processing	4-0-0	4	PCC
BM3101	Personality Development-II	2-0-0	1	
MM3701	Mechanical Working Of Materials Lab	0-0-3	2	PCC
MM3702	Heat treatment Lab	0-0-3	2	PCC
MM3901	Seminar – III	0-0-1	1	
Total		**22-0-7**	**26**	

III YEAR
II SEMSESTER

CODE	SUBJECT	L-T-P	Credits	Category
MM3201	Materials Joining	4-0-0	4	PCC
MM3202	Introduction to Ceramic Technology	4-0-0	4	PCC
MM3203	Corrosion and Environmental Degradation Of Materials	4-0-0	4	PCC
MM3204	Powder Metallurgy	4-0-0	4	PCC
CS3001	OOPS Through JAVA	4-0-0	4	ESC
HS3201	Soft Skills-II	2-0-0	1	HSMC
MM3801	Materials Joining Lab	0-0-3	2	PCC
MM3802	Corrosion and Environmental Degradation Of Materials Lab	0-0-3	2	PCC
CS3601	OOPS Through JAVA Lab	0-0-3	2	ESC
MM3902	Seminar-IV	0-0-0	1	
MM3000	Comprehensive Viva-I	0-0-0	1	
	TOTAL	**22-0-9**	**29**	

IV YEAR
I SEMESTER

Subject Code	Subject	L-T-P	CREDITS	Category
MM3900	Summer Internship	0-0-0	6	
MM44XX	Elective-I	3-1-0	3	PEC
MM44XX	Elective-II	3-1-0	3	PEC
MM44XX	Elective-III	3-1-0	3	PEC
	Free Elective-I	4-0-0	3	OEC
BM4001	Managerial Economics and Financial Analysis	4-0-0	3	HSMC
Total		**17-3-0**	**21**	

IV YEAR
II SEMESTER

Subject Code	SUBJECT NAME	L-T-P	Credits	Category
	Free Elective-II	4-0-0	3	
MM4800	Project		16	
MM4000	Comprehensive Viva-II		1	
Total		**4-0-0**	**20**	

List of Free-electives:

BM4501	FOUNDATIONS OF MANAGEMENT
BM4502	ENTREPRENEURSHIP AND NEW VENTURES
BM4503	INTELLECTUAL PROPERTY RIGHTS
BSBE4501	SUSTAINABLE TECHNOLOGY
BSBE4502	PHARMACEUTICAL TECHNOLOGY
BSBE4503	BIO MATERIALS
CH4504	Computational Fluid Dynamics

Metallurgical and Materials Engineering

B14 Batch Course Structure and Detailed Syllabus

I YEAR
I SEMESTER

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MA1101	Mathematics-I	4-0-0	4	BSC
ME1001	Engineering Mechanics	4-0-0	4	ESC
HS1001	English	4-0-0	3	HSMC
CY1001	Chemistry	4-0-0	4	BSC
CS1101	Programming in C	4-0-0	4	ESC
HS1101	Communication Skills-I	6-0-0	1	HSMC
HS1601	English Lab	0-0-3	2	HSMC
CY1601	Chemistry Lab	0-0-3	2	BSC
CS1701	Programming in C Lab	0-0-3	2	ESC
Total		**26-0-9**	**26**	

L – Lectures, T – Tutorials, P – Practicals, C – Credits

Category: **Basic Science Course** Subject code: **MA1101**

MATHEMATICS-I

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To give a thorough explanation of real sequences and series.
- To introduce the concepts of Euclidean space and the behavior of functions in them.
- To emphasize the applications of differentiation on real functions and their geometrical inferences.
- Introduction to Numerical analysis.
- To Introduce Fourier series and it's applications.

Course Outcomes:

At the end of the course student will be able to

- Explain concept of limit of function of two variables
- Understand the two path criterion to show that a limit does not exist and apply it to solve problems about limits
- Memorize definition of partial derivative and illustrate geometric meaning withthe aid of sketches.
- Provide geometrical meaning of second partial derivative with respect to onevariable
- Calculate directional derivatives and gradients &Apply it to solve problems involving steepest ascent and normal vectors to level curves.
- Apply the method of Lagrange Multipliers to solve such constrained optimizationproblems.
- Understand & apply various theorems like, Rolle's theorem.Lagrange's Mean value theorem, Cauchy Mean Value theorem in Calculus.
- Understand & Apply various tests for convergence of sequences & series
- Find the find the fourier series of periodic functions
- Find the Fourier sine and cosine series for functions defined on an interval.
- Use to numerical methods in modern scientific computing
- Find the roots of various types of equations using Numerical methods & find the area under the curve using Trapezoidal Rule, Simpson $\frac{1}{3}$ Rule, Simpson $\frac{3}{8}$ Rule

UNIT-I

Sequence: Definition of sequence, convergence, limit of a sequence, divergence, oscillation, bounded and monotonic sequences, Bounded sequences, Sandwich theorem, Algebra of limits, L'Hospital Rule in sequences, subsequences and its limit.

Series: Infinite series, partial sum, convergence, divergence, oscillation, Geometric series, Telescoping series, Algebra of Limits, n^{th}- term test, Comparison test, Comparison test (Limit Form), Integral test, D'Alembert's Ratio test, Cauchy's Root test, Alternating series, Leibnitz's Rule, Absolute convergence, Conditional convergence, Power series, Radius of convergence for a power series.

UNIT-II

Differential calculus: Rolle's theorem, Lagrange's mean value theorem, Cauchy's Mean-value theorem, Taylor's Theorem and Expansion, Maclaurin's Theorem and Expansion, Indeterminate forms and application of L'Hospital Rule. Radius of curvature, Envelope, Increasing and decreasing functions, concavity, convexity and point of inflexion, Asymptotes-Curve Tracing(Sketching)

UNIT-III

Functions of Several Variable Calculus:

Definition of continuity and differentiability in single variable, n-dimensional Euclidean space, Neighborhood of a point in n-dimensional Euclidean space, Functions in n-variables, Functions in 2 & 3 variables, Interior points, Boundary points, open and closed regions, Limit and continuity, Two-path test, Discontinuities, Partial Differentiation, Clairaut's theorem(for mixed Partial Derivatives), Laplace equation, Homogeneous functions , Euler's theorem for Homogeneous functions, Differentials and derivatives, Derivatives of composite functions, Chain Rule, Jacobians, Taylor's Theorem, Maxima and minima, Lagrange's method of multipliers.

UNIT-IV:

Fourier Series:

Definition of Fourier Series, Fourier Series representation of function, Limit of Convergence of Fourier Series, Even & Odd functions, Gibb's Phenomenon, Sine and Cosine Series, Limit of Convergence of Sine & Cosine Series. Integration and Differentiation of Fourier Series, Bessel's Inequalities, Parseval's Theorem.

UNIT-V

Numerical Methods:

Introduction: True value, Approximate Value, Error, Error percentage, Application of Numerical Analysis in various fields.

Numerical Analysis in solving Algebraic equations: Algebraic equations, Transcendental equations, Bisection Method, Regula -Falsi Method, Newton-Raphson Method.

Numerical Integration: Trapezoidal Rule, Simpson $\frac{1}{3}$ Rule, Simpson $\frac{3}{8}$ Rule

Text Books:

1. Thomas Calculus, Maurice D.Wier, Joel Hass Eleventh Edition, Pearson Education ,2008
2. R.K. Jain & S.R.K.Iyengar, Advanced Engineering Mathematics, Third Edition, Narosa publications, 2007.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons Ltd 2006.

Suggested References:

1. B.S. Grewal and J.S. Grewal, "Higher Engineering Mathematics",(40th Edition), Khanna Publishers,2007
2. S.S. Sastry ,Introductory Methods of Numerical Analysis ,Third Edition, Prentice Hall India

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Engineering Science Course** Subject code: **ME1001**

ENGINEERING MECHANICS

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To understand the resolution of forces, equilibrium and compatibility conditions ofstatic loads
- To determine the various forces in the members, and analyze the sections using various methods
- To obtain friction, centroid, and moment of Inertia for various regular and irregularbodies

Course Outcomes

- Ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- Ability to analysis the forces in any structures.
- Ability to analyze rigid body subjected to dynamic forces.

UNIT-I

Force Systems: Resultant of collinear, parallel, coplanar and non-coplanar concurrent and non-concurrent force systems. Resolving a planar or non-coplanar force system into different directions. Moment of force and its applications, Couples and Wrench of a force system.

UNIT -II

Equilibrium of Force Systems: Free body diagram, Equations of equilibrium, Equilibrium of planner and spatial system.

UNIT -III

Analysis of structures: Analysis of trusses by method of joints and method of sections, Analysis of frames by method of members.

UNIT -IV

Friction: Laws of friction. Application to simple systems, connected systems and belt friction. Wedge friction.

UNIT -V

Centroid and Moment of Inertia: Centroids of lines, areas and volumes, Areas and volumes of revolution, Pappu's theorems and their applications, Area moment of inertia, Product moment of Inertia, Composite areas, radius of gyration.

Suggested Readings:

1. Ferdinand L. Singer (1975). "Engineering Mechanic" *Collins, Singapore.*
2. Timoshenko, S.P. and D.H. Young. (1983). "Engineering Mechanics." *McGraw-Hill International Edition.*
3. Rajeshakharam, S. and Sankarasubrahmanyam, G. (2002). Mechanics." *Vikas Publications.*
4. Junarkar, S.B. and H.J. Shah. (2001). "Applied Mechanics, Publishers.
5. Shames, J.H (1987). "Engineering Mechanics", *Prentice Hall.*

6.Bhattacharyyya, B. (2015). "Engineering Mechanics." *Oxford Higher Education*

Category: **HSM Course** Subject code: **HS1001**

English for Communication

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks **4-0-0-3**

Course Objectives:

- To complement the comprehensibility of the Technical subjects in a better way.
- To make them competent to attempt and qualify in various tests.
- To develop the study skills in formal and informal situations.

Course Outcomes:

Students will be able

- To learn the impacts of technology on language and personal life.
- To pronounce better and enhance their reference skills.
- To appreciate the aesthetic understanding and pleasure reading.
- To improve analysis skills through movies.
- To strengthen public speaking skills.
- To refine their comprehensive writing skills

UNIT-I

A Road Not Taken by Robert Frost: Understanding the Poem- Importance of the poem – Figures of Speech –Simile- Metaphor- Alliteration- Onomatopoeia - Invictus (2009)

UNIT-II

Phonetics: Commonly Mispronounced Words - Consonants - Vowels – Voiced & voiceless - BBC Phonetic Transcription – Syllabification - Word Stress - Tongue Twisters – The King's Speech (2010) – My Fair Lady (1968)

UNIT-III

What's Up? An Excerpt from The Hindu (September 29, 2015) – Binomials and Portmanteau - Common errors in English Usage

UNIT-IV

Malala's Speech: An Excerpt from www.noble.org (10 December 2014): Self-Introduction - One Word Substitutes - Homophones, Homonyms and Homographs - Debate - Group Discussion – Girl Rising (2013)

UNIT-V

The Nightingale and the Rose by Oscar Wilde: - Skimming and Scanning - Dialogue writing: Seeking Permission, Requesting, and Interrupting – Tangled (2010)

UNIT –VI

Anand's Super 30 for IIT - JEE : An Excerpt from The India Today (July 11,15): Letter Writing - Formal Letter - Informal Letter - Notice Writing - Email writing – Freedom Writers (2007)

UNIT –VII

Education and Technology - Burj Khalifa : www.natgeotv.com : Burj Khalifa (Documentary Video)- JAM/PPT Presentations - Essay Writing

UNIT –VIII

A Missile Man – Dr. APJ Kalam: An Excerpt from The Hindu (Sept 25, 2006) – Interviews - Curriculum Vitae or Resume preparation – I am Kalam (2010)
FURTHER STUDIES (SELF STUDY): U-I: Capitalization, Punctuation (commas, full stop, inverted marks) - U-II: Words often Confused, Affixes (Prefixes and Suffixes), Commonly Mispronounced Words, Tongue Twisters - U-III: Articles - Prepositions, Spotting the Error –

UIV: Index –Grammar (Additional Information)

Tenses – U-V: Active and Passive, Direct and Indirect Speech – U-VI: Understanding the rules of spelling Part1&2 – U-VII: Commonly Used Phrasal Verbs & Idioms – U-VIII: Antonyms and synonyms

Suggested References:

1. Meenakshi Raman, Sangeetha Sharma. "***Effective Technical Communication***." Oxford: Oxford University, New Delhi, 2015.
2. Murali Krishna, ***"English for Engineers."*** Pearson Education, Inc. New Delhi, 2015.
3. 3. E. Suresh Kumar, P. Sreehari and J. Savithi***. "English for Success."*** Foundation Books, Inc. New Delhi, 2014.
4. 4. Ashraf. M. Rizvi, ***"Effective Technical Communication."*** Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2015.
5. 5. Hari Mohan Prasad and Rajnish Mohan, ***"How to prepare for Group for Group Discussion and Interview."*** 2nd Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2015.
6. 6. R.P Bhatnagar and Bhargava Rajal, ***"English for Competitive Examinations".*** McMillan India limited, 1989.
7. 7. Upendran. S, ***"Foundation Course in Spoken English Part I".*** McMillan India limited, 1989.
8. 8. Upendran. S, ***"Foundation Course in Spoken English Part II".*** McMillan India limited,1989.

Web sources:

1. www.usingenglish.com
2. www.talkenglish.com
3. www.oxforduniversity.com
4. www.wikipedia.com
5. www.about.com

For Literature:

1. www.cliffsnotes.com

2. www.sparksnotes.com
3. www.gradesaver.com
4. www.nofearshakespeare.com

Category: **Basic Science Course** Subject code: **CY1001**

ENGINEERING CHEMISTRY

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Course Objectives:

- To understand the basic organic reactions and their mechanisms with examples
- To understand the importance of the spectroscopy in determining the structures of chemical compounds
- To understand the importance of electrochemistry in technical filed
- To undertand the rates of some of the reactions and derivation of their rate laws
- To understand the phase rule with some examples

Course Outcomes:

- Will be able to understand the structural elucidation of organic compounds using spectroscopy.
- Will gain knowledge on basic electrochemical reactions, corrosion and prevention of corrosion.
- Will gain knowledge on rate law, kinetic reactivity of complex reactions and phase rule.
- Will gain necessary knowledge in catalysis.
- Will understand the basic concepts of polymers, lubricants, and nanomaterials, essential for engineering graduates

Unit1: Organic reactions and Mechanisms

Elimination reactions: types of elimination reactions. α-eliminations with examples, Reimer-Tiemann reaction and its mechanism, β-eliminations with examples, Hofmann elimination and Saytzeff elimination reactions and their mechanisms, Classification of β-eliminations into E1 and E2 reactions with examples, γ-elimination reactions with examples, Aldol condensation with mechanism.

Addition and Substitution reactions: Classification of addition reactions into electrophilic, nucleophilic and free radical addition reactions with examples and their mechanisms, Markonikov's law, anti-Markonikov's rule and Kharasch effect, Michael reaction, Skraup synthesis, Polyvinyl chloride synthesis and their mechanisms. Classification of substitution reactions into electrophilic, nucleophilic and free radical substitutions with examples and their mechanisms, S_N^1 and S_N^2 reactions with examples, S_E^1 and S_E^2 reactions with examples.

Bio-organic Reactions: amino acids and proteins, peptide bond formation and examples, methods of representing a peptide bond and its synthesis, Lipids, functions of lipids, classification of lipids, lipid metabolism, occurrence of lipids, properties of lipids, analysis of fats and oils.

Polymerization reactions: classification of polymerization, detailed reaction mechanism of free radical polymerization with examples, condensation polymerization reaction with mechanism, ionic polymerization with examples, classification of ionic polymerization into cationic and anionic polymerization.

Mechanism of catalytic reactions: catalyst definition, characteristics and types of catalysis, theories of catalysis, intermediate compound formation theory with examples and mechanism, drawbacks of intermediate compound formation theory, adsorption or contact theory with examples and mechanisms, enzyme catalysis, characteristics and mechanism of enzyme catalysis.

Unit 2: Spectroscopy

Introduction to spectroscopy, electromagnetic radiations, different types of spectroscopy, principle of spectroscopy, spectrophotometer

Microwave spectroscopy: principle, microwave spectra of diatomic molecules, selection rules for microwave spectra, applications of microwave spectroscopy: determination of bond length, dipolemoment measurement, determination of isotopic mass of an element.

Infrared spectroscopy: introduction and principles of IR, types of vibrations: bending and stretching, Hooke's law for stretching vibrations, characteristic frequencies of common functional groups, IR instrumentation, interpretation and applications of IR spectrum with examples.

Ultra-violet spectroscopy: Introduction and principle of UV spectroscopy, color interpretation with VBT and MOT, types of electronic transitions, selection rules, chromophores and auxochromes with examples, conjugation effect, absorption and intensity shifts, applications of UV spectroscopy.

Unit 3: Electrochemistry

Types of electrodes: introduction, metal-metal ion electrodes, metal-insoluble salt-anion electrodes, calomel electrode, gas-ion electrodes, hydrogen and chlorine electrodes, oxidation-reduction electrodes, amalgam electrodes.

Types of cells: classification into chemical and concentration cells, chemical cells with transference and without transference, classification of concentration cells into electrolyte and electrode concentration cells, electrolyte concentration cells with and without transference, amalgam and gas concentration cells, examples for these cells.

EMF and applications of EMF: determination of pH, determination of the valency of the ions, potentiometric titrations.

Thermodynamic data: enthalpy and entropy of cell reactions, Gibbs-Helmholtz equation and applications.

Activity coefficients: fugacity and activity, their derivations, determination of activity and activity coefficients from cell potentials, ionic strength and its determination.

Solubility product: solubility and solubility product definitions, determination of solubility product using potentiometric and conductometric methods.

pH: definition of pH and determination of pH by various methods, acid-base titrations.

Corrosion: introduction, causes of corrosion, factors affecting the corrosion: nature of the metal and nature of the environment, thermodynamics of the corrosion, theories of corrosion: electrochemical/wet/immersion theory and chemical/dry/direct chemical attack theory.

Prevention of corrosion: protective coating - metal and nonmetal coatings, cathodic and anodic protection and their limitations, corrosion inhibitors – organic and inorganic inhibitors with examples.

Unit 4: Chemical kinetics

Complex reactions: definition and classification of complex reactions, definition of reversible reactions with examples, rate law derivation for reversible reactions.

Consecutive reactions: definition, rate law derivation and examples of consecutive reactions.

Parallel reactions: definition, rate law derivation and examples of parallel reactions.

Steady-state approximation: introduction, kinetic rate law derivation by applying steady state approximation in case of the oxidation of NO and pyrolysis of methane.

Chain reactions: introduction, types and mechanism of chain reactions, stationary and non-stationary chain reactions with examples, deriving the kinetic rate equation using a general chain reaction.

Photochemical reactions: introduction, Stark-Einstein law of photochemical equivalence, photophysical processes: IC, ISC, fluorescence and phosphorescence with examples, kinetic rate law derivation incase of photochemical decomposition of HI and photochemical combination of H_2 and Br_2.

Unit 5: Phase and reaction equilibrium

Phase equilibrium: introduction, definition of phase equilibrium, phase rule, definition and explanation of the terms used in the phase equilibrium: phase, components, degrees of freedom with examples, Lead – silver system.

Chemical equilibrium in mixture: energy changes, degree of advancement of reaction, effect of adding an inert gas on equilibrium.

Reference books:

1. Applied Chemistry – A textbook for engineers and technologist by H.D. Gesser
2. Engineering Chemistry: by P C Jain & Monika Jain
3. A Text Book of Engineering Chemistry: by Shashi Chawla
4. Fundamental of Organic Spectroscopy by Y. R. Sharma
5. Introduction to spectroscopy by Pavia, Lampman, Kriz

Category: **Engineering Science Course** Subject code: **CS1101**

PROGRAMMING IN C

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Prerequisites

1. No prerequisites

Course Objectives

- Requires analytical skills and logical reasoning.
- This course starts from the basics of computers and program development.
- It introduces searching and sorting algorithms

Course Outcomes

- Develop C programs for computing and real life applications using basic elements like control statements, arrays, functions, pointers and strings and Implement searching and sorting algorithms

UNIT – I

Introduction to Computer Programming: Computing Environments, Computer Languages, Creating and Running Programs. Algorithm and Flow charts. Introduction to C Language syntax.

UNIT-II

Selection: Logical Data and Operators, if-else, switch Statements, Standard Functions. Repetition: loops, while, for, do-while statements, break, continue. Arrays and its applications in searching and sorting. Strings and string manipulation functions.

UNIT – III

Functions: Designing Structured Programs, Functions Basics, User Defined Functions, Inter Function Communication, Standard Functions, Scope, Storage Classes, Scope Rules, and Type Qualifiers. Recursion

UNIT – IV

Pointers, pointers to arrays, pointers as arguments and dynamic memory allocation.

UNIT – V

Structures, unions, file input and output.

Text book:

1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition, Pearson Education.
3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education

Category: **HSM Course** Subject code: **HS1101**

Communication Skills- I

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks **2-0-0-1**

Course Objectives:

- To make the students efficient communicators via experiential learning.
- To enhance learners' analytical and creative skills, so that they will be capable to address a wide variety of challenges in their professional lives.
- To help learners to improve the leadership qualities and professional etiquette
- To expose learners to an effective communicative environments.

Course Outcomes:

Students will be able to:

- develop interpersonal communication, small group interactions and public speaking.
- exercise the writing assignments, precise writing for informational, persuasive and creative purposes.
- apply right form of structural usage of sentences in their written and oral communication.
- develop confidence and skills related reading comprehension.
- improve a logical framework for the critical analysis of spoken, written, visual and mediated messages upon a diverse platforms.
- demonstrate the ability to apply vocabulary in practical situations.

Unit I – Introduction to communication

Introduction – Importance of Communication Skills – Definition – Scope and Nature – Verbal and Nonverbal communication

Unit II – Reading Skills

Reading Comprehension of unseen passage – Prose – News Paper Reading and Analysis (Editorial)

Unit III - Grammar

1. Parts of Speech
2. Subject and predicate
3. Articles – Determiners
4. Conjunctions (Linkers; connectors; cohesive devices)
5. Verbs – Transitive and Intransitive - Finite and Infinite - Regular and Irregular - Modals
6. Tenses
7. Prepositions/ Prepositional verbs
8. Adverbs – types and their order in sentences
9. Adjectives

10. Including Degrees of Comparison and also Quantifiers

Unit IV – Enhancing Vocabulary

Developing Professional vocabulary – Using Dictionary: Spelling – Grammar and Usage

Unit V - Composition

Paragraph – Essay - Expansion - Describing the Pictures – Giving Directions – Situational Dialogue writing – Social and Professional Etiquette – Telephone Etiquette

Suggested References:

1. Joseph Mylal Biswas book of English Grammar

2. R. Murphy -Cambridge Press

3. Wren and Martin

4. The Good Grammar book by OUP

5. Communication skills by M. Raman and Sangeeta Sharma

6. How to Win Friends and Influence people by Dale Carnigie

7. How to Read and Write Better by Norman Lewis

8. Better English by Norman Lewis

9. Use of English Collocations by OUP

10. www.humptiesgrammar.com

11.www.bbcenglisgh.com

12.www.gingersoftware.com

13. www.pintest.com

Category: **HSM Course** Subject code: **HS1601**

English Lab

Externals: 60 Marks **L-T-P-C***
Internals: 40 Marks **0-0-3-2**

Course Objectives:

* To sensitize students to their communication skills.
* To make the students practice the language skills (L, S, R, W).

Course Outcomes:

- Students will be able to write essays and paragraphs that demonstrate proper usage of grammar.
- Students will demonstrate the ability to critique their grammar assignments.
- Students will be able to assess their pronunciation of words.
- Students will analyze the forms of different expressions in English Language that reflect the individual, social, and cultural values.
- Students will demonstrate the proficiency in oral and written communication.

UNIT-I

Grammar – Adjectives – Comparatives and Superlatives – Adverbs – Countable and Uncountable Nouns – Pronouns – Simple present – Present continuous – Simple past- Conjunctions – Prepositions – Plurals – Articles a, an, the – Infinitive or –ing – Questions and Negatives -1 - Questions and Negatives - 2

UNIT-II

Pronunciation – Pill/Fill – Buy/My – Tie/Die – Ship/Chip – Yet/ Jet – Game/ Came – Wail/Veil – Think/Sink – There/Dare – Price/ Prize – Asia/ Hard – Ran/Rang – Right/Light – Ship/Sheep – Head/Had- Schwa – Luck/ Look - Hat/Heart – But/Boot – Who/ Her – Pot/Port – Hair/ Hear – Pay/Pie – Boy/Buy – Know/ Now

UNIT-III

Writing – Writing a Thank You Letter – Writing about your life – Writing Instructions – Writing a Story – Writing an Essay – Writing a Business Letter – Writing a Film Review – Writing a Biography – Writing a Complaint Letter – Writing a Covering Letter - Writing a Pen friend Post - Writing about a Special Day - Writing an E-mail of Apology - Writing a Short Report - Writing a Post Card

UNIT – IV

Reading - The diamond thief – The guru and sweets – Taking a course – Reading a story - Using a dictionary – Making a journey – Reading a newspaper – Making friends – Reading an email – Finding information – A pen friend letter – The doctor says…- Choosing a holiday – Struck by lightning – Health matters :Yoga

UNIT – V

Listening – What shall we play? – An exciting weekend – A school outing – The morning assembly – Instructions on planting – Excuse me, can you lend me…- Manish's summer – Vignesh's hobby – What can I do for you? – What are you doing Ramesh? – I've got a few questions…- Geetha's day – Anil's new purchase – What are we having tonight? – What is the problem?

Suggested References:

1. Clarity English Success - Software
2. http://www.clarityenglish.com/program/practicalwriting/
3. http://www.clarityenglish.com/program/roadtoielts/
4. http://www.clarityenglish.com/program/clearpronunciation1/
5. http://www.clarityenglish.com/program/resultsmanager/

Category: **Basic Science Course** Subject code: **CY1601**

CHEMISTRY LABORATORY

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **0-0-3-2**

Course Objectives:

- To learn the preparation of organic compounds in the laboratory
- To estimate the hardness and alkalinity of the given sample of water
- To understand the Job's method for determining the composition
- Learns how to use the pH meter and polarimeter

Course Outcomes ;

- Minimum knowledge on basic synthesis, quantitative and qualitative analysis is being imparted
- **Synthesis**
- Synthesis of soap from cheap oil.
- Synthesis of Thiokol rubber

- **Volumetric analysis**
- Estimation of alkalinity of water
- Estimation of total hardness of water by EDTA method

- **Job's method**
- Determination of composition of Ferric-Thiocyanate complex by Job's method

- **pH meter**
- Estimation of the strength of a weak acid by pH metry

- **Polarimeter**
- Determination of specific rotation of sucrose by polarimeter

Reference books:

1. College Practical Chemistry by V K Ahluwalia, Sunita Dhingra, Adarsh Gulati
2. Practical Engineering Chemistry by K Mukkanti
3. A Text Book of Engineering Chemistry: by Shashi Chawla
4. Essentials of Experimental Engineering Chemistry by Shashi Chawla
5. Comprehensive Practical Organic Chemistry – Preparation and Quantitative analysis byV K Ahluwalia, Renu Aggarwal

Category: **Engineering Science Course** Subject code: **CS1701**

PROGRAMMING IN C LAB

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-3-2**

Course Objectives:

- Able to have fundamental concept on basics commands in Linux.
- Able to write, compile and debug programs in C language.
- Able to formulate problems and implement algorithms in C.
- Able to effectively choose programming components that efficiently solve computing problems in real-world

Experiments:
Suggested assignments to be conducted on a 3-hour slot. It will be conducted in tandem with the theory course so that the topics for problems given in the lab are already initiated in the theory class. The topics taught in the theory course should be appropriately sequenced for synchronization with the laboratory. A sample sequence of topics and lab classes for the topic are given below:

1. Familiarization of a computer and the environment and execution of sample programs
2. Expression evaluation
3. Conditionals and branching
4. Iteration
5. Functions
6. Recursion
7. Arrays
8. Structures
9. Files

For the detailed list of programs refer the lab manual.

Note: Any experiment according to the syllabus of CS1101 can be substituted

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

I YEAR
II SEMESTER

Subject Code	Subject Name	L-T-P	Credits	Category
PH1001	Engineering Physics	4-0-0	4	BSC
MA1201	Mathematics-II	4-0-0	4	BSC
CS1201	Scripting Languages	4-0-0	3	ESC
EE1001/2001	Basic Electrical and Electronics Engineering	4-0-0	4	ESC
HS1201	Communication Skills-II	2-0-0	1	HSMC
CE1001	Engineering Drawing	4-0-0	4	ESC
PH1601	Engineering Physics Lab	0-0-3	2	BSC
EE1601/2601	Basic Electrical and Electronics Engineering Lab	0-0-3	2	ESC
ME1601	Workshop	0-0-3	2	ESC
TOTAL		**22-0-9**	**26**	

Category: **Basic Science Course** Subject code: **PH1001**

ENGINEERING PHYSICS

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To Inculcate in the Students a sense of yearning to learn the basic Physics behind the applications that we look around in day to day life.
- To deliver the basic Principles of Physics that form the basis for the development of Technology.
- The basic details of Solid state Physics, Optics and Electrodynamics and Quantum Physics provided in a subtle fashion dealt in finer details to have strong basics in these areas.

Course Outcomes:

- The Students would be in a position to understand the innate Physics principles that go into the day to day phenomenon specifical to Optical domain.
- The Students would get hold of the basic Electro magnetic Wave concepts that are crucial in understanding the Communication Phenomenon.
- The Students would have realized the difference between the Newtonian Domain(Classical Physics) and quantum domain(Quantum Mechanics) and get to know the Physics that happens at the Quantum Domain.
- The Students would be equipped with concepts in understanding the crystals and materials from a basic point of view which form a backbone in understanding the properties exhibited by these materials..

UNIT – I
MATHEMATICAL PHYSICS (3)

1.1 Gradient, Divergence, Curl and their physical significance

Scalar and Vector point Functions, Differential operator, Gradient , Physical significance, Divergence, Significance, Curl, Physical Significance, Vector Identities

1.2 Stokes theorem & Gauss theorem

Vector Integral Theorems, Line Integral, Surface and Volume Integrals, Stokes Theorem, Gauss-Divergence Theorem, Application

1.3 Curvilinear coordinates

Types of Coordinate systems, Polar coordinates, Cylindrical and Spherical coordinates, Equations Relating Cartesian, Spherical and Cylindrical coordinate

UNIT – II
ELECTRODYNAMICS (6)

2.1 Maxwell's Equations

Electrodynamics before Maxwell, Fixing of Ampere's Law, Maxwell Equation in matter, Boundary Conditions.

2.2 Poynting theorem and conservation laws

Continuity Equation, Poynting Theorem, Conservation Law Newton Third law in Electrodynamics

2.3 Wave equation

Wave equation, wave form Boundary conditions, Reflection and Transmission for a string

2.4 Electro Magnetic Waves in vacuum

Wave equation for E and B, Monochromatic Plane Waves, Energy and Momentum in EM Waves in vacuum

2.5 Electro Magnetic waves in Matter

Propagation in Linear Media, Reflection and Transmission at Normal Incidence Oblique Incidence

2.6 EM wave in conducting surface.

Reference Books :

1. Electrodyamics by David j.Griffiths

UNIT – III
OPTICS (12)

3.1 Interference by division of wave front (Biprism)

Introduction , Interference of Light Waves, Interference Pattern , Intensity Distribution, Fresnel Biprism

3.2 Interference by division of amplitude (Newton's rings)

Interference by Plane parallel Wave, Cosine Law, Interference by a film with Non-Parallel reflecting surface, Wedge, Newton's Rings.

3.3 Michelson's interferometer

Interference by Plane film illuminated by a point source, Michelson's Interferometer.

3.4 Fraunhoffer diffration (Single slit)

Introduction, Types of Diffraction,Single Slit Frauhoffer Diffraction, Position of Maxima and Minima,Graphical Method for determining roots

3.5 Frauhoffer diffraction Double slit & multiple slits

Double slit Fraunhoffer diffraction by N- Parallel slits

3.6 Diffraction Gratings, Grating and Resolving Power

Diffraction Grating, Construction of Grating, Grating Spectrum, Resolution, Resolving Power of a diffraction Grating

3.7 Fresnel diffraction and Zone Plate

Types of Diffraction, Fresnel diffraction, Fresnel Half Period zones, Zone plate Application of Zone, Lens

3.8 Production of Plane Polarised light & double refraction

Introduction , Polarisation of Light waves, Representation of various types of light, Polarization by Reflection,Brewster's Law, Laws of Malus and proof, Geometry of Calcite Crystal, Double Refraction, Nicol's Prism, Applications.

3.9 Quarter & Half – wave plate, elliptical & circular polarized lights

Huygen's Theory of Double Refraction, Quarter Wave plate, Half Wave Plate, Elliptically and Circularly Polarised light.

3.10 Production & detection of elliptical & circular Polarised lights

Elliptically polarised Light, Circularly polarised light, Conversion of Elliptically polarized light to Circularly polarised light, Analysis of polarized light of Different Kinds.

3.11 Theory of Laser

Introduction, Spontaneous Emission, Stimulated Emission, Relation between Spontaneous and Stimulated emission Probabilities, Population Inversion, Pumping, Active systems.

3.12 Different kinds of Lasers

Ruby laser Working Semiconductor laser,He-Ne laser ,Application of Laser.

Reference Books :

1. Engineering Physics By Malik and Singh
2. Optics by Ajoy Ghatak
3. Optics by Pedrotti and Pedrotti.

UNIT – IV

QUANTUM MECHANICS (6)

4.1 Failures of classical physics

Limitations of classical physics, Blackbody Radiation, Spectral Lines, Photoelectric Effect, Planck's Quantum Hypothesis, Einstein's Theory of photoelectric Effect, Compton effect, Existence of stationary states, Stern-Gerlach Experiment

4.2 DeBroglie waves & Uncertainity Principle

Introduction, Matter waves Electron Diffraction Experiment Standing waves of an electron in orbit, Uncertainity Principle Single Slit Experiment, Application of Uncertainty Principle.

4.3 Wave function, Schrodinger Equation & probablity interpretation

Time Dependent Schrodinger Equation ,1- D Equation for a free particle, extension to 2-D, Inclusion of forces, Probability current Density

4.4 Operators , expectation values & Time independent Schrodinger Equation

Operators ,Expectation Value, Ehrenfest Theorem, time independent schrodinger Equation and Admissibility Conditions on Wave function.

4.5 Solution for generalised potential

Motion of a particle in a Potential – Classical view .

4.6 Particle in a box

Square well potential with Rigid walls, Energies and Wave functions

Reference Books:

1. Modern Physics by A. Beiser
2. Quantum Mechanics by Aruldhas.

UNIT – V
CONDENSED MATTER PHYSICS (6)

5.1 CRYSTALLOGRAPHY-I

Introduction, Crystal ,Single, poly and Amorphous state, Lattice Points and Space Lattice, Unit cell, Primitive Unit Cell in 2-D ,Non-primitive Unit Cell in 2-D lattice ,Primitive unit cell in 3-D ,Non Primitive unit cell in 3-D,Bravais Lattice and crystal systems, Atomic Packing, Crystal structure

5.2 Crystallography-II

Miller Indices, Positions, Directions, Planes Obtaining Miller indices, Important Cubic crystal structures, SC, BCC, FCC, Closed Packed structures, Packing fraction, NaCl Structure, Diamond , ZnS Structure.

5.3 X-ray diffraction

Introduction, Bragg's Law, Diffraction Direction Experimental Methods of x-Ray Diffraction, Powder method Debye - Scherrer Method Measurement of Bragg Angle

5.4 Defects in crystals

Introduction, Classification of Imperfections, Point Defects, vacancies, Schottky defects, Intersitial, Frenkel defects, Impurities, Colour centres, Line defect Planar Defects, Volume Defects, Thermodynamical consideration for Existence of Defect equilibrium

concentration of Schottky defects in metals, Equilibrium concentration of schottky defects in Ionic crystals, Frenkel defect in metals, Frenkel defects in ionic crystals

5.5 Electron theory of metals

Important properties of metals, electron theory of solids, classical free elecrtron theory, DC Electrical Conductivity, Gains of Drude Model, Sommerfeld quantum Model, Fermi Energy, Density of Energy States, carrier Concentration, Drawbacks of Sommerfeld Theroy

5.6 Band theory of solids

Introduction, Formation of Energy Bands in Crystals, Characteristics, Bonding, Classification, Intrinsic and Extrinsic Semiconductors, Band structure, Energy Bands, Fermi Level and Fermi Energy, Carrier Concentration, Density of electrons in Conduction band, Position of Fermi level, Hall Effect, Applications

Reference Books:

1. Solid state Physics by Dekker
2. Solid state Physics By C.Kittel

Category: **Basic Science Course** Subject code: **MA1201**

MATHEMATICS – II

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

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

Course Objectives:

- To learn the concepts of Eigen values, Eigen vectors, vector spaces and its basis.
- Toprovideanoverviewofordinary differentialequations
- To study the methods of solving improper integrals and the concepts of multiple integrals
- To studyvectordifferentialandintegralcalculus

Course Outcomes:

At the end of the course student will be able to

- Understand the definitions of Vector Spaces, Basis and Dimension of Vector Space.
- Understand the concept Linear Transforms and related theorems.
- Find the Eigen values & Eigen vectors of a given Matrix
- Apply Cayley Hamilton theorem for problems in Matrices
- Identify an ordinary differential equation and its order
- Classify ordinary differential equations into linear and nonlinear equations
- Model radioactive decay, compound interest, and mixing problems using first order equations
- Solve first order linear differential equations and special non linear first order equations like Bernouli , Riccati &Clairaut's equations
- Find the general solution of second order linear homogeneous equations with constant coefficients
- Use the method of undetermined coefficients to solve second order, linear homogeneous equations with constant coefficients
- Use the method of variation of parameters to find particular solutions of second order, linear homogeneous equations
- Compute double integrals over rectangles and \type I and II" regions in the plane
- Compute double integrals over a sector of an annulus using polar coordinates
- Memorize the statement of the change of variables theorem for double integrals, illustrate its geometric meaning with the aid of sketches, and apply it to computeintegrals over regions that are neither type I nor type II.
- Explain the concept of a vector field andmake sketches of simple vector fields inthe plane.
- Memorize statement and understand proof of Fundamental Theorem of Calculusfor functions on curves.
- Explain concept of a conservative vector field, state and apply theorems that give necessary and sufficient conditions for when a vector field is conservative, and describe applications to physics
- Memorize Green's Theorem, and make sketch illustrating it. Explain how Green's Theorem is a generalization of the Fundamental Theorem of Calculus.

UNIT-I

Linear Algebra: System of Linear equations ,Vector spaces, Subspaces, Linear combination of vectors, linear dependence and independence of vectors, Basis and Dimension of Vector Space.

Linear transformations, Range and Kernel of Linear Transformations, Rank-Nullity theorem. Matrix representations of Linear Transformation.Eigenvalues and Eigenvectors of a Linear Transformation and their properties , Cayley - Hamilton Theorem, Hermitian and skew Hermitian matrices. Quadratic forms, reduction of quadratic form to canonical form by orthogonal transformation.

UNIT-II

Ordinary Differential Equations of first order: Exact first order differential equation, finding integrating factors, linear differential equations, Bernoulli's , Riccati , Clairaut's differential equations, finding orthogonal trajectory of family of curves, Newton's Law of Cooling, Law of Natural growth or decay.

UNIT-III

Ordinary Differential Equations of higher order: Linear dependence and independence of functions, Wronskian of n- functions to determine Linear Independence and dependence of functions, Solutions of Second and higher order differential equations (homogeneous & non-homogeneous) with constant coefficients, Method of variation of parameters, Euler-Cauchy equation.

UNIT-IV

Integral Calculus : Convergence of improper integrals, tests of convergence, Beta and Gamma functions - elementary properties, differentiation under integral sign, differentiation of integrals with variable limits - Leibnitz rule. Rectification, double and triple integrals, computations of surface and volumes, change of variables in double integrals - Jacobians of transformations, integrals dependent on parameters – applications.

UNIT-V

Vector Calculus : Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, Laplacian, line and surface integrals, theorems of Green, Gauss and Stokes.

Text Books:

1.Advanced Engineering Mathematics (3rd Edition) by R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, New Delhi

Suggested References:

1. Advanced Engineering Mathematics (8th Edition) by Erwin Kreyszig, Wiley-India.

2. Dr. M.D. Raisinghania, Ordinary and Partial differential equations, S.CHAND, 17th Edition 2014.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Engineering Science Course** Subject code: **CS1201**

SCRIPTING LANGUAGES

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-3**

Prerequisites

1. Programming in C and Data Structures.

Course Objectives

1. To learn scripting languages- Python, Perl, PHP

Course Outcome

1. Student will be able to write dynamic web pages and will also be able to build a basic search engine using python and also search through text files using Perl.

UNIT-I

Python - Introduction-Variables, Strings, numbers, comments, Lists- introducing list, lists and looping, common list operations, removing items from list, numerical lists, list comprehensions, strings as lists, tuples, file I/O, functions, conditional statements and iterative statements.

UNIT –II

Python - Dictionaries, common operations with dictionaries, looping through dictionaries, nesting, classes, inheritance, modules and classes, exceptions and testing. Exceptions, sorting, introduction to standard libraries, building a Search Engine using all the above concepts.

UNIT-III

Perl – Data types, scalar functions, Quoting Basics, Functions, Control Structures, Inputs, Error Handling.

UNIT-IV

Perl – File input output, text processing functions, Hashes, DBM Databases, Regular Expressions.

UNIT- V

HTML – Styles, links, images, Static and Dynamic pages, Paragraphs and Fonts, Lists, CSS introduction, Introduction to HTML5 and semantics.
PHP – Loops, String Functions, Email function, Data and time, Image Uploading, Error Handling.

Text Books:-

3. Programming Python, 4th Edition Powerful Object-Oriented Programming By Mark Lutz
4. Learning Perl, Randal L Schwartz.
5. Web Programming, building internet applications, Chris Bates 2nd edition, WILEY Dreamtech

Category: **Engineering Science Course** Subject code: **EE1001/2001**

BASIC ELECTRICAL & ELECTRONICS ENGINEERING
(Common to CSE, CIVIL, Chemical, ME & MME)

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-2-4**

Course Objectives:
This course introduces the concept of

- Electrical DC and AC circuits, basic law's of electricity, different methods to solve the electrical networks
- Construction operational features of energy conversion devices i.e., DC and AC machines, transformers.
- It also emphasis on basics of electronics, semiconductor devices and their characteristics and operational features.

UNIT- I DC CIRCUIT ANALYSIS
Electrical Circuits - R-L-C Parameters, Voltage and Current Independent and Dependent Sources, Source Transformation – V–I relationship for Passive elements, Kirchoff's Laws, Network reduction techniques – series, parallel, series parallel, star–to-delta, delta-to-star transformation, Mesh Analysis and Nodal Analysis

UNIT- II AC CIRCUIT ANALYSIS
Single Phase AC Circuits - R.M.S. and Average values, Form Factor, steady state analysis of series, Parallel and Series parallel Combinations of R, L and C with Sinusoidal excitation, concept of reactance, Impedance, Susceptance and Admittance – phase and phase difference, Concept of Power Factor, j-notation, complex and Polar forms of representation.
Resonance – Series resonance and Parallel resonance circuits, concept of bandwidth and Q factor, Locus Diagrams for RL, RC and RLC Combinations for Various Parameters.

UNIT- III NETWORK THEOREMS AND THREE PHASE AC CIRCUITS
Network Theorems - Thevenin's, Norton's, Maximum Power Transfer, Superposition, Reciprocity, Tellegen's, Millman's and Compensation theorems
Three phase ac circuits -Three phase EMF generation, delta and Y connections, line and phase quantities, solution of three phase circuits, balanced supply voltage and balanced load, phasor diagram, measurement of power in three phase circuits

UNIT- IV BASIC ELECTRONICS

Introduction to electronics and electronic systems, Semiconductor and devices like diodes, zener diode, BJT, FET, MOSFET, Rectifier and ripple Filters, Transistor biasing. Small signal transistor amplifiers, Operational amplifiers, Feedback and Oscillators, Introduction to digital circuits

UNIT- V ELECTRICAL MACHINES

DC machines: Construction, EMF and Torque equations, Characteristics of DC generators and motors, speed control of DC motors and DC motor starters.

Transformers : Construction, EMF equation, ratings, phasor diagram on no load and full load, equivalent circuit, regulation and efficiency calculations, open and short circuit tests, auto-transformers.

Induction motors: The revolving magnetic field, principle of orientation, ratings, equivalent circuit, Torque-speed characteristics, starters for cage and wound rotor type induction motors.

TEXT BOOKS:

1. Electrical Technology- Hughes Prentice Hall, 7th edition
2. Problems In Electrical Engineering- S. Parker Smith, 9 edition
3. Electronic Devices and Circuits – R.L. Boylestad and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
4. Millman's Electronic Devices and Circuits – J.Millman and C.C.Halkias, Satyabratajit, TMH, 2/e, 1998.
5. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, Mc Graw Hill Company, 6th edition.
6. Electric Machines –by I.J.Nagrath & D.P.Kothari,Tata Mc Graw Hill, 7th Edition.2005

REFERENCES:

1. Electronic Devices and Circuits - K. Lal Kishore, B.S. Publications, 2nd Edition, 2005.
2. Electronic Devices and Circuits – Anil K. Maini, Varsha Agarwal –Wiley India Pvt. Ltd. 1/e 2009.
4. Network Theory by N.C.Jagan & C.Lakshminarayana, B.S. Publications.
5. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
6. Electrical machines-PS Bhimbra, Khanna Publishers.

Category: **HSM Course** Subject code: **HS1201**

COMMUNICATION SKILLS -II

Externals: **L-T-P-C***
Internals: **2-0-0-1**

Course Objectives:

- To develop the learners ability to read fluently and critically.
- To make awareness of the common punctuation marks and the importance of it in writing
- To build academic vocabulary of the learners
- To offer the learners opportunity to practice creative writing
- To make the learners apply the skills and strategies of a successful listener

Course Outcomes;

The learners will be able to:

- make use of contextual clues to infer meanings of unfamiliar words from context and make inferences and predictions based on comprehension of a text
- punctuate simple sentences correctly
- produce appropriate vocabulary and correct word forms;
- Write creatively and accurately. They will also have a critical awareness of their writing in terms of unity, content, coherence and linguistic accuracy (grammatical structure and choice of vocabulary).
- Comprehend the talks and presentations, take organized notes on lectures and listening passages

Unit I - Reading

Reading Skills – Importance - Definition –Types -Techniques and strategies

Unit II – Punctuation and Capitalization

Punctuation - Use of Capital Letters

Unit III – Vocabulary

1. Antonyms

2. Synonyms
3. Affixation
4. Vocabulary in context
5. Proverbs /Collocations
6. One word substitutes
7. Idioms and Phrasal verbs

Unit IV – Writing Skills

Creative writing – Story Writing – Precise - Letter writing

Unit V - Listening

Listening Skills – Academic Listening – Listening to Talks and Presentations – Note Taking

References:

1. Meenakshi Raman and Sangeeta Sharma ***"Communication skills"*** Oxford University press, 2013
2. Wren and Martin, NDV Prasad Rao. *"**High School English Grammar and Composition***" S. Chand& Compay Ltd, 2012
3. Michael Swan, ***"Practical English Usage"*** 3rd edition: guide to problems in English, Oxford University press, 2011
4. Edgar Thorpe and Showick Thorpe, ***"Objective English"*** 3rd Edition, Pearson, 2010

Category: **Engineering Science Course** Subject code: **CE1001**

ENGINEERING DRAWING

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To understand the basic concepts of drawing and use of drafter.
- To draw the basic geometrical constructions and curves used in engineering.
- To understand and draw the projections of points, lines, planes and solids.
- To know about isometric projections.

Course Outcomes

- **Ability to draw the 3 dimentional structure by using isometric and perspective views**
- **Ability to draw the section elevation of a structure**

Concepts and conventions: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning

UNIT-1

Plane curves and free hand sketching: Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves, Scales: Construction of Diagonal and Vernier scales. Visualization concepts and Free Hand sketching: Visualization principles – Representation of three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT-II

Projection of points, lines and plane surfaces: Orthographic projection- principles- Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces - Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method

UNIT-III

Projection of solids: Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

UNIT-IV

Projection of sectioned solids and development of surfaces: Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

UNIT V

Isometric and perspective projections: Principles of isometric projection – isometric scale – Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones-combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Computer aided drafting (demonstration only)

Introduction to drafting packages and demonstration of their use.

Suggested Readings:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50 Edition, 2010.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age publications
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern EconomyEdition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age

Category: **Basic Science Course** Subject code: **PH1601**

ENGINEERING PHYSICS LAB

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-2-2**

1. Coupled Pendula
2. Specific rotation - Polarimeter
3. Diffraction Grating
4. Dispersive power of a prism
5. Franck Hertz experiment
6. Photoelectric effect
7. Four probe Experiment
8. Hall effect
9. Ultrasonic Waves

Category: **Engineering Science Course** Subject code: **EE1601/2601**

BASIC ELECTRICAL & ELECTRONICS ENGINEERING LABORATORY

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-2-2**

List of Experiments:

1. Verification of Network Theorems
2. R-L-C Series Circuit
3. Series and parallel resonanance
4. Three phase power measurement by two Wattmeter method
5. Speed control of DC motor
6. OC and SC Test of Single Phase Transformer
7. OCC of separately excited DC Shunt Generator
8. V-I characteristics of Diodes and BJT
9. Half-wave and full-wave rectifiers, rectification with capacitive filters, zener diode
10. Studies on logic gates

Category: **Engineering Science Course** Subject code: **ME1601**

ENGINEERING WORKSHOP

Instruction	: 3 Hours/Week (3 Practical)
Duration of External Exam	: 3 Hours
Scheme of External Exam	: 60 Marks
Scheme of Internal Exam	: 40 Marks
Credits	: 2

Course Objectives:

The budding Engineer may turn out to be a technologist, scientist, entrepreneur, practitioner, consultant etc. There is a need to equip the engineer with the knowledge of common and newer engineering materials as well as shop practices to fabricate, manufacture or work with materials. Essentially he should know the labour involved, machinery or equipment necessary, time required to fabricate and also should be able to estimate the cost of the product or job work. Hence engineering work shop practice is included to introduce some common shop practices and on hand experience to appreciate the use of skill, tools, equipment and general practices to all the engineering students.

1. TRADES FOR EXERCISES:

a. Carpentry shop–

Two joints (exercises) involving tenon and mortising, groove and tongue: Making middle lap T joint, cross lap joint, mortise and tenon T joint, Bridle T joint from out of 300 x 40 x 25 mm soft wood stock

b. Fitting shop–

Two joints (exercises) from: square joint, V joint, half round joint or dove tail joint out of 100 x 50 x 5 mm M.S. stock

c. Sheet metal shop–

Two jobs (exercises) from: Tray, cylinder, hopper or funnel from out of 22 or 20 guage G.I. sheet

d. House-wiring–

Two jobs (exercises) from: wiring for ceiling rose and two lamps (bulbs) with independent switch controls with or without looping, wiring for stair case lamp, wiring for a water pump with single phase starter.

e. Foundry–

Preparation of two moulds (exercises): for a single pattern and a double pattern.

f. Welding –

Preparation of two welds (exercises): single V butt joint, lap joint, double V butt joint or T fillet joint

2. TRADES FOR DEMONSTRATION:

a. Plumbing
b. Machine Shop
c. Metal Cutting

Apart from the above the shop rooms should display charts, layouts, figures, circuits, hand tools, hand machines, models of jobs, materials with names such as different woods, wood faults, Plastics, steels, meters, gauges, equipment, CD or DVD displays, First aid, shop safety etc. (though they may not be used for the exercises but they give valuable information to the student). In the class work or in the examination knowledge of all shop practices may be stressed upon rather than skill acquired in making the job.

REFERENCE BOOKS:

1. Engineering Work shop practice for JNTU, V. Ramesh Babu, VRB Publishers Pvt. Ltd., 2009
2. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.
3. Engineering Practices Lab Manual, Jeyapoovan, Saravana Pandian, 4/e Vikas
4. Dictionary of Mechanical Engineering, GHF Nayler, Jaico Publishing House.

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

II YEAR
I SEMESTER

CODE	SUBJECT	L-T-P	Credits	Category
MM2101	Physical Metallurgy	4-0-0	4	PCC
MM2102	Mineral Processing	4-0-0	4	PCC
MM2103	Metallurgical Thermodynamics	4-0-0	4	PCC
MM2104	Foundry Technology	4-0-0	4	PCC
BSBE2001/3001	Environmental Science	3-0-0	3	
HS2101	Soft Skills-I	2-0-0	1	HSMC
MM2701	Physical Metallurgy Lab	0-0-3	2	PCC
MM2702	Foundry Technology Lab	0-0-3	2	PCC
MM2901	Seminar – I	1-0-0	1	
Total		**22-0-6**	**25**	

Category: **Professional Core Course** Subject code: **MM2101**

PHYSICAL METALLURGY

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the basic concepts of crystal structures and geometry of different materials
* To study the possibility of formation of solid solutions, solidification process
* To plot equilibrium diagrams and analyze various binary phase diagrams including Iron – iron carbide equilibrium phase diagram
* To analyze TTT, CCT diagrams and classifications of steels and cast irons
* To study various heat treatment processes and importance of alloying

Course Out Comes:

- Students will be able to conceive the arrangement of atoms into different crystallographic arrangements.
- An understanding on the crystallographic changes in the materials which occur with the variation in temperature and apply the knowledge in various metallurgical operations will be developed.
- The pupil will be able to identify systems which can form either solid solutions or compounds based on the interactions between them.
- The concept of phase stability can be deduced from the phase diagrams and the evolution of different phases under a given set of conditions can be studied.
- Understanding of the allotropic transformations of iron along with the changes in the phases with variations in Carbon content and temperature can be developed. The difference between steels and cast irons can be identified.
- Effect of alloying additions and temperatures on the nucleation and transformation of different phases can be analyzed by using TTT and CCT diagrams.
- Heat treatment operations and their influence on the grain size, material behavior and phases can be studied.
- Theoretical and problematic understanding can be developed.

UNIT – I: Atomic structure and bonding in solids, crystal structures, crystalline and non-crystalline materials, Indexing of lattice planes and directions, Indexing of lattice directions, Co-ordination no., Atomic packing factor, Ceramic crystal structures, Imperfections in solids like point, line and interfacial defects, Diffusion: Mechanism, Steady & Non-steady diffusion, Influencing factors.

UNIT – II: Equilibrium diagrams: Basic definitions, Hume-Rothery's rules, Gibbs phase rule, Polymorphism, Solidification of a pure metal, Cricital size of nucleus, Shape of crystals, Dendritic growth, Types of cooling curves, Plotting of equilibrium diagram, Lever rule.

UNIT – III: Unary phase diagram, Binary Phase diagrams (Type-I, II, III, IV, V, VI, VII), Iron – Iron carbide equilibrium diagram, Critical temperatures, Solidification and microstructure of slow cooled steels.

UNIT – IV: Classification & Specification of steels, Transformation of austenite to pearlite, bainite, martensite, Time Temperature Transformation (TTT) diagrams, Continuous Cooling Transformation (CCT) diagrams, Precipitation and Age hardening, Recovery, Recrystallization and Grain growth, Classification of cast irons

UNIT – V: Heat Treatments: Annealing and its types, Normalizing, Hardening and Tempering, Case hardening: Carburizing, Nitriding, Carbonitriding, Flame hardening and Induction hardening, Classification and effect of alloying elements, Properties and uses of alloying elements, Types of alloy steels and its designations.

Books:

1. Materials Science and Engineering – V. Raghavan
2. Physical Metallurgy – V. Raghavan
3. Material Science and Engineering – Callister
4. Introduction to Physical Metallurgy – Avner
5. Material science and Metallurgy – V. D. Kodgire, S. V. Kodgiri

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2102**

MINERAL PROCESSING

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

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

Course Objectives:

***** A clear understanding of ores, minerals and their sources to be provided.

* To understand the basic concepts and operations of ore dressing

* To study mineral liberation by different unit operations like crushing, grinding etc.,

* To understand the concept of classification and concentration and their difference.

* To understand the behavior of minerals in fluids for sizing and concepts of sizing operations

* To study the classification of minerals based on their density, size and shape in different mediums

* Studying the different concentration processes like heavy media separation, froth floatation, magnetic separation, jigging, tabling etc.,

Course Outcomes:

- Students will be able to understand and apply the knowledge of mineral beneficiation in preparing the ore for extraction of metals.
- Identification of the differences between ores, minerals and gangue particles so as to facilitate their optimal separation.
- An understanding of the different unit level operations which form the grass roots of all metal extraction processes is developed.
- A clear conception on the effect of several factors like particle density, size, shape, magnetic properties etc., on the beneficiation process.
- To conceive the step wise working of industries in liberation and beneficiation of ores before sending them for economical extraction of concerned metals.

UNIT-I

Scope and objectives of ore dressing. Sampling of ores by different methods. Theory of liberation of minerals. Crushers: -Jaw, Gyratory, Cone, Rolls and toothed roll crushers. Types of grinding operations like batch and continuous dry and wet grinding, open circuit and closed circuit grinding. Grinding Mills:

Ball mills, theory of ball mill operation, rod and tube mills. Comminution laws: - Rittinger's laws, Kick's law and Bond's law.

UNIT-II

Sizing: Study of laboratory sizing techniques and reporting of sizing data. Industrial sizing units: Types of screen surfaces. Grizzlies, trommels, vibrating and shaking screens. Movement of solids in fluids: Stokes and Newton's laws. Terminal velocity and its relation with size. Relation between time and velocity. Relation between distance traveled and velocity. Equal settling ratio, Free and hindered settling ratios. Quantifying concentrating operations: Ratio of concentration, recovery, selectivity index and economic recovery.

UNIT-III

Classification of classifiers, study of settling cones, rake classifier, spiral classifier and cyclones.Heavy media separation: Principles, flow chart, different media used. Heavy media separation using heavy liquids and heavy suspensions. Washability curves for easy, normal and difficult coal.

UNIT-IV

Jigging: Theory of jigging. Jigging machines: hand jig, harz jig, denner jig baum jig, Hancock jig, James coal jig and halkyln jig. Design considerations in a jig. Tabling: -study of stratification on a table. Shaking tables, wilfley table. Humphrey's spiral classifier.

UNIT-V

Flotation: Principles of flotation.Factors affecting flotation.Classification of collectors and frothers.Regulators factors affecting their efficiency. Flotation machines: -Pneumatic and mechanical flotation cells. Application of flotation process for Cu,Pb and Zn ores. Magnetic separation processes and electrostatic separation process.

TEXT BOOKS:

1. Principles of Mineral Dressing by A.M. Gaudin.

2. Ore Processing by S.K Jain

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2103**

METALLURGICAL THERMODYNAMICS

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

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

Course Objectives:

* To understand the basics of thermodynamics.

* To make the students understand and apply the concept of phase and to predict the number of phases that can coexist under the given conditions

* To study and understand different laws of thermodynamics and their applications.

* To evolve the concept of stability of a system and the effect of different variables on it by the application of thermodynamic laws.

* To enable the students understand and solve the necessary derivations and problems, improving their application skills.

* To study the kinetics of thermodynamic reactions in the system.

* To facilitate a study of the stability of compounds under the influence of temperature by the application of Ellingham-Richardson's diagrams and apply this concept to understand reduction kinetics and of a compound by different reducing agents.

* To study electrochemical cells and the kinetics of electrolytic reactions.

Course Out comes:

- Students will be able to understand the concepts of thermodynamics and its kinetics, and apply the knowledge in various extractive metallurgical operations.
- A reasonable clarity on the concept of phase and its stability can be arrived at and the pupil should be able to apply Gibbs phase rule to predict the number of phases that can coexist for a given set of components for a given set of variables.
- Drawing the concept of enthalpy from the first law of thermodynamics.
- To introduce the concept of entropy and free energy of the system. Apply the relation between free energy, entropy and free energy to describe stability.
- The pupil is able to determine the possibility of reduction of a compound by determining suitable reducing agent and temperature of reduction using the Ellingham diagrams. Application of carbon as a reducing agent can be understood for different compounds.

- Kinetic of electrochemical and galvanic cells and their kinetics is to be understood.
- By the end of the course, the student is expected to be able to understand the feasibility and kinetics of a metallurgical reaction along with its nature.
- Problem solving ability of the student will be improved along with analytical and logical skills.

UNIT-I

Importance of thermodynamics, definition of thermodynamic terms; concept of states, systems equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Gibbs phase rule, Phase diagram of a single component system. Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

UNIT-II

The Second law of thermodynamics, entropy and free energy, degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, transformation formula, Gibbs- Helmoltz equation.

UNIT-III

Concept of Third law, temperature dependence of entropy, statistical interpretation of entropy, Deby and Einstein concept of heat capacity, relation between Cp and Cv, Consequences of third law, Fugacity, activity, equilibrium constant, chemical potential, use of Y S - functions, controlled atmospheres, homogeneous and heterogeneous equilibria.

UNIT-IV

Ellingham-Richardson diagrams, phase stability diagrams. Solution thermodynamics, Solutions, partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, quasi-chemical approach to solution, statistical treatment. Change of standard state. Phase relations and phase rule-its applications. Free energy composition diagrams for binary alloysystems, determination of liquidus, solidus and solvus lines.

UNIT-V

Thermodynamics of electrochemical cells, solid electrolytes. Thermodynamics of point defects in solids. Thermodynamic applications in extraction, refining of metals and materials processing.

TEXT BOOK:

1. Introduction to Metallurgical Thermodynamics – D.R. Gaskel
2. Text Book of Materials and Metallurgical Thermodynamics: Ahindra Ghosh (PHI)

REFERENCES:

1. Physical chemistry for Metallurgists – J. Mackowick
2. Thermodynamics of solids-R.S.Swalin
3. Physical chemistry of metals-L.S.Darken & Gurry
5. Fundamentals of thermodynamics-Sonntag et al

Category: **Professional Core Course** Subject code: **MM2104**

FOUNDRY TECHNOLOGY

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the basic concepts of casting tools and equipment for mold preparation
* To design the pattern and understand the pattern and core characteristics
* To understand the designing of the gating system and riser
* To study various other casting processes suiting various applications
* To study about the melting furnaces along with the testing methods and identify the defects

Course Out comes:

- Students will be able understand the fundamentals concepts of metal casting operations and apply the knowledge in solving various operational problems arise during metal casting.
- Clear conception of the entire process of production of a component can be developed.
- An understanding on the process and problems involved in molding and casting is achieved.
- Different types of patterns can be identified.
- The student should be able to design gating systems and identify the importance of pressurized and un-pressurized gating systems on casting process. This will show a clear understanding on the student's part about the importance of gating systems.
- Study of different types of casting processes and their specialty.
- Evaluation of different modes of testing (destructive and non-destructive) the cast parts.

UNIT – I :

Introduction: Introduction and overview of subject, Foundry processes – Molding & Casting, Casting in green sand mold, Foundry tools and equipment, Mold materials and their selection, Molding sands, Constituents of molding sand, Sand preparation and conditioning, Characteristics of molding sand, Molding sand for casting different materials

UNIT – II :

Patterns and Molds: Pattern colors, Pattern materials, Pattern allowances, Types of patterns, Cores, Types of cores, Characteristics of core, Core materials, Types of molds.

UNIT – III :

Gating System and Risers: Solidification of casting, designing gating system in sand molds, Gating ratio, Types of gates, designing of risers.

UNIT – IV :

Casting methods: Sand mold casting, Metallic mold casting, Slush casting, Pressure casting, Die casting, Centrifugal casting, Shell molding, Investment casting, Continuous casting, Chill casting and Metals and alloys used in casting.

UNIT – V :

Testing: Inspection and testing of casting, Testing of molding sands, **Metal melting furnaces:** Crucible, Electric, Cupola, Rotary; Casting defects – appearance, cause and remedies.

Books:

1. Metal casting Technology – P. N. Rao
2. Foundary Technology – O. P. Khanna
3. Manufacturing Technology – P. N. Rao
4. Production Engineering – Dr. Swadesh Kumar Singh
5. Manufacturing Processes – J. P. Kaushish

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: Subject code: **BSBE2001/3001**

ENVIRONMENTAL SCIENCES

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

Course Objectives:

- To study the sources of water,floods and its impact on environment
- To know about the ecosystem and energy resource system
- To understand the Biodiversity concept and its advantages
- To study different types of pollution and its impact on environment
- To know the social and environment related issues and their preventive measures

Course Outcomes

- To get the idea about the relation between biotic and abiotic environment in nature
- To get the idea about the nature and the pollutants
- To get opportunity to know the value of bio diversity and threats of bio diversity
- To know about the conservation of biodiversity
- Ability to know the environmental impact

Unit - I

Environmental studies: Definition, scope and importance, need for public awareness.

Natural resources: Water resources; use and over utilization of surface and ground water, Floods, drought, conflicts over water, dams-benefits and problems. Effects of modern Agriculture, fertilizer-pesticide problems, water logging and salinity.

Unit - II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in ecosystem, food chains, ecological pyramids, aquatic ecosystem(ponds, streams, lakes, rivers, oceans, estuaries).

Energy resources: Growing energy needs renewable and non-renewable energy sources.

Land resources.land as resource, land degradation, soil erosion and desertification.

Unit - III

Biodiversity: Genetic species and ecosystem diversity, bio-geographical classification of India. Value of biodiversity, threats to biodiversity, endangered and endemic species of India, conservation of biodiversity.

Unit - IV

Environmental pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution and solid and liquid waste management.

Environment protection act: Air, water, forest and wild life Acts, enforcement of Environmental legislation.

Unit - V

Social Issues and the Environment: Water conservation, watershed management, and environmental ethics. Climate change, global warming, acid rain, ozone layer depletion.

Environmental Disaster management: Types of disasters, impact of disasters on environment, infrastructure, and development. Basic principles of disaster mitigation, disaster management, and methodology, disaster management cycle, and disaster management in India.

Suggested readings:

1. A.K De, Environmental Chemistry,Wiley Eastern Ltd.
2. E.P. Odum, Fundamentals of Ecology,W.B. Sunders Co., USA.
3. M.N, Rao and A.K. Datta, Waste Water Treatment Oxford and IBK Publications.
4.Benny Joseph, Environmental Studies, Tata McGraw Hill, 2005.
5. V.K. Sharma, Disaster Management, National Centre for Disaster Management, IIPE, Delhi, 1999.

Reference:

1. Green Buildings Council of India, Teri Document.
2. GL. Karia and R.A. Christian, Waste Water Treatment, Concepts and Design Approach, Prentice Hall of Indian, 2005

Category: **HSM Course** Subject code: **HS2101**

HS2101 **Soft Skills- I**

Externals: **L-T-P-C***
Internals: **2-0-0-1**

Course Objectives:

- To make the students to understand the pattern of the Various Competitive Exams
- To make them to enhance Grammar, Comprehension and Vocabulary to appear for the Exams
- To make them practice the sentence building, correct usage, comprehension, and composition

Course Outcomes:

- Students will be able to get the clarity of various exams of SSC, AEE, TSPSC and UPSC
- Students will be able to improve their Grammar, Comprehension and Vocabulary
- Students will be able to get the confidence enough to appear for the Exams

Unit – I – Grammar-I

1. Previous question papers of AEE/TSPSC/SSC/Banking
2. Error Correction and Sentence Rearrangement
3. Clauses (Noun Clauses – Adjective Clauses; Adverbial Clauses) and Phrases (Noun phrases; verb phrases; adverbial phrases), If clauses
4. Types of sentences Positive/Negative/Interrogative/Negative interrogative
5. Transformations (Simple, Complex and Compound)

Unit – II – Grammar-II

1. Voice
2. Direct and Indirect Speech
3. Infinitives; Gerunds; Participles
4. Phrasal verbs; Idioms; Prepositional phrases
5. Forming Questions and Question Tags

Unit – III - Pronunciation

Aspects of Pronunciation

1. Consonant, Vowel Sounds and Diphthongs
2. Syllabification – Stress - Word Stress
3. Intonation: Falling – Raising – Falling and Raising

Unit – IV – Appreciation of poetry

Critical Appreciation of Selected Poems

Unit – V – Essay Writing

Opinion Essay – Argumentative Essay – Article Writing – Report Writing

REFERENCES:

5. R.P Bhatnagar and Bhargava Rajal, ***"English for Competitive Examinations".*** McMillan India limited, 2016.
6. Wren and Martin, NDV Prasad Rao. "***High School English Grammar and Composition***" S. Chand& Compay Ltd, New Delhi.
7. Murali Krishna, ***"English for Engineers."***Pearson Education, Inc. New Delhi, 2015.
8. E. Suresh Kumar, P. Sreehari and J. Savithi***. "English for Success."*** Foundation Books, Inc. New Delhi, 2014.
9. RS Agarwal, Vikas Agarwal, ***"Objective English"***S. Chand & Compay Ltd, New Delhi, 2016
10. http://www.bankexamstoday.com/2015/09/bank-exams-question-papers.html

Category: **Professional Core Course** Subject code: **MM2701**

PHYSICAL METALLURGY LAB

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-3-2**

Course Objectives:

* To provide hands on experience of different metallographic operations
* To study and understand microstructures of different metals
* To analyze results and draw conclusions from the results of the tests

Course Out comes:

- Students will be able to understand the metallographic operations and apply the knowledge in quality assessment and control of any metal or alloy produced.
- An understanding of phases and their differentiation.
- Skill in metallographic operations will be developed.
- An understanding on working principles of different Instruments.

List of experiments:

1. Study of optical microscopes.
2. Sample preparation for microscopy
3. To study the annealed and normalized microstructures of ferrous materials
   Steels (Low, Medium and High carbon steels)
   Stainless steel
   Cast irons (Gray, White and Nodular cast irons)
4. To study the microstructures of non – ferrous materials
   Aluminium
   Copper
   Brass
5. To study the effect of cold working (0-90%) and annealing on metallic materials; 50% cold worked metals (Cu, Brass) with respect to temperature and time.
6. Metallography analysis of microstructures.
7. Demo of sampling by electro polishing method.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2702**

FOUNDRY TECHNOLOGY LAB

Externals: 60Marks **L-T-P-C ***
Internals: 40Marks **0-0-3-2**

Course Objectives:

* To provide hands on experience of foundry operations
* To design patterns and sand moulds
* To simulate and analyse the results of casting operation
* To understand different casting techniques
* To understand and analyse different casting defects .

Course Out comes:

- Students will be able to understand various steps involved in producing a cast.
- They can also perform various quality assessment operations to identify the defects produced after casting and apply the knowledge in preventing those defects.
- Skills on different casting operations will be developed.
- An understanding of different simulation software

List of experiments:

Testing of molding sands

1. To test the size of sand grains and the distribution of grains of different sizes in a molding sand.
2. To prepare a sand mold and produce an aluminum casted product.
3. To determine the permeability number of the sand specimen.
4. To determine the green, dry and shear strength of the sand mold.
5. To determine the moisture content in the sand mold.
6. To determine the hardness of the mold.
7. To design a pattern by considering pattern allowances.
8. To design a gating system for minimum pouring time.
9. To design a riser for optimum solidification time.
10. Simulations using PRO CAST software.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: Subject code: **MM2901**

MM2901 **SEMINAR – I**

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

Internals: 40Marks **0-0-2-1**

Course Objectives:

- To improve the presentation skills
- To prepare PPT more effectively

Student has to choose a general topic to give a power point presentation

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

II YEAR
II SEMESTER

CODE	SUBJECT	L-T-P	Credits	Category
MM2201	Mechanical Metallurgy	4-0-0	4	PCC
MM2202	Materials Characterization Techniques	4-0-0	4	PCC
MM2203	Iron Making	4-0-0	4	PCC
MM2204	Non Ferrous Extractive Metallurgy	4-0-0	4	PCC
MM2205	Phase Transformations	4-0-0	4	PCC
BM2201	Personality Development-I	2-0-0	1	
MM2801	Mechanical Metallurgy Lab	0-0-3	2	PCC
MM2802	Materials Characterization Lab	0-0-3	2	PCC
MM2803	Non Ferrous Extractive Metallurgy Lab	0-0-3	2	PCC
MM2902	Seminar-II	1-0-0	1	
	TOTAL	**23-0-9**	**28**	

Category: **Professional Core Course** Subject code: **MM2201**

MECHANICAL METALLURGY

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* Emphasize on the importance of the basic phenomenon and mechanical relationships of materials
* To understand the description of stress and strain
* To introduce the concept of defects (1, 2 and 3 dimensional), dislocations, stacking faults etc., with special influence on dislocations, their interactions and energies between them.
* To analyze the influence of defects and their concentration on the mechanical properties and flow relations of materials.
* To familiarize different mechanisms of deformation like slip, twinning etc., and to describe the effects of different strengthening mechanisms on the deformation behavior of materials.
* To study major mechanical property tests.
* To know the basics of fracture mechanics
* To make the student bridge the gap between theoretical and problematic understanding by introducing different numerical and research problems.

Course Outcomes:

* A foundational understanding among the students on the structure property relations of materials.
* Studying of the different types of stress-strain relations and their importance in material deformation.
* To develop an understanding about the influence of dislocations and their interactions on the flow behavior of materials and to visualize the importance of dislocations in phenomenon like strain hardening, solid solution strengthening, cold working etc.,
* Student should be able to distinguish between different deformation mechanisms and reason with them.
* To be able to theoretically understand different mechanical testing processes and identifying the necessary conditions and possible deformation mechanisms associated. In addition a correlation between different mechanical properties is established.
* Estimating the life of structural components under given conditions.
* Predicting the manner of component failure and preventing it.
* Problem solving ability of the student will be improved along with analytical and logical skills.

Unit 1: Introduction:

Introduction, elastic, plastic, visco-elastic behavior and stress-strain relationships.

Unit 2: Plastic deformation:

Elements of plasticity, flow curve, dependence of flow curve on strain-rate, temperature and strain hardening effect, yield criteria, lattice defects, deformation by slip, critical resolved shear stress for slip, deformation by twinning, stacking faults, deformation bands and kink bands, micro-strain behavior.

Unit 3: Dislocation theory:

Observation of dislocations, burgers vector and dislocation loop, forces on and between dislocations, dislocation climb, intersection of dislocations, dislocation sources and multiplication, strengthening mechanisms.

Unit 4: Mechanical testing:

Hardness - hardness tests like Brinell, Rockwell, Vickers, Meyer, Knoop, Shore-scleroscope, relationships with flow curve.

Tension - evaluation of tensile properties, tensile instability, effect of strain-rate & temperature on flow properties, bend test.

Compression - Comparison with tension, buckling & barreling
Torsion - Stresses for elastic & plastic strain, Torsion Vs. Tension.

Impact - Notched bar impact tests, transition Temperature & metallurgical factors affecting it. Fatigue: S-N curve, low cycle fatigue, structural features, surface effects and metallurgical variables. Creep: Creep, the creep curve, stress rupture test, structural changes, creep mechanisms, DMM (deformation mechanism maps), and superplasticity.

Unit 5: Fracture mechanics:

Fracture, types of fracture, brittle fracture, Griffith theory of brittle fracture of material, ductile fracture, notch effects, and fracture mechanics.

Suggested References:

1. Dieter, G, E., Mechanical metallurgy (SI metric edition), McGraw-Hill book company, 1988.
2. Hertzberg, R, W., Deformation and fracture mechanics of engineering materials (3rd edition), John Wiley & sons, 1997
3. Hull, D and Bacon, D, J., Introduction to dislocations (4th edition), Butterworth-Heinmann, 2001.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2202**

MATERIALS CHARACTERIZATION TECHNIQUES

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the basic concept of different characterization techniques
* To know the working principles of materials characterization techniques.
* To analyze and understand the behavior of materials from characterization techniques.
* To study crystal structure, chemical composition, phase, residual stress and texture of materials.
* To study the microstructure of materials from optical and electron microscopes.
* To understand the spectroscopic, thermal and electrical characterization techniques.

Course Out comes:

- Students can be able to identify a suitable technique to characterize the material depending on the type of analysis required.
- Ability of the students to understand and characterize different systems from their X-ray data.
- Different microscopic techniques can be studied. Difference between optical and electron microscopic techniques is established.
- Spectroscopic techniques and their application in identifying the chemical characteristics of different systems.
- Students will gain the knowledge of the design and working principle of all characterization techniques involved.

UNIT-I

Introduction, Scope of subject, classification of techniques for characterization, macro & micro-characterization structure of solids

UNIT-II

Diffraction methods: X-ray diffraction (crystal systems and space groups, Bravais lattices, direct and reciprocal lattice, Bragg's law, powder diffraction and phase identification, single crystal diffraction, structure factor, X-ray crystal structure determination).

UNIT-III

Metallographic techniques: Optical metallography, image analysis, quantitative phase estimation. Electron optical methods: Scanning electron microscopy and image formation in the SEM, Transmission electron microscopy (TEM), Scanning tunneling microscopy (STM), Atomic force microscopy (AFM) and scanning transmission electron microscopy (STEM).

UNIT-IV

Optical & X-ray spectroscopy: Atomic absorption spectroscopy, X-ray spectrometry, infrared spectroscopy, Raman spectroscopy, EDS and WDS.

UNIT-V

Bulk averaging techniques: Thermal analysis, DTA, DSC, TGA, TMA, dilatometry, resistivity/conductivity.

Suggested References:

1. Spencer, Michael, Fundamentals of Light Microscopy, Cambridge University Press,1982.
2. David B. Williams, C. Barry Carter, " Transmission Electron Microscopy: A Textbook for Materials Science", Springer, pub. 2009.
3. Joseph I Goldstein, Dale E Newbury, Patrick Echlin and David C Joy, "Scanning Electron Microscopy and X-Ray Microanalysis", 3rd Edition, 2005.
4. B.D.Cullity and S.R.Stock, "Elements of X-Ray Diffraction" Third edition, Prentice Hall, NJ, 2001.
5. G.W.H. Hohne, W.F. Hemminger, H.-J. Flammersheim , "Differential Scanning Calorimetry", Springer, 2nd rev. a. enlarged ed., 2003.
6. 'Fundamentals of light microscopy and electronic imaging' Douglas B. Murphy, 2001, Wiley-Liss, Inc. USA
7. Electron optical applications in materials science (McGraw-Hill series in materials science and engineering) by Lawrence Eugene Murr.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2203**

IRON MAKING

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

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

Course Objectives:

* To study history of iron production and methods of producing iron from its ores.
* To study and understand iron production by blast furnace
* To study the physical chemistry during iron production from its ores at higher temperatures
* To understand the difficulties of iron production by blast furnace and sponge iron making methods.
* To study and understand iron production by sponge iron making process.

Course Out comes:

- Students will be able to understand various iron making operations, design and development of the operations.
- Identifying the importance of different agglomeration processes in the blast furnace iron making along with the mechanism involved in these.
- Study of different zones of the blast furnace and the physical chemistry in these zones.
- A pragmatic understanding of the methods of improving the overall efficiency of the blast furnace by coal injection, blast humidification, effective gas utilization etc.,
- Develop the ability to carry out burden calculations for the blast furnace.
- Case studies of different alternative processes for iron making.
- Students will gain the knowledge of various raw materials utilized in iron making and the physical chemistry during iron making.

UNIT-I

Introduction to pig iron production in India and the world, Occurrence and distribution of iron ore , limestone and coke in India. Preparation of iron ores; Agglomirtion of Iron ore fines, Sintering, Pelletising, Coke properties and its production.

UNIT-II

B.F profile and design considerations. Furnace lining. Furnace cooling system. Hoisting equipment.B.F. Stoves. BF gas cleaning system and gas uses,Coal injection, reduction and gas utilization- Rist diagram, thermal reserve zone, chemically inactive zone.

UNIT-III

Physical chemistry of Iron making; Blast furnace reactions; Physical and chemical factors affecting reduction of ores; Relevant CO/CO2 and H2/H2O diagram. Controls of C, Si, S, P in metals and slags,effect of alkali materials, types of Pig Irons & Blast furnace Slags,Furnace: combustion zone,
RAFT, deadman's zone, cohesive zone- size and shape.

UNIT-IV

Blast furnace operations and difficulties; Modern Trends in Blast furnace; Burden calculation; Limitations of Blast furnace Iron production; Alternate Routes of Iron Making.

UNIT-V

Principles of Sponge Iron Making, Degree of Metallization, Percentage Reduction, Classification of Sponge Iron making methods.Sponge Iron Production 1. Using gases reducing agent a. Midrex process b. HYL, c. Kiln Krupp-Renn; 2. Using solid reducing agent process such as SL/RN process, Smelt Reduction Methods; COREX, INRED, ELRED, Plasma Smelting; Iron making in India

TEXT BOOKS:

1. Principles of Blast furnace Iron making – A.K Biswas.

2. Modern Iron Making – Dr. R. Tupkary

3. Iron making and Steel making – Ahindra Ghosh & Amit

Chaterjee REFERENCES:

1. Beyond Blast furnace – Amit Chaterjee – CRC Press.

2.Hand Book of Extractive Metallurgy – Fathi Habhashi Vol. 1 Metals Industry Ferrous Metals

3. Hot metal Production by Smelting Reduction of Iron Oxides – Amit chaterjee,

T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2204**

NONFERROUS EXTRACTIVE METALLURGY

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

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

Course Objectives:

* To understand the methods of metal extraction and sources of non ferrous metals
* To study the thermodynamics principles involved in metal extraction
* To study the methods of extracting non ferrous metals from their sources
* To study various methods of refining the extracted metals.

Course Out comes:

- Students will be able to identify various resources of non ferrous metals and understand their extraction and refining methods by applying thermodynamic concepts for extraction.
- Clear differentiation between ferrous and non ferrous materials to be achieved along with identifying their sources.
- Understanding the application of Ellingham diagrams in the extraction of metals.
- Studying the general methods of extraction (pyro, hydro and electro metallurgical) along with their principles along with methods of refining.
- Study of extraction of metals from oxide sources, conversion of sulphide ores to oxides followed by their reduction.
- Extraction of metals from metal halides to be understood.
- The student should be able to perceive the extraction processes industrially and for economic purposes.

UNIT-I

History of Non ferrous Metals: Early developments in metal extraction (Introduction, discovery of metals and their importance, important landmarks, nonferrous metals in Indian history, uses of nonferrous metals), Sources of None ferrous metals(Sources in land and sea, exploration methods, methods of beneficiation, nonferrous metals wealth in India).

UNIT-II

Principles of metals extraction, (Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry), General methods of extraction, (Pyro-metallurgy – calcinations, roasting and smelting, Hydrometallurgy – leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy – electrolysis and electro-refining),General methods of refining, (Basic approaches, preparation of pure compounds, purification of crude metal produced in bulk).

UNIT-III

Extraction of metals from oxide sources: Extraction of metals such as magnesium, aluminum, tin and ferro-alloying elements, production of ferro alloys.

UNIT-IV

Extraction of metals from sulphide ores: Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc.)

UNIT-V

Extraction of metals from halides, (Production of halides and refining methods, production of reactive and reactor metals. Methods of extraction of metals such as titanium, rare earths, uranium, thorium, plutonium, beryllium, zirconium etc.)

TEXT BOOKS:

1. Extraction of Non-Ferrous Metals - HS Ray, KP Abraham and R. Sridhar. .

2. Non Ferrous Extractive Metallurgy – G B Gill John Wiley & Sons.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2205**

PHASE TRANSFORMATIONS

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To revise the basics of thermodynamics and stability concept of phase transformations
* To understand the principles of solidification
* To analyze the mechanisms and phenomenon associated with diffusion
* To study pearlitic and bainitic transformation
* To know the diffusionless transformation

Course Out comes:

- A pragmatic understanding on the concept of phase and the relationship between thermodynamics of materials and the transformations occurring in them.
- Understanding the concept of nucleation and growth of solid phases from the liquid to obtain different grain morphologies.
- A complete idea of the formation of different phase like peritectic or eutectic mixtures along with their free energies to be deduced.
- Analyzing the conditions and transformations associated with solidification of metals.
- Study of the effect of diffusion on the phase shift along with their kinetics.

Unit 1: Introduction

Phase equilibrium: Introduction, Thermodynamics and stability of phases, classification of phase transformations, order of transformation, Gibbs rule and application, phase diagrams, construction and interpretation.

Unit 2: Liquid-solid transformation:

Nucleation: homogeneous and heterogeneous, Growth: continuous and lateral, interface stability; alloy solidification: cellular and dendritic, eutectic, off-eutectic, peritectic solidification, welding, casting and rapid solidification.

Unit 3: Diffusion:

Atomic mechanism, interstitial and substitutional diffusion, atomic mobility, tracer diffusion in binary alloys and diffusion in multiphase binary systems.

Solid state diffusive transformation:

Classification, nucleation and growth - homogeneous and heterogeneous mechanism, precipitate growth under different conditions, age hardening, spinodal decomposition, precipitate coarsening, transformation with start range diffusion, recrystallization, grain growth, eutectoid transformation, discontinuous reactions.

Unit 4: Pearlitic and bainitic transformation:

Factors influencing pearlitic transformation, mechanism of transformation, nucleation and growth, orientation relationship, degenerate pearlite.
Bainite: mechanism of transformation, nucleation and growth, orientation relationships, surface relief, classical and non-classical morphology, effect of alloying elements.

Unit 5: Non-diffusive transformation:

Characteristics of transformation, thermodynamics and kinetics, nucleation and growth, morphology, crystallography, stabilization, strengthening, mechanisms, non-ferrous martensite, shape memory effect/alloys and glass transition concept.

Suggested References:

1. Porter, D, A and Easterling, K. E., Phase transformations in metals and alloys (2nd edition), CRC press, 1992.
2. Reed-Hill, R, E and Abbaschian, R., Physical Metallurgy Principles (3rd edition), PWS-Kent publishing company, 1994.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

MM2206 MATERIAL SCIENCE (For Chemical Engg Only)

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **4-0-0-4**

Course Objectives:

- Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing.
- Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, x-rays and x-ray diffraction, defect structure.
- Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels.
- Study detailed information on types of corrosion and its prevention.
- Learn information on selection of materials for design and manufacturing.

Course Out Comes:

- Students will be able to understand the crystallographic changes in the materials which occur with the variation in temperature and apply the knowledge of structure property relationship in various metallurgical operations.
- An understanding of crystal geometry is developed and the student will be able to identify and index different planes and directions in metals and compounds which are of importance in metallurgical and chemical engineering operations.
- An insight into different defects in the crystals is given.
- An ability to predict solid solution formation of a given set of metals and associated phase transformations is developed by the study of phase diagrams.
- Structure property relations of several metals are analyzed with reference to their crystal structures, phase compositions, working conditions, defect concentration etc.,
- Student will be able to predict the conditions of failure in materials under a given set of conditions.
- This inter-disciplinary course is expected to arouse in the students an interest and understanding of different metallurgical systems which are applicable in chemical processes.

Unit-1

Introduction: Engineering Materials – Classification – levels of structure.

Crystal Geometry and Structure Determination: Space lattice and Unit cell. Bravais lattices, crystal systems with examples. Lattice coordinates, Miller indices, Bravais indices for directions

and places: crystalline and non crystalline solids; ionic, covalent and metallic solids; packing efficiency, coordination number; structure determination by Bragg's X-ray diffraction and powder methods.

Unit-2

Crystal Imperfection: Point defects, line defects-edge and screw dislocation, Berger's circuit and Berger's vectors, dislocation reaction, dislocation motion, multiplication of dislocations during deformation , role of dislocation on crystal properties; surface defects, dislocation density and stress required to move dislocations.

Unit-3

Basic thermodynamic functions: phase diagrams and phase transformation: Primary and binary systems-general types with examples; tie line& lever rule, non equilibrium cooling: phase diagrams of Fe-Fe_3-C, Pb-Sn, Cu-Ni systems.

Phase transformations in Fe-Fe_3-C steels, Time-Temperature-Transformation (TTT) curves for eutectoid steels and plain carbon steels; effect of alloying elements on properties of steels; types of steels, alloys and other metals used in chemical industry.

Unit-4

Elastic, an elastic and plastic deformations in solid materials; rubber like elasticity, visco elastic behavior (models); shear strength of real and perfect crystals, work hardening mechanisms, cold working, hot working; dynamic recovery, recrystallization, grain growth, grain size and yield stress, Brief description of heat treatment in steels.

Magnetic materials: Terminology and classification, magnetic moments due to electron spin, ferro-magnetism and related phenomena, domain structure, hysteresis loop, soft and hard magnetic materials.

Unit-5

Fracture in ductile and brittle materials, creep: mechanism of creep and methods to reduce creeping in materials, creep rates and relations. Fatigue-mechanisms and methods to improve fatigue resistance in materials. Composite materials: types; stress-strain relations in composite materials, applications.

Oxidation and Corrosion: Mechanisms of oxidation, oxidation resistant materials, principles and types of corrosion, protection against corrosion.

Text Book:

1. Materials Science and Engineering, 5thed. V. Raghavan, PHI Learning Pvt. Ltd., New Delhi, 2009.
2. Physical Metallurgy – V. Raghavan
3. Material Science and Engineering – Callister
4. Introduction to Physical Metallurgy – Avner
5. Material science and Metallurgy – V. D. Kodgire, S. V. Kodgiri

References:

1. Elements of Materials Science, L.R. Van Vlack,
2. Science of Engineering Materials, vols. 1&2, Manas Chanda, McMillan Company of India Ltd.

Category: Subject code: **BM2201**

PERSONALITY DEVELOPMENT –I

L-T-P-C

2-0-0-1

Foundation Course

Guidelines: Learning approach is based on Real time case studies with class room activities

Course Objectives:

- To develop interpersonal skills and be an effective goal oriented team player.
- To develop professionals with idealistic, practical and moral values.
- To develop communication and problem solving skills.
- To re-engineer attitude and understand its influence on behavior.
- To enhance holistic development of students and improve their employability skills.

Course Outcomes:

After the successful completion of this course, the learner will be able to know:

- Self analysis and self analysis techniques there by learning the various aspects of their personality.
- SWOT Analysis, and use SWOT in their life for various opportunities.
- Set Goals and prioritize their resources to achieve them.
- Diversify career risk and optimize results.
- Understand; realize the importance of team work.
- Upgrade their interpersonal skills.
- Overcome fear of public speaking and effective group participation.
- How to think in a creative way and rationalization of ideas.

UNIT I-SELF ANALYSIS

SWOT Analysis, Who am I, Personality Traits, Importance of Self Confidence, Self Esteem.

UNIT II-GOALS SETTINGS

Short term , Long term goal settings, SMART concept

Diversifying Risk and Optimizing Returns

UNIT III- Team Dynamics with Interpersonal Skills

Team Dynamics, Team Work, Interpersonal Skills

Behavioral Skills GD, PI, Body Language Public Speaking, Verbal, Non Verbal Communications

UNIT IV-CREATIVITY and Rationality

Out of Box thinking, Idea Generation with creativity

Brain Storming, Effective group meetings, Rationalization of ideas and way to effective implementation

Note: Class room activities coupled with group tasks will be taken depending upon time availability

Category: **Professional Core Course** Subject code: **MM2801**

MECHANICAL METALLURGY LAB

Externals: 60Marks **L-T-P-C ***
Internals: 40Marks **0-0-3-2**

Course Objectives:

* To provide hands on experience of different mechanical testing procedures
* To understand the mechanisms of deformation
* To be able to identify the difference in ferrous and non-ferrous materials in terms of mechanical properties.
* To correlate the different mechanical testing processes to understand the behavior of a metal under different loading conditions.
* To analyze results and draw conclusions from the results of the tests

Course Outcomes:

***** Experience in designing and conducting tests to devaluate the mechanical properties of different materials.
* Differentiating the materials based on their strength, ductility, toughness etc.,
* Exposure to different testing machines
* Skill development in the areas of analyzing results and suggesting preventive measures for material failure.
* Hands on approach for the testing of materials.

List of Experiments:

1. Hardness Test: to determine the Brinell Hardness Values of values of ferrous and non-ferrous samples.

2. Tension Test: - To determine the elastic modulus, ultimate tensile strength, breaking stress, Ercentage elongationed percentage reduction in area of the given specimen. - To determine the strain distribution along the gauge length.

3. To Conduct Erichson cupping test.

5. Impact Testing: - To determine the charpy and Izod (V & U Groove notch) values of a given material at room temperature. - To establish the ductile - brittle transition temperature of the material.

6. To determine the Rockwell hardness values of heat treated steels.

7. To find the microhardness of phases by using vickers hardness tester.

Suggested References:

1. Dieter, G, E., Mechanical metallurgy (SI metric edition), McGraw-Hill book company, 1988.
2. Hertzberg, R, W., Deformation and fracture mechanics of engineering materials (3rd edition), John Wiley & sons, 1997

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2802**

MATERIALS CHARACTERISATION LAB

Externals: 60Marks **L-T-P-C ***
Internals: 40Marks **0-0-3-2**

Course Objectives:

* To provide hands on experience of XRD, FESEM, and EDX
* To study and analyse the peaks of XRD of materials
* To analyse quantitatively the chemical composition of materials
* To analyse the microscopic images of materials produced by FESEM

Course Out comes:

- Students can estimate the crystal structure and chemical composition of the given material by XRD and FESEM data.
- Students can analyze the phases present in a metal by image analysis using FESEM.
- Identifying the different crystal structures of materials by observing and analyzing XRD data
- Carrying out lattice parameter calculations by mathematical and graphical methods and their comparisons and residual stress calculations
- Micro-structural and chemical understanding of the materials by FESEM and EDS analyses.
- Student gets a flavor of operation and usage of high end equipment like XRD and FESEM.

List of experiments

1) Index and calculate the lattice parameter of cubic systems by analytical method.
2) Index and calculate the lattice parameter of cubic systems by mathematical method.
3) Calculate the precise lattice parameter by mathematical method.
4) Calculate the precise lattice parameter by graphical method.
5) Calculate the crystalline size from given XRD data.
6) Calculate the residual strain from given XRD data.
7) Calculate the residual stress from given XRD data.
8) Phase identification from given XRD data.

9) Demonstration on FESEM image formation.

10) Demonstration on EDX.

11) Demonstration on powder XRD.

12) Demonstration on thin film XRD.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM2803**

NON FERROUS EXTRACTIVE METALLURGY LAB

Externals: 60Marks **L-T-P-C ***
Internals: 40Marks **0-0-3 -2**

Course Objectives:

* To understand the extraction methods of ferrous metals and non ferrous metals.
* To demonstrate physical and chemical beneficiation of metals from their ores.
* To compare different extraction processes and deduce the most effective one.
* To correlate laboratory and industrial extractions.

Course Out comes:

* Students will gain the knowledge and experience on some of the mineral beneficiation and extraction operations of minerals.

* Understanding the different unit operations like crushing, grinding and classification.

* To study roasting, calcination and smelting of ores.

* Electroplating and electro-chemical refining of metal.

* The student is able to visualize industrial operations which are a part of the extraction of ferrous and non-ferrous metals.

List of Experiments:

1. Preparation of lead by reaction of lead (II) oxide with carbon.
2. Preparation of iron by reaction of iron (III) oxide with aluminum (Thermite reaction)
3. Roasting of a sulphide concentrate (FeS , FeS2,ZnS)
4. Formation of aluminum trihydrate and its calcinations to Al2O3.
5. Leaching of Al2O3 from A mixture SiC and Al2O3
6. Electroforming of copper on an aluminum mandrel.
7. Electrolytic dissolution study of a precipitation harden nonferrous alloy.
8. Making of copper metal from its dissolved copper compounds.

9. Electro-less plating of copper on a low carbon steel

10. Oxidation studies of nonferrous metal like copper and ferrous metal like high carbon steel.

11. Determination of Iron ore or any non-ferrous ore.

12. Extraction of Hf/Zr.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: Subject code: **MM2902**

SEMINAR-II

Externals: 60 Marks **L-T-P-C**
Internals: 40 Marks **0-0-2-1**

Course Objectives:
• To improve the presentation skills
• To prepare PPT more effectively

Student has to choose a general topic to give a power point presentation

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

III YEAR
I SEMSESTER

CODE	SUBJECT	L – T - P	Credits	Category
MM3101	Mechanical Working Of Materials	4-0-0	4	PCC
MM3102	Steel Making	4-0-0	4	PCC
MM3103	Heat treatment	4-0-0	4	PCC
MM3104	Polymer Engineering and Technology	4-0-0	4	PCC
MM3105	Composite Materials and Processing	4-0-0	4	PCC
BM3101	Personality Development-II	2-0-0	1	
MM3701	Mechanical Working Of Materials lab	0-0-3	2	PCC
MM3702	Heat treatment Lab	0-0-3	2	PCC
MM3901	Seminar – III	0-0-1	1	
Total		**22-0-7**	**26**	

L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3101**

MECHANICAL WORKING OF MATERIALS

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the basic concepts of the stress and strain for different materials

* To study about the cold, warm and hot deformation processes

* To analyze the parameters affecting the deformation processes such as forging, rolling, extrusion and drawing

* To study and analyze various sheet metal forming processes like bending, deep drawing, etc

Course Out comes:

- Students can classify the metal working processes .
- Students can explain principle of forging, determination of forging load & its application.
- Understand the manufacturing of tubes and pipe by extrusion method..
- Describe the manufacturing of wire and rods and able to analyze the variable affecting it.
- Acquainted with sheet metal working.
- elect the material for die manufacturing and software utilize for designing of it
- Students will gain knowledge on various conventional and advanced deformation operations.
- Students will be able to identify appropriate deformation operation for a particular material.
- Students will be able to apply the concepts of stress-strain in the design of various deformation processes.

UNIT – I:
Stress-strain relations in elastic and plastic deformation, concept of flow stress, deformation mechanisms, basic metal working concepts and plasticity, yield criterion, slip line fields, role of temperature and friction in metal working.

UNIT – II:
Hot and cold working, forging, rolling – types, analysis, parameters affecting the process, defects, their causes and remedial measures.

UNIT – III:
Extrusion, wire and tube drawing – types, analysis, parameters affecting the process, defects, their causes and remedial measures.

UNIT – IV:
Sheet metal working processes – Classification of metal forming processes, estimation of force and energy requirements; Metals used in press working, Lubrication, press, theory of shearing, shearing operations, blanking, piercing, bending and stretch forming.

UNIT – V:
Deep drawing, hydro forming, coining and embossing – types, parameters affecting the process, lubrication in metal forming processes, defects in various sheet metal forming processes, their causes and remedial measures

Books:

1. Mechanical Metallurgy – Dieter
2. Production Engineering – Dr. Swadesh Kumar Singh
3. Manufacturing processes – J.P. Kaushish

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3102**

STEEL MAKING

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To study past present and future of steel making
* To study and understand thermodynamics and kinetics of the reactions during steel making
* To study and understand primary and secondary steel making operations
* To study the casting and rolling operation performed to produce final steel product.

Course Outcomes:

- Students will be able to understand various primary and secondary steel making operations.
- Students will be able to calculate the rate of processes from the knowledge of thermodynamics and kinetics of the reactions
- Students will gain knowledge on design and development of steel making and casting operations.

UNIT-I

History of steel Making, Classification of Steel making Processes. Raw materials for steel making. Factors affecting efficiency of steel making, Energy in Iron and Steel Industry.

UNIT-II

Metallurgical Thermodynamics in Steel Making– Chemical Equilibrium - Activity and Equilibrium Constant G0 for Oxides - Activity Composition Relationships - Concentrated Solutions – Dilute Solutions - Chemical Potential and Equilibrium.

Fluid Dynamics - Inference of Fluid Flow in steelmaking - Force Balance Expressions and Momentum Conservation Equations – Boundary Conditions - Laminar and Turbulent Flows - Calculation of Turbulent Flows in Steelmaking.

Heat Transfer - Mechanism of Heat Transfer - Heat Conduction - Convective Heat Transfer -Radiation.

Mass Transfer and Metallurgical Kinetics -Mechanism of Mass Transfer Molecular Diffusion - Convective Mass Transfer – Chemical Reaction Kinetics.

UNIT-III

Primary Steel Making

Oxygen Steel Making: Pre - treatment of Hot Metal, Classification of Steels and the Role of Impurity Elements, Steelmaking Fundamentals – Chemical Reactions Equilibria - Carbon - Oxygen Reaction- Phosphorous - Oxygen Reaction - Manganese - Oxygen Reaction - Silicon - Oxygen Reaction - Sulphur - Oxygen Reaction (Desulphurization) - Iron-Oxygen Reaction - Slag Formation - Role of Slag - Basicity - Foaming Tendency - Oxidizing/Reducing Potential of Slag. The LD Steelmaking (Practice) process - The LD Converter - Lance - LD Shop Layout – Charge Calculations - Feed Materials - Physico - Chemical Characteristics of LD Steelmaking - Description of a Typical Heat - Exit Gases - Tapping - Modern Trends - Post Combustion - Slag Splashing, Bottom Blown Steelmaking. The Evolution of Combination Blown, Steelmaking and its Distinctive Features.

UNIT-IV

Primary Steel Making

Electric Steelmaking: Steelmaking in Electric Arc Furnaces (EAF) -Construction of an Arc Furnace - Operation - Steelmaking in EAF - Eccentric Bottom Tapping - Comparison with Oxygen Steelmaking - Environmental issues in Arc Furnace Steelmaking. Developments in EAF steelmaking Technology - Oxygen lancing including Co jet - Gas injection through bottom - Post Combustion – Automation and Process control.

Alloy Steelmaking in EAF with Some Example

UNIT-V

Secondary Steel Making

Impact of Slag carry over in the Ladle, Deoxidation in the Ladle: Reactions, Kinetics and products, Ladle metallurgy: Construction, Inert gas stirring, Temperature and composition control, Injection Metallurgy, vaccum Degassing, Tundish Metallurgy, Solidifaction and Continous casting.

TEXT BOOK;

1. Steel Making – A. K. chakrabarthi (PHI) 2007

2. Iron Making & Steel Making Theory and Practice - Ahindra Ghosh & Amit chatterjee

REFERENCES;

* Modern Steelmaking – Dr. R.H. Tupkary and V.H. Tupkary
* Steel Making – V. a. Kudrin

- Fundamentals of Steel Making practice - Brahma Deo & Rob Boom
- Secondary Steel Making; Principles and applications – Ahindra Ghosh
- Physical Chemistry of Iron & Steel by Boodsworth

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3103**

HEAT TREATMENT

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To introduce the concept of heat treatment and its classification
* To understand nucleation and growth kinetics, precipitation in age-hardening alloys, austenitic, eutectoid, pearlitic and bainitic transformations in steel.
* To analyze diffusionless transformations and hardenability
* To study different surface treatments
* To note different ferrous and non-ferrous heat treatments.

Course Outcomes:

* An understanding on the modification of the physical structures of metals and thereby their properties using thermal treatments.
* Knowledge on the solidification mechanisms of metals during casting and also controlling the final crystallite size of the system.
* Study of the procedures to alter the surface and sub-surface structures with varying properties along the cross-sections.
* Analytical and logical thinking development associated with the subject.

Unit 1: Introduction

Introduction, time-temperature parameters of a heat treatment process, classification of heat treatment processes, heat treatment as applied to the products of steel-making industry, machine building and automobile industry, tool making industry, etc.;

Unit 2: Diffusional transformation and principles of heat treatment:

Homogeneous nucleation in solids, heterogeneous nucleation, precipitate growth, overall transformation kinetics – TTT diagram, precipitation in age-hardening alloys, austenitic transformation, eutectoid transformation, pearlitic and Bainitic transformations in steel, continuous cooling diagrams, massive transformations, and order-disorder transformation.

Unit 3: Diffusionless transformations and hardenability:

Introduction to diffusionless transformation, martensitic transformation, martempering, Concept of critical diameter, joining-endquench test, effect of parameters viz: alloying elements, carbon content, austenic grain size, retained austenite, section size and quenching media.

Unit 4: Surface treatments:

Surface heat treatment, carburizing, cyaniding, flame and induction hardening, residual stresses, deep freezing, thermo mechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoformy.

Unit 5: Heat treatment processes:

Heat treatments of some important steels, cast irons (along with their classifications), Heat treatment of non-ferrous alloys: Precipitation hardening, aging treatment, study of copper and its alloys, aluminum and its alloys, nickel and its alloys.

TEXT BOOKS:

1. Rajan, T. V and Sharma, C. P., Heat treatment principles and techniques (2nd edition), Prentice hall of India, 1994.
2. Reed-Hill, R, E and Abbaschian, R., Physical Metallurgy Principles (3rd edition), PWS-Kent publishing company, 1994.
3. Raghavan, V., Physical metallurgy: principles and practice (2nd edition), Prentice hall of India, 1994.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3104**

Polymer Engineering & Technology

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

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

Course Objectives:

- To introduce the characteristics which distinguish polymers from their analogous class in materials engineering – with study of definition, classification, structure-&-properties relations & Processing for engineering & technical aspects.
- To discuss the reactions of polymers that are useful of modifying or synthesizing new polymers for structural, functional applications.
- To discuss characterization & fundamental testing methods of polymers & polymer blends.
- To discuss advances in polymers with conductive, smart, power polymer, etc. And environmental aspects of polymers.

CourseOutcomes:

- Understand the techniques and their characteristics/limitations of synthesis of polymers.
- Understand the structure-processing-property relationship of polymers.
- Understand and apply the various processing and manufacturing techniques.
- Understand the basic issues involved in polymer blends, composites and nanocomposites.

UNIT-I

Introduction: Basic concepts, classification of polymers, structure and size & molecular weight relations, tacticity & isomerism and morphology relations in polymers.

UNIT-II

Chemistry of polymerization & properties: Condensation & addition polymers – types & their engineering, copolymerization & their techniques, control of polymer structure and molecular weights.

UNIT-III

Polymer characteristics and polymer characterizations: Elastomeric and Visco-elastic behaviours, glassy state, characterization techniques of polymers.

UNIT-IV

Plastics & Rubbers, Polymer blends & composites: Plastics & rubbers – materials & processing techniques.

UNIT-V

Miscellaneous polymers, polymers & their environmental impacts: Conductive and dendritics, inorganic and power polymers, nanotechnology. Recovery & recrystallization of polymers. Polymer – waste management.

Suggested References:

1. 'Polymer Science and Technology' - by - P.Ghosh
2. 'Polymer Science' – by - VR Gowariker, N V Viswanathan, Jayadev Sreedhar.
3. 'Textbook of Polymer science' – by – Fred W. Billmeyer Jr.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3105**

COMPOSITE MATERIALS AND PROCESSING

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

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

Course Objectives:

- To study the fundamentals, classifications and properties of composites.
- To study various methods of producing Metal Matrix, Ceramic Matrix and Polymer Matrix composites.
- To Characterize and analyse MMC's, CMC's, PMC's prepared.
- To study advanced methods of producing composites

Course Out comes:

- Students will be able to design the process for the production of a composite and asses the quality of the composite by different characterization techniques.
- The student will develop a knowledge of the manufacturing of composite materials.
- The student will be introduced to the various composite components e.g. reinforcement and matrices.
- The student will demonstrate basic knowledge on the various composite processing techniques.
- The student will develop a working knowledge of the various testing and performance protocols for composite materials.
- The student will demonstrate the ability to test the as synthesized composite materials.
- The student will demonstrate the ability to assess the performance of the composites.
- The student will develop an understanding of the economics of composite materials.
- The student will demonstrate an ability to determine material cost through modeling and case studies.

UNIT –I

Fundamentals of composites; Need for composites – Enhancement of properties; Classification of composites – Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC); Reinforcements– introduction, glass fibers, boron fibers, carbon fibers, organic fibers, ceramic fibers, whiskers, nonoxide reinforcements, effect of high temperature exposure on the strength of ceramic fibers, comparison of fibers; Matrix materials – polymers, metals and ceramic materials; Interfaces. Iso Strain condition, Iso Stress condition, Load friction shared by the fibers.

UNIT – II

Polymer matrix resins – Thermosetting resins, thermoplastic resins – Reinforcement fibers – Rovings – Woven fabrics – Non woven random mats – various types of fibers. Processing of PMCs - Hand lay up processes – Spray up processes – Compression moulding – Reinforced reaction injection moulding - Resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fiber reinforced plastics (FRP), Glass fiber reinforced plastics (GRP); Structure & properties of PMCs; Applications.

UNIT – III

Characteristics of MMCs; Various types of MMCs; Alloy vs. MMC; Advantages & limitations of MMCs; Important Metallic Matrices; Reinforcements – particles, fibers; Processing of MMCs – liquid state, solid state & in-situ; interfaces in MMCs; Properties & applications.

UNIT – IV

Processing of CMCs – cold pressing & sintering, hot pressing, reaction bonding, infiltration, direct oxidation, in-situ chemical reaction, solgel, polymer infiltration & pyrolysis, electrophoretic deposition, selfpropagating high temperature sysnthesis; Interface in CMCs; Properties of CMCs, Toughness of CMCs; Thermal shock resistance; Applications of CMCs.

UNIT – V

Forging and extrusion of composites – critical issues, dynamic recovery and dynamic recrystallization, mechanical properties; Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplasticgraphite composite, Weld bonding, Brazing of MMC.

TEXT BOOKS;

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman and Hall, 1st edition.
2. Composite Materials science and Application –Deborah.D.L.Chung
3. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.

REFERENCE;

1. Hand Book of Composite Materials-ed-Lubin
2. Composite Materials Science and Applications – Deborah D.L. Chung
3. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen

W. Tasi

4. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd,
5. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: Subject code: **BM3101**

PERSONALITY DEVELOPMENT -I I

Guidelines: Learning approach is based on Real time case studies with class room activities

Course Objectives:

- To develop interpersonal skills and be an effective goal oriented team player.
- To develop professionals with idealistic, practical and moral values.
- To develop communication and problem solving skills.
- To re-engineer attitude and understand its influence on behavior.
- To enhance holistic development of students and improve their employability skills.

Course Outcomes:

After the successful completion of this course, the learner will be able to know:

- Self analysis and self analysis techniques there by learning the various aspects of their personality.
- SWOT Analysis, and use SWOT in their life for various opportunities.
- Set Goals and prioritize their resources to achieve them.
- Diversify career risk and optimize results.
- Understand; realize the importance of team work.
- Upgrade their interpersonal skills.
- Overcome fear of public speaking and effective group participation.
- How to think in a creative way and rationalization of ideas.

UNIT I-SELF ANALYSIS

SWOT Analysis, Who am I, Personality Traits, Importance of Self Confidence, Self Esteem.

UNIT II-GOALS SETTINGS

Short term, Long term goal settings, SMART concept
Diversifying Risk and Optimizing Opportunities

UNIT III- TEAM DYNAMICS WITH INTERPERSONAL SKILLS

Team Dynamics, Team Work, Interpersonal Skills

Behavioral Skills GD, PI, Body Language Public Speaking, Verbal, Non Verbal Communications

UNIT II-CREATIVITY and Rationality

Out of Box thinking, Idea Generation with creativity

Brain Storming, Effective group meetings, Rationalization of ideas and way to effective implementation

.Class room and team activities coupled with group tasks depending upon time availability

Category: **Professional Core Course** Subject code: **MM3701**

MECHANICAL WORKING OF MATERIALS LAB

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-3-2**

Course Objectives:

- To understand the designing of tool setup and simulate in realistic conditions for various deformation processes
- To analyze the simulated deformed material at various stages during the deformation process
- To conduct the experiment and compare the experimental and simulated results

Course Out comes:

- Students will be able design the setup by simulating various deformation processes.
- Students will apply the knowledge gained by simulations on to a practical setup of deformation process.
- Students will understand the working principles of various deformation operations.

List of experiments:

1. To design the setup and analyze the deep drawing process in simulation software.
2. To design the setup and analyze the die bending process in simulation software.
3. To design the setup and analyze the air bending process in simulation software.
4. To determine the spring back and thickness variations of dual phase steel sheet in air bending by comparing the simulation and experimentation results.
5. To determine the spring back and thickness variations of aluminum sheet in air bending by comparing the simulation and experimentation results
6. To determine the spring back and thickness variations of copper sheet in air bending by comparing the simulation and experimentation results.
7. To determine the bend allowances for different materials.
8. To design the setup for extrusion in simulation software for bulk deformation.
9. To design the setup for forging in simulation software for bulk deformation.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3702**

HEAT TREATMENT LAB

Externals: 60Marks **L-T-P-C ***
Internals: 40Marks **0-0-3-2**

Course Objectives:

* To provide hands on experience of different heat treatment processes
* To understand the transformations associated with these heat treatments and their influence on mechanical properties of materials being tested.
* To analyze results and draw conclusions from the results of the tests

Course Outcomes:

***** Hands on experience on the thermal treatments and analyses of the microstructural variations with them.

* Learning the functioning and operation of furnaces like muffle furnace, direct heating furnace, tubular furnace etc.,
* Developing experiments to understand continuous and step wise treatments.

List of Experiments:

1. Annealing of medium carbon steel and observation of microstructure.
2. Normalizing of medium carbon steel and observation of microstructure.
3. Hardening of medium carbon steel and observation of microstructure.
4. Study of tempering characteristics of water quenched steel.
5. Study of age hardening phenomena in duralumin.
6. Spheroidizing of a given high carbon steel.
7. Determination of hardenability of medium carbon steel by Jominy end Quench Test.

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Suggested References:

1. Rajan, T. V and Sharma, C. P., Heat treatment principles and techniques (2nd edition), Prentice hall of India, 1994.
2. Reed-Hill, R, E and Abbaschian, R., Physical Metallurgy Principles (3rd edition), PWS-Kent publishing company, 1994.
3. Raghavan, V., Physical metallurgy: principles and practice (2nd edition), Prentice hall of India, 1994.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: Subject code: **MM3901**

MM3901 **SEMINAR – III**

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

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

Objectives:

• To improve the presentation skills

• To prepare PPT more effectively

Student has to choose a topic related socio-economic matter to give a power point presentation.

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

III YEAR
II SEMSESTER

CODE	SUBJECT	L-T-P	Credits	Category
MM3201	Materials Joining	4-0-0	4	PCC
MM3202	Introduction to ceramic technology	4-0-0	4	PCC
MM3203	Corrosion and Environmental Degradation Of materials	4-0-0	4	PCC
MM3204	Powder Metallurgy	4-0-0	4	PCC
CS3001	OOPS Through JAVA	4-0-0	4	ESC
HS3201	Soft Skills-II	2-0-0	1	HSMC
MM3801	Materials Joining Lab	0-0-3	2	PCC
MM3802	Corrosion and Environmental Degradation Of materials Lab	0-0-3	2	PCC
CS3601	OOPS Through JAVA Lab	0-0-3	2	ESC
MM3902	Seminar-IV	0-0-0	1	
MM3000	Comprehensive Viva-I	0-0-0	1	
	TOTAL	**22-0-9**	**29**	

Category: **Professional Core Course** Subject code: **MM3201**

MATERIALS JOINING PROCESSES

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the basic concepts of the joining and welding processes
* To study about the arc and resistance welding processes
* To study about the other welding processes like gas, solid state and thermo chemical welding
* To understand the metallurgical principles involved in welding various materials
* To study the testing methods and identify the weld defects

Course Out comes:

- Students will again fundamental knowledge on conventional and advanced materials joining operations.
- Students will be able to identify appropriate joining operation for a given material.
- Students will understand the advantages and limitations of different materials joining operations.
- Students will be able to analyze the welding defect and will be able to take necessary precautions.

UNIT – I:

Introduction, applications, classification, welding positions, welding joints, arc welding processes, arc characteristics, shielded metal arc welding (SMAW), features of SMAW, V-I characteristics, electrodes used in SMAW.

UNIT – II:

Other arc welding processes – SAW, GMAW, ESW, EGW, TIG, PAW; Resistance welding – spot, seam, projection, high frequency resistance, resistance butt, percussion welding – principle, variables, advantages, applications.

UNIT – III:

Thermo chemical welding – thermit and atomic hydrogen welding; radiant energy welding – laser beam and electron beam welding; solid state welding – diffusion, ultrasonic, explosive, friction and forge welding; gas welding; oxy acetylene welding, types of oxy acetylene welding; weldability.

UNIT – IV:

Metallurgical principles involved in welding of cast irons, carbon steels, tool steels, cast steels, stainless steels, aluminium alloys, copper alloys, titanium alloys and nickel alloys.

UNIT – V:

Welding defects, inspection and testing of weldments – destructive and non destructive testing – visual inspection, magnetic particle inspection, liquid penetration inspection, stethoscopic (sound) test and leakage tests.

Books:

1. Welding process and technology – R. S. Parmar
2. Welding and welding technology – Richard Little
3. Welding Metallurgy – Sindo Kou
4. Morden Arc Welding Technology – S.V. Nadkarni
5. Manufacturing Processes – J.P. Kaushish

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3202**

INTRODUCTION TO CERAMIC TECHNOLOGY

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To introduce traditional ceramics & Advanced ceramics class of materials.
- To know basic raw materials for processing of ceramics of traditional & advanced kind.
- Basic step to follow the processing of ceramics.
- Finding ceramics for advanced applications –of – structural & functional kind.

Course Outcomes:

- Knowledge of the crystal structures of a wide range of ceramic materials.
- Knowledge of the structure of clays, minerals, and glasses.
- Given a ceramic component be able to calculate its intrinsic and extrinsic defect populations.
- Design a suitable sintering schedule for heat-treating ceramics and understand the effects of existing microstructural features (e.g., porosity, impurities, etc.) on microstructural evolution during this process.
- Knowledge of properties of ceramics and their structural origin.

Familiarization with a wide array of characterization techniques.Familiarization with a wide array of characterization techniques.

UNIT-I

Fundamental of Ceramics: Introduction, bonding characteristics, structure of ceramics – simple and complex ceramics, phase diagrams, phase stability and transformations in ceramics.

UNIT-II

Processing & Fabrication of ceramics –I: Overview, powder processing – shape/forming processes - densification - final machining of ceramics.

UNIT-III

Processing & Fabrication of ceramics –II: Processing of glass and glass-ceramics, ceramic – composites, thin films, coating, membranes.

UNIT-IV

Properties & Applications of Ceramics – Engineering ceramics: Ceramic bearings, cutting tools, ceramic decorative, high strength and high-temperature ceramics.

UNIT-V

Properties & Applications of Ceramics – Functional ceramics**:** Ceramic conductors, Semiconductive, dielectric and insulators, ceramics for piezoelectric, pyroelectric and magnetic applications.

Suggested References:

1. 'Fundamentals of Ceramics' – by – Michel W. Barsoum.
2. 'Modern ceramic engineering' – by – D. W. Richerson.
3. 'Principles of ceramic processing' – by – James S. Reed
4. 'Handbook of Ceramics- processing and applications, Vol-II' – by – Elsevier publishers.

Category: **Professional Core Course** Subject code: **MM3203**

CORROSION AND ENVIRONMENTAL DEGRADATION OF MATERIALS

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the technological importance of corrosion studies
* To study types and basic concepts of corrosion
* To study and understand the kinetics of corrosion
* To study and understand the preventive measures of corrosion

Course Outcomes:

- Ability to understand electrochemical fundamentals
- Ability to understand corrosion preventing methods
- Ability to understand environmental induced corrosion
- Ability to solve corrosion problems

UNIT -1: Introduction

Technological importance of corrosion study-Introduction to corrosion, definition, learning objectives, Degradation process-Mechanical and Chemical process. Dry corrosion and wet corrosion. Local and uniform corrosion. Cost of corrosion-direct loss and indirect loss, cost of corrosion in various industries.

UNIT -2: Basic Concepts of Corrosion

Electochemical principles of corrosion-cell analogy, cathode, anode, electrolyte, cathodic and anodic reactions, types of corrosion cell. Concept of free energy (driving force of corrosion based on thermodynamical studies), cell potential and emf, Nernst equation and their application on corrosion. Concept of single electrode potential, reference electrodes, half cell reaction, types of reference electrode-SHE, Ag-AgCl, SCE, Cu-Cuso4. Emf and galvanic series-their uses in corrosion studies. Eh-pH diagrams-fundamental aspects. Construction of Eh-pH diagrams.

UNIT -3: Corrosion Kinetics

Corrosion rate expressions-Faradays law, area effect, weight loss, thickness loss. Electrode-Solution interface- overpotential, Definition and types of polarization-factors affecting them. Exchange current density-polarization relationships. Mixed potentials-concepts and basics. Mixed potential theory-Mixed electrodes (Bimetallic couples), Activation and diffusion controlled processes. Application of Mixed potential theory. Corrosion rate measurements (determination). Passivity-Definitions and influencing parameters. Passivity-Design of corrosion resistant alloys, Factors affecting passivity.

UNIT -4: Types Of Corrosion

Different forms of corrosion – Mechanism, characteristic features, causes and remedial measures of uniform corrosion, galvanic corrosion, crevice corrosion. Pitting corrosion, intergranular corrosion (including weld decay & knife-line attack). Erosion corrosion, selective leaching and stress corrosion cracking. Hydrogen damage-types, characteristics, mechanism and preventive measures.

UNIT -5: Cathodic Protection Ad Coating

Principles of corrosion prevention-material selection, control of environment including inhibitors. Cathodic protection-principle, classification, influencing factors and design aspects. Anodic protection-principle, influencing factors and design aspects. Coatings and design considerations (corrosion prevention).

References:

1. ‘Corrosion Engineering’ – by – Fontana.
2. ‘Principles of Corrosion engineering and corrosion control’ – by – Zaki Ahmad.
3. 'Handbook of Corrosion Engineering' - by - Pierre R. Roberge.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3204**

POWDER METALLURGY

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **4-0-0-4**

Course Objectives:

* To understand the basic introduction and overview of powder metallurgy
* To study various powder production methods and analyzing its characteristics
* To understand various cold and hot compacting methods
* To study various sintering and post sintering processes

Course Out comes:

- Students will be able to produce powders of different materials by optimizing the operational parameters.
- Students will understand different powder characterizing techniques.
- Students will understand the operational limitations in converting powders into bulk materials by compaction and sintering.
- Students will be able to optimize process parameters of the powder making operations.

UNIT – I: Introduction, historical background, steps in powder metallurgy, advantages of powder metallurgy process, advantages of powder metallurgy processing over conventional material processing, applications of powder metallurgy, limitations of powder metallurgy, recent trends; **Powder production methods:** Mechanical – milling, machining, other impaction techniques, mechanical alloying, Chemical – reduction, thermal decomposition, hydride-dehydride process, Physical methods – electrolytic deposition, gas atomization, water atomization, centrifugal atomization, other atomization approaches, atomization limitations.

UNIT – II: Powder treatment and handling: powder treatments – cleaning of powders, grinding, powder classification and screening, blending and mixing; coating of metal powders;

Metal powder characteristics: sampling, metal powder characterization – chemical composition analysis, particle shape analysis, particle size, measurement techniques – microscopy, screening, sedimentation, light scattering, light blocking, x-ray techniques;

microstructural features; packing and flow characteristics of powders – angle of repose, flow rate; density – apparent density, tap density; porosity; compressibility of metal powder; strength properties.

UNIT – III: Compaction of metal powders: powder pressing – powder shaping and compaction, binders; powder compaction methods – pressure less compaction techniques, pressure compaction techniques; classification of powder metallurgy parts; cold isostatic compaction – process, types, advantages, applications; powder rolling – steps involved, influence of powder characteristics on powder rolling, advantages, disadvantages, application;
miscellaneous compaction techniques – continuous compaction, explosive compaction; **High temperature compaction:** principles of pressure sintering – uniaxial hot pressing, hot extrusion, spark sintering, hot isostatic pressing, injection moulding.

UNIT – IV: Sintering: types of sintering – solid state sintering, liquid phase sintering, activated sintering, reaction sintering, rate controlled sintering, microwave sintering, self propagating high temperature synthesis, gas plasma sintering, spark plasma sintering; sintering theory – thermodynamics of solid state sintering process, stages in solid state sintering, driving force for sintering, sintering mechanisms; variables – process variables, material variables; effects of sintering – dimensional changes, microstructural changes; sintering atmospheres – need for sintering atmosphere, functions of a sintering atmosphere, hydrogen, reformed hydrocarbon gases, nitrogen based mixtures, dissociated ammonia, inert gases, vaccum.

UNIT – V: Post sintering operations: introduction, sizing, coining, repressing, resintering, impregnation, infiltration, heat treatment, steam treatment, machining, joining, plating, and other coatings.

Books:

1. Powder metallurgy science – R M German
2. Powder metallurgy science, technology and applications – PC Angelo and R Subramanian

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Engineering Science Course** Subject code: **CS3001**

OBJECTED ORIENTED PROGRAMMING THROUGH JAVA

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **4-0-0-4**

Course Objectives:

- To be able to differentiate between structures oriented programming and object oriented programming.
- To be able to use object oriented programming language like Java and associated libraries to develop object oriented programs.
- To Able to understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using Java language.
- To be able to apply concepts of operator overloading, constructors and destructors.
- To be able to apply exception handling and use built-in classes

Course Outcomes:

CO 1: Learning principals of object oriented programming paradigm in Java including classes, Objects, Methods, Abstraction, encapsulation, inheritance and polymorphism.

CO 2: Understand fundamentals of programming such as variables, conditional and iterative execution, methods, packages & interfaces etc.

CO 3: Learning the concept of inheritance to create new classes from existing one & Design the classes needed given a problem specification;

CO 4: Learning how to detect exceptions and to handle strings & Implement the designed classes using the object oriented programming language

CO 5: Learn how to test, verify, and debug object-oriented programs; and Learning about multithreading and multitasking.

CO 6: Creating and Demonstrating Applications using the concept of OOPS, event handling, JDBC Connectivity used in GUI with Java.

UNIT-1:

Introduction to OOPS: Paradigms of Programming Languages, Basic concepts of Object Oriented Programming, Differences between Procedure Oriented Programming and Object

Oriented Programming, Objects and Classes, Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication, Benefits of OOP , Application of OOPs.

Java : History, Java features, Java Environment, JDK, API.

Introduction to Java : Types of java program, Creating and Executing a Java program, Java Tokens, Keywords, Character set, Identifiers, Literals, Separator, Java Virtual Machine (JVM), Command Line Arguments, Comments in Java program.

UNIT -2:

Elements: Constants, Variables, Data types, Scope of variables, Type casting, Operators: Arithmetic, Logical, Bit wise operator, Increment and Decrement, Relational, Assignment, Conditional, Special operator, Expressions – Evaluation of Expressions

Decision making and Branching: Simple if statement, if, else statement, Nesting if, else, else if Ladder, switch statement, Decision making and Looping: While loop, do, While loop, for loop, break, labelled loop, continue Statement.-, Simple programs

Arrays: One Dimensional Array, Creating an array, Array processing, Multidimensional Array, Vectors, Wrapper classes, Simple programs

UNIT-3:

Strings: String Array, String Methods, String Buffer Class, Simple programs

Class and objects: Defining a class, Methods, Creating objects, Accessing class members, Constructors, Method overloading, Static members, Nesting of Methods, this keyword, Command line input, Simple programs

Inheritance: Defining a subclass, Deriving a sub class, Single Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Overriding methods, Final variables and methods, Final classes, Finalizer methods, Abstract methods and classes, Visibility Control: Public access, Private access, friend, protected. Interfaces: Multiple Inheritance, Defining interface, Extending interface, Implementing Interface, Accessing interface variables, Simple programs

UNIT- 4:

Packages: Java API Packages, System Packages, Naming Conventions, Creating & Accessing a Package, Adding Class to a Package, Hiding Classes, Programs

Applets: Introduction, Applet Life cycle, Creating & Executing an Applet, Applet tags in HTML, Parameter tag, Aligning the display, Graphics Class: Drawing and filling lines, Rectangles, Polygon, Circles, Arcs, Line Graphs, Drawing Bar charts, Programs

AWT Components and Even Handlers: Abstract window tool kit, Event Handlers, Event Listeners, AWT Controls and Event Handling: Labels, TextComponent, ActionEvent, Buttons,

CheckBoxes, ItemEvent, Choice, Scrollbars, Layout Managers- Input Events, Menus, Programs

UNIT-5:

Exception Handling: Limitations of Error handling, Advantages of Exception Handling, Types of Errors, Basics of Exception Handling, try blocks, throwing an exception, catching an exception, finally statement

Multithreading: Creating Threads, Life of a Thread, Defining & Running Thread, Thread Methods, Thread Priority, Synchronization, Implementing runnable interface, Thread Scheduling.

I/O Streams: File, Streams, Advantages, The stream classes, Byte streams, Character streams.

JDBC, ODBC Drivers, JDBC ODBC Bridges, Seven Steps to JDBC, Importing java SQL Packages, Loading & Registering the drivers, Establishing connection. Creating &Executing the statement.

Suggested References:

1. Programming with Java - E. Balagurusamy
2. Java the complete reference, 7th editon, Herbert schildt, TMH.
3. Understanding OOP with Java, updated edition, T. Budd, pearsoneduction.
4. Object oriented Programming in Java - Dr. G.Thampi
5. Let us Java – Yashavant Kanetkar - BPB Publications, New Delhi - First Edition 2012

An Introduction to Oops with Java - C Thomas WU - TataMc-Graw Hill, 4th Edition

Category: **HSM Course** Subject code: **HS3201**

Soft Skills-II

Course Objectives:

1. To enable students speak effectively in formal and informal situations
2. To equip the students with necessary writing skills in order to face the corporate world
3. To strengthen the writing skills of the students and help them in documentation
4. To enable students sharpen their communication skills towards writing a persuasive resume and effective job application letters
5. To equip students with pre-presentation steps, to understand the structure of a good presentation, and devise various techniques for delivering a successful presentation
6. To make students understand the importance of team work and group presentations and group discussions

Course Outcomes:

Students will be able:

1. communicate effectively in formal and informal situations
2. understand the structure and mechanics of writing resumes, reports, documents and e-mails
3. present effectively in academic and professional contexts
4. develop communication in writing for a variety of purposes
5. identify areas of evaluation in Group Discussions conducted by organizations as part of the selection procedure
6. overcome stage fear and tackle questions

UNIT-I

Activities on Fundamentals of Inter-personal Communication

Starting a conversation - responding appropriately and relevantly - using the right body language-Role Play in different situations & Discourse Skills using visuals.

UNIT-II

Activities on Reading Comprehension

General Vs Local comprehension- reading for facts- guessing meanings from context- scanning- skimming- inferring meaning- critical reading - effective googling.

UNIT-III

Activities on Writing Skills

Structure and presentation of different types of writing- Resume writing/ e-correspondence/ Technical report writing- planning for writing - improving one's writing.

UNIT-IV

Activities on Presentation Skills

Oral presentations (individual and group) through JAM sessions/seminars/PPTs and written presentations

UNIT-V

Activities on Group Discussion and Interview Skills - Dynamics of group discussion-intervention-summarizing-modulation of voice-body language-relevance-fluency and organization of ideas and rubrics for evaluation- Concept and process-pre-interview planning-opening strategies-answering strategies-interview through tele-conference & video-conferencing - Mock Interviews.

Suggested References:

1. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.

2. Advanced Communication Skills Laboratory Manual by Sudha Rani, D, Pearson Education 2011.

3. Technical Communication by Paul V. Anderson , 2007. Cengage Learning pvt. Ltd. New Delhi.

4. Business and Professional Communication: Keys for Workplace Excellence, Kelly M. Quintanilla & Shawn T. Wahl. Sage South Asia Edition. Sage Publications, 2011.

5. The Basics of Communication: A Relational Prespective, Stev Duck & David T. Mc Mahan. Sage South Asia Edition. Sage Publications, 2012.

6. English Vocabulary in Use series, Cambridge University Press 2008.

7. Handbook for Technical Communication by David A. McMurrey & Joanne Buckley, 2012. Cengage Learning.

9. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.

10. Handbook for Technical Writing by David A McMurrey & Joanne Buckely CENGAGE Learning 2008.

Category: **Professional Core Course** Subject code: **MM3801**

MATERIALS JOINING TECHNOLOGY LAB

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-3-2**

Course Objectives:

- To understand the steps involved in various welding operations.
- To analyze the quality of the welded materials by metallographic methods.
- To perform NDT on welded samples to identify welding defects.
- To perform welding on similar and dissimilar metals and alloys.

Course Out comes:

- Students will be able to choose an appropriate welding operation and characterize the welded joint.
- Students will be able to understand the parameters effecting the welding of similar and dissimilar metals.
- Students will be able to perform arc and gas welding operation.
- Students will be able to perform Friction Stir welding operation.
- Students will be able to identify various welding defects and take necessary precautions.

List of experiments:

1. To weld the mild steel samples by manual metal arc welding process and visually inspect the defects along with the microstructure variations.
2. To weld the mild steel samples by metal inert gas welding process and visually inspect the defects along with the microstructure variations.
3. To weld the mild steel samples by oxy acetylene gas welding process and visually inspect the defects along with the microstructure variations.
4. To weld the aluminum samples by tungsten inert gas welding process and visually inspect the defects along with the microstructure variations.
5. To weld two similar metals by friction stir welding process and visually inspect the defects along with the microstructure variations
6. To weld two dissimilar metals by friction stir welding process and visually inspect the defects along with the microstructure variations

7. To study the microstructural variations in a metal by friction stir processing.
8. To study the microstructural variations at the interface of the metals by friction surfacing.
9. To test the weldments by non destructive testing method.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Professional Core Course** Subject code: **MM3802**

Corrosion and Environmental Degradation of Materials (CEDM) Lab

Externals: 60Marks **L-T-P-C***
Internals: 40Marks **0-0-3-2**

Course Objectives:

- To evaluate the corrosion rate interms of weight loss & applied potential of metals with specific environments.
- To evaluate the selective corrosion of galvanic, stress, crevice, pitting, intergranular type corrosion.
- To evaluate the preventive methods of corrosion with coatings.

Course Outcomes:

- Students will be able to apply the knowledge of various causes and remedies for corrosion in preventing failures of the materials by corrosion.
- Students will be able to select various corrosion preventing methods for each material
- Students will be able to understand the effects of various corrosive environments.

– List of Experiments

Experiment No.: 1

Weight loss –Corrosion rate measurement: Determination of corrosion rate of different metal sheets to chemical environments (acidic, salt and alkaline solutions) by weight-loss measurement..

Experiment No.: 2

Weight loss – corrosion rate measurement: Determination of corrosion rate of a metal sheet to chemical environment with varying concentrations (acidic, salt and alkaline solutions) by weight - loss measurement.

Experiment No.: 3

Effect of inhibitor on rate of corrosion (Inorganic inhibitor or organic inhibitor): To evaluation the efficiency of an inorganic inhibitor or organic inhibitor on rate of corrosion of an metal steel sample by weight-loss measurement..

Experiment No.: 4

Effect of inhibitor on rate of corrosion (Green inhibitor): To evaluation the efficiency of a green inhibitor (natural leaf or vegetable extract) on rate of corrosion of metal steel sample by weight -loss measurement.

Experiment No.: 5

Crevice & Pitting corrosion testing: test method for pitting and crevice corrosion resistance of steels and related alloys by use of $FeCl_3$ solution

Experiment No.: 6

Corrosion prevention - Anodisation of Aluminium: To evaluate the voltage effect on electrochemical Anodisation to get porous /dense coating of aluminium metal sheets.

Experiment No.: 7

Corrosion prevention – Protective coatings (hardness test by pencil test): Determination of the film hardness of an organic coating on a metal sheet substrate in terms of drawing pencil leads of known hardness.

Experiment No.: 8

Corrosion prevention – Protective coatings (Immersion test): Evaluation of the resistance of industrial protective coatings to immersion in chemicals

Experiment No.: 9

Corrosion prevention – Protective coatings (Salt spray test): Determination of the film stability of industrial protective coatings on metal sheet substrates to salt spray

Experiment No.: 10

Corrosion rate Measurement – Electrochemical work station or Potentiostate: Determination of corrosion rate of metal sheets to chemical environments by drawing Tafel-plot and slop measurements and impedance analysis.

Suggested References:

1. **ASTM G3-14** --- Standard Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing.
2. **ASTM G5 - 14** --- Standard Reference Test Method for Making Potentiodynamic Anodic Polarization Measurements.
3. **ASTM G31 - 72(2004)** --- Standard Practice for Laboratory Immersion Corrosion Testing of Metals.

4. **ASTM G59 - 97(2014)** --- Standard Test Method for Conducting Potentiodynamic Polarization Resistance Measurements.
5. **ASTM G48 - 11** --- Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

Category: **Engineering Science Course** Subject code: **CS3601**

OBJECTED ORIENTED PROGRAMMING THROUGH JAVA LAB

Externals: 60Marks **L-T-P-C**
Internals: 40Marks **0-0-3-2**

Course Objectives:

- To be able to apply an object oriented approach to programming and identify potential benefits of object-oriented programming over other approaches.
- To be able to reuse the code and write the classes which work like built-in types.
- To be able to design applications which are easier to debug, maintain and extend.
- To be able to apply object-oriented concepts in real world applications.

Course Outcomes:

CO 1: Be able to analyze and design a computer program to solve real world problems based on object-oriented principles.

CO 2: Be able to write simple GUI interfaces for a computer program to interact with users, and to understand the event-based GUI handling principles.

CO 3: A competence to design, write, compile, test and execute straightforward programs using a high level language.

CO 4: Demonstrate the ability to employ various types of selection constructs in a Java program. Be able to employ a hierarchy of Java classes to provide a solution to a given set of requirements.

CO 5: Become familiar with the fundamentals and to acquire programming skills in the Java language.

Experiments:

1. A program to illustrate the concept of class with constructors, methods and overloading.
2. A program to illustrate the concept of inheritance and dynamic polymorphism.
3. A program to illustrate the usage of abstract class.
4. A program to illustrate multithreading.
5. A program to illustrate thread synchronization.
6. A program to illustrate Exception handling.
7. A program to illustrate user-defined Exceptions
8. A program to demonstrate use of User-defined Packages.

9. A program using String Tokenize.
10. A program using Linked list class
11. A program using Tree Set class
12. A program using Hash Set and Iterator classes
13. A program using Map classes.
14. A program using Enumeration and Comparator interfaces.
15. A program using File and Filename Filter
16. A program to illustrate the usage of Byte and Character I/O streams.
17. A program to illustrate the usage of Serialization.
18. Program using Data class.\
19. An application involving GUI with different controls, menus and event handling.
20. A program to implement an applet.

For the detailed list of programs refer the lab manual.

Note: Any experiment according to the syllabus of CS3001 can be substituted

Category: Subject code: **MM3902**

SEMINAR-IV

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

Course Objectives:
- To improve the presentation skills
- To prepare PPT more effectively

Student has to choose a general topic to give a power point presentation

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

IV YEAR
I SEMESTER

Subject Code	Subject	L-T-P	CREDITS	Category
MM3900	Summer Internship	0-0-0	6	
MM44XX	Elective-I	3-1-0	3	PEC
MM44XX	Elective-II	3-1-0	3	PEC
MM44XX	Elective-III	3-1-0	3	PEC
	Free Elective-I	4-0-0	3	OEC
BM4001	Managerial Economics and Financial Analysis	4-0-0	3	HSMC
Total		**17-3-0**	**21**	

List of Electives:

Elective- I	MM4401	Nano-structured materials
Elective- I	MM4402	Instrumental methods of analysis
Elective- I	MM4403	X-ray powder diffraction
Elective- I	MM4404	Computational Materials Science
Elective- I	MM4405	Electron microscopy
Elective- I	MM4406	Alloy Design
Elective- II	MM4411	Secondary steel making
Elective- II	MM4412	Advanced Materials and processing
Elective- II	MM4413	Nuclear Metallurgy
Elective- II	MM4414	Principles of Extractive Metallurgy
Elective- II	MM4415	Electro Ceramics
Elective- II	MM4416	Electro Metallurgy
Elective- III	MM4421	Fatigue, creep and fracture
Elective- III	MM4422	Fracture mechanics
Elective- III	MM4423	Super alloys

MM4401 **NANOSTRUCTURED MATERIALS**

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

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

Course Objectives:

- To understand the properties of nanoparticles.
- To know the synthetic aspects for the design of nanostructured materials.
- To understand the different approaches including both the bottom-up(includes both chemical and physical methods) and the top-down methods(mainly physical methods) for the synthesis of nanostructured materials.
- To understand the different type of nanostructures with a special emphasis on carbon nanotubes (CNT), metal and metal oxide nanoparticles, core-shell nanostructures and self assembly of these nanostructures.
- The dependence of various properties (dielectric, magnetic and optical) with size will be discussed.

Course Outcome:

- Students will gain the knowledge on preparation, characterization and application of nano materials.
- Top-down and bottom-up approaches for the synthesis of nano-materials and their differences are studied.
- Synthesis of nano materials by chemical processes are studied against the physical processes. Design of functional nanomaterials, integrated nanosystems etc., and the difference in their properties with reference to the initial manufacturing processes and particle size are analyzed.
- Application of nanomaterials in critical technologies and futuristic technologies is understood.

Chapter-I

An overview of natural and classical nanosystems. Nanosized metals and alloys, semiconductors, ceramics- a comparison with respective bulk materials.

Chapter-II

Organic semiconductors, carbon nanotubes, nanorods, nanocomposites consisting of organic, inorganic and biomaterials. Zero-, one-, two-, and three dimensional nanostructures-quantum dots, quantum wells, quantum rods, quantum wires. Nucleation and growth of nanosystems, Physical methods-mechanical milling, laser ablation, sputtering, microwave plasma etc.

Chapter-III

Chemical methods-chemical reduction and oxidation, sol-gel processes, photolysis, radiolysis, metallo organic chemical vapor deposition. Designing of advanced integrated nanocomposites, functional nanomaterials and nanostructured thin films.

Chapter-IV

Size and shape dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, non-linear optical; catalytic and photocatalytic properties. Transition metal sols, origin of plasmon band, Mie theory, influence of various factors on the plasmon absorption, quantum confinement in semiconductors-particle in a box like model for quantum dots, origin of charge on colloidal sols, their stability and implications in making building blocks.

Chapter-V

Development of nanoscale catalysts, photocatalysts, sensitizers, sensors, composites, polymers, ceramics, biomaterials, pharmaceuticals, nanopaints, nanofluids, optical, fluorescent, electronic, magnetic and photonic devices, future perspectives of nanotechnology in miniaturization of devices and fabrication of value added products.

Suggested References:

1) **Guozhong Cao, Nanostructures and Nanomaterials : Synthesis, Properties and Applications, Imperial College Press 2004.**
2) **T. Pradeep, Nano: The Essentials Understanding nanoscience and nanotechnology, Tata McGraw-Hill Publishing Company Limited** NEW DELHI, 2007.
3) **Nanomaterials Synthesis, Properties and Applications** Edited by A S Edelstein and R C Cammarata, IOP Publishing Ltd 1996.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

MM4402 **Instrumental Methods of Analysis (IMA)**

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

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

Course Objectives:

- To study and understand thermometric methods and their applications.
- To study and understand atomic emission/absorption methods and their applications.
- To study and understand surface analytical methods and their applications.
- To study and understand magnetic methods, properties and their applications.
- To study and understand radiometry, and its applications**.**

Course Out comes:

- Students will gain the knowledge on thermometric , atomic emission/absorption, surface analytical, magnetic, and radiometry methods along with their applications.
- Thermometic analyses methods, their differences and their applications in different scenarios are understood by the students.
- A study on the different emission and absorption methods and their applications in the chemical analyses of samples is carried out.
- A brief insight into different instrumental techniques for characterization of materials in the fullest detail is given.
- The student gets a flavor of different types of instrumental characterization methods used extensively in research.

UNIT-I

Thermometric methods: Instrumental methods (TGA / DTA, DSC) – scope and methodology, applications and limitations.

UNIT-II

Atomic emission/absorption: Instrumental methods (AAS, ICT-OES, Fluorescence) – scope and methodology, applications and limitations.

UNIT-III

Surface analytical methods: Instrumental methods (SEM, STEM, TEM, AFM, BET, XPS) – scope and methodology, applications and limitations.

UNIT-IV

Magnetic methods: Measurement of magneto-resistivity and VSM, others.

UNIT-V

Radiometry: Principle and applications of MWR (Microwave radiometer), ultrasonic testing, reflectivity measurements.

MM4403 **X-Ray powder Diffraction**

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

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

Course Objectives:

- To study and understand crystalline states of materials by XRD.
- To study and understand X-ray production, Scattering and diffraction.
- To study and understand different diffractometers and experimental techniques.
- To study reciprocal lattice concept, laue equations, planes, normals, Ewald spheres etc., in the analysis of diffraction patterns of crystals.
- Calculation of crystal size, qualitative analyses, residual stresses of materials through X-ray analyses.
- To process and analyze the diffracted data.

Course Outcomes:

- Students will gain the knowledge on x-ray production techniques and its applications.
- Students will be able to analyze the crystalline states of materials by XRD
- Qualitative chemical analysis of materials is understood by analyzing diffraction patterns.
- The pupil is in a state where they can estimate crystal structures and process conditions by XRD analyses.
- Grain size estimation, residual stress calculations and texture studies are understood.
- The student is able to appreciate the application of XRD in research and analysis.

UNIT-1

Crystalline state :

Crystal lattices, symmetry operations, finite and infinite symmetry operations, Crystallographic groups, crystal systems, point groups, unit cells, Bravais lattices, Infinite symmetry elements, space groups, stereographic projection.

UNIT_II

X-ray productions, scattering and diffraction :

Nature and sources of x-rays, production of x rays, Collimation and characteristic x-ray spectra, Conventional sealed x-ray sources, Rotating anode x-ray sources, Collimation and

monochromatization, Detection of x-rays, Point detectors, Line and area detector, x-ray scattering by electrons, atoms, and lattices, Laueequations and Bragg's law, Reciprocal and Ewald's sphere, Origin and representation of the powder diffraction pattern, Position of powder diffraction peaks, shapes of powder diffraction peaks, Peak shape functions, Intensity of powder diffraction peaks, Structure factor, Effect s of symmetry on the structure amplitude, Fourier transformation, Phase problem

UNIT-III

Diffractometers and experimental techniques :

Diffractometer optics,slits,absorbers,cradles,Debye-Scherror-Hull,Seeman-Bohlin,and BRAGG-Brentano diffractometers used in transmission and reflection mode, monochromators and their use, Divergence and receiver slit configurations, Resolution, parallel beam optics, theta-theta, theta-two theta configurations, vertical and horizontal goniometers.

UNIT-4

Processing the diffraction data: continuous and step scan ,Aberration ,factors affecting the intensity, line profile ,and resolution of diffraction pattern ,crystallographic maze, from raw diffraction data to working pattern , indexing th powder pattern of cubic and non cubic crystal structures, precise lattice pattern determination , line profile analysis, Fourier and Patterson maps.

UNIT-5

Analysis: Quantitative phase analysis by peak –search method .ICDD database and matching of experimental pattern. Determination of crystallite size and strain, Quantitative phase analysis methods, Calculation of diffraction patterns, Rietveld analysis

Reference Books:

1) B.D.Cullity and S.R.Stock, "Elements of X-Ray Diffraction" Third edition, Prentice Hall, NJ, 2001.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

MM4404 COMPUTATIONAL MATERIALS SCIENCE

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

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

Course Objectives:

- To study and understand different simulation techniques used in Nano-Meso-Micro scale operations in different fields of science and engineering.
- To study different numerical solutions and development of required equations.
- To understand simulations for statistical mechanics in atomic scale simulation and integration.
- Studying dislocations, their interactions and dynamics in a simulated test condition and understanding phase transformations, diffusion etc., under given conditions.
- To understand the importance of simulation studies in predicting the material behavior in any set of conditions.

Course Outcomes:

- Students will be able to utilize different simulation techniques in design and development of various metallurgical operations.
- Students will be able to apply numerical modeling on dislocation dynamics thereby study predict the mechanical behavior of materials under given set of conditions.
- An understanding of the atomic scale migrations, phase stabilities and transformations developed in the students.
- Nano and meso scale modeling studied in detail.

UNIT-I

Modeling and simulation in materials science : Basic ideas behind modeling, Generalized state variable concept, Numerical modeling, categories models ,Fundamentals and solution of differential equations. and finite difference and finite element methods of numerical solution.

UNIT-II

Simulation techniques at nano - meso scale: statistical mechanics in atomic scale simulation and integration , metropolis montecarlo method, spin montecarlo methods, lattice types, Examples of MC method in Materials science.

Molecular dynamics: interatomic potentials, Equations of motion for atomic system, integration of equation of motion, boundary conditions, examples of Molecular dynamics in Materials science.

UNIT-III

Simulation techniques at Micro-meso scale: Introduction, discrete dislocation statics and dynamics, Kinematics of discrete dislocation dynamics dislocation reaction and annihilation, example of dislocation dynamics in materials in materials science

Phase field kinetics models: diffusional phase transformation, continuum phase field kinetics models, continuum phase field kinetic models, application of phase field kinetic models in materials science.

UNIT-IV

Cellular automata : Introduction and scope of cellular automata in materials science , lattice gas cellular automata, Mesh types for cellular automata simulation, Cellular automata and Montecarlo simulations , simulation of nonequilibrium phenomena , applications o cellular automata in materials science.

Mesoscale kinetics montecarlo and Potts models, Geometrics and component models topological and vertex models.

UNIT-V

Simulation techniques at the Meso-macroscale: Geometrics and component models topological and vertex models

MM4505 ELECTRON MICROSCOPE

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

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

Course Objectives:

- To study and understand the working principle of electron microscopy
- To understand the mechanism of electrons transmission through the materials.
- To analyse the images obtained from TEM.
- To study bright field and dark field imaging techniques and associated analyses.
- Kikuchi pattern study.

Course Outcomes:

- Students will be able to operate and analyze the images obtained from TEM.
- Students will be able to understand the mechanism of electron ejection.
- Students understand converging beam techniques and visualization of the properties of the system by analyzing its diffraction patterns.
- An understanding of kikuchi patterns and their applications.
- Understanding the applications of high resolution TEM in atomistic modeling.

UNIT-I

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

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

Weak beam dark field microscopy, high resolution TEM.

Suggested References:

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

MM4411 **SECONDARY STEEL MAKING**

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

Course Objectives:

- To understand the influence of thermodynamic, fluid, heat and mass transfer properties on secondary steel making.
- To study and understand different refining techniques of secondary steel making
- To understand the metallurgy involved in tundish used for storing refined steel before CC.
- To understand the mechanism of solidification during continuous casting.

Course Outcomes:

- Students will gain the knowledge on various secondary steel making operations which include refining, cleaning etc .
- Students will be able to apply the knowledge of thermodynamics, heat transfer, and mass transfer in controlling the rate of the processes.
- Laddle and tundish metallurgical operations like alloying, deoxidation, inert gas stirring etc., are studied with emphasis on their kinertics.
- Removal of gaseous impurities and inclusions from the steels by different degassing operations are studied.
- Solidification kinetics, castings, ingot castings, continuous casting etc., their defects and final finishing operations of steels are studied with reference to the industrial processes to produce final products.

UNIT-I

Introduction: Metallurgical Thermodynamics – Chemical Equilibrium - Activity and Equilibrium Constant - ΔG^0 for Oxides - Activity Composition Relationships - Concentrated Solutions - Dilute

Solutions - Chemical Potential and Equilibrium.

Fluid Dynamics - Inference of Fluid Flow in steelmaking - Force Balance Expressions and Momentum Conservation Equations – Boundary Conditions - Laminar and Turbulent Flows - Calculation of Turbulent Flows in Steelmaking.

Heat Transfer - Mechanism of Heat Transfer - Heat Conduction - Convective Heat Transfer - Radiation.

Mass Transfer and Metallurgical Kinetics - Mechanism of Mass Transfer – Molecular Diffusion - Convective Mass Transfer – Chemical Reaction Kinetics.

UNIT-II

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Slag Carry-over: Impact on Ladle Metallurgy, Deoxidation - Techniques of Deoxidizer Addition - Physical and Chemical Interaction between Solid Additions and Steel Melt - Types of Deoxidation - Deoxidation Kinetics and Products.

Ladle Metallurgy Steelmaking Operations - Construction of Steelmaking ladles; Ladle Refractory, Preheating and Recycling – The Method of Inert Gas Stirring in Ladles - Temperature and Composition Control in Ladles - The Ladle Furnace - Injection Metallurgy - Miscellaneous Issues in Ladle Metallurgy.

UNIT-III

Vacuum Degassing - Principles – Degassing Techniques - Stream Degassing – Tank Degassing - Circulation Degassing - Thermodynamics and Kinetics of Hydrogen and Nitrogen Removal under Vacuum – Water Capacity of Ladle Slags.

Clean steel - Cleanliness Assessment - Inclusions and Mechanical Properties – Sources of Inclusion in steel - Types of Inclusions - Properties of Inclusions - Inclusion Engineering.

UNIT-IV

Tundish Metallurgy - Tundish Design and Operations - Temperature and Cleanliness Control in Tundish - Sequence Casting and Grade Transition - Residual Metal loss in Ladles and Tundish.

UNIT-V

Fundamental Aspects of Solidification, Casting Processes - Ingot Casting – Continuous Casting - Process description – Continuous Casting Products and Casting Defects - Emerging Trends in Continuous Slab Casting -EM stirring and EM braking - Gas Injection in Mold - High Speed Slab Casting - Thin Slab casting - Strip Casting. Final Finishing Operations - Surface Treatment - Heat Treatment - Shaping and Secondary Product Manufacturing (Including Deformation Processing).

Text Books:

1. Ghosh, A. and Chatterjee, A., Principles and Practices in Iron and Steel making, Prentice Hall of India.
2. Ghosh, A., Secondary Steelmaking, CRC Press.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

MM4422 **FRACTURE MECHANICS**

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

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

Course Objectives:

* To provide an overview of the problems of fracture in structural materials and understand the basics of fracture mechanics.

* To understand the concept of plastic zone size and difference in fracture behavior of materials based on the crack-tip plastic deformation of materials.

* Effect of temperature and stress state on the fracture mechanics of different materials.

* To analyze the effect of energy supplied on fracture

* To study different fracture tests.

* To familiarize students to different case studies involving fracture of materials.

* To know the method of fractographic analyses.

Course Outcomes:

- Evolution of a pragmatic understanding regarding the conditions of the failure of materials.
- Honing the skills of the pupil in studying fractographic images and identifying the cause and type of failure.
- Students develop an ability to design different samples and tests for fracture toughness estimations and fractographic analyses of different materials.
- Study of the plastic deformation characteristics at the crack tip.
- To imbibe in the students the ability to derivative several stress equations to describe fracture of samples along with problem solving.
- Enhancing the ability of students to simulate real time situations and develop methods to avoid fracture under the given conditions.

Unit 1: Introduction
Introduction, overview of the basic problems of fracture in structural materials, theoretical cohesive strength, stress-concentration factor and external variables effecting fracture, types of fracture, Griffith crack theory, stress analysis of cracks.

Part 2: Concept of plastic zone and effect on fracture toughness
Elastic stress field and linear elastic fracture mechanics, crack-tip plastic zone and the elastic plastic fracture mechanics, design philosophy, the role of microstructure on fracture toughness and the fracture toughness approach for toughening of structural materials, plane stress and plane strain fracture modes.

Part 3: Energy and fracture relations
Transition temperature phenomenon, impact fracture test methods, impact energy-fracture toughness correlations, limitations, concepts of subcritical crack growth in cyclic loading, in environmental assisted cracking and at elevated temperature applications of structural materials.

Part 4: Testing
LEFM, EPFM and GYFM approach, plane strain fracture toughness measurement (E-399), indentation fracture toughness, plane stress fracture toughness measurement, J-integral approach, COD measurement.

Part 5: Fractograpy:
Mechanisms of failure associated with varied fractographic features, approach for failure analysis, problems and case studies.

Suggested References:

1. Dieter, G, E., Mechanical metallurgy (SI metric edition), McGraw-Hill book company, 1988.
2. Hertzberg, R, W., Deformation and fracture mechanics of engineering materials (3rd edition), John Wiley & sons, 1997
3. Broek, D., Elementary engineering fracture mechanics (3rd edition), Martinus Nijhoff publications, 1982.
4. Knott, J. F., Fundamentals of fracture mechanics, Butterworth publications, 1973.

*L-T-P-C stands for number of lectures, tutorials, practices and credits

MM4406 **Alloy Designing**

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

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

Course Objectives:

- To study and understand different alloying techniques to produce various alloys and intermetallics.
- To introduce the different types of cast irons, their properties and effect of alloying additions to them.
- To familiarize the students to the different types of steels and effect of alloying additions on them.
- To study light metals and their applications.
- To study and analyze the factors effecting alloying.
- To study special grade alloys and their functional intricacies.

Course Outcomes:

* Students will be able to design an alloy by considering various physical and chemical properties of the elements considered for alloying.
* The students understand the application of different cast irons in different fields of metallurgical industry.
* The preparation of different steels industrially is understood.
* Preparation and application of materials with high strength to weight ratios for high end applications.

UNIT-I

Principles of alloying: Introduction & Overview; Alloying For – Mechanical Service, Processing & Physical Properties; Alloying Techniques; Surface Alloying

UNIT-II

Cast Irons: Overview, composition control, alloying practice, effect of alloying of properties & Microstructure - of - Gray Irons Ductile Irons, Compact Graphite Irons, Malleable Irons, High-Alloy White Irons.

UNIT-III

Carbon and alloy steels: Overview, composition control, alloying practice, effect of alloying of properties & Microstructure - of - Carbon & Alloy Steels, High-Strength Low-Alloy Steels, Tool Steels, Maraging Steels, Austenitic Manganese Steels, Stainless steels, Super Alloys, Refractive Metal Alloys, Ordered Intermetallics.

UNIT-IV

Light Metals & Alloys & Other Nonferrous Alloys : Al - Aluminium Alloys, Ti - Titanium Alloys, Mg - Magnesium Alloys. Cu, Ni, Zn, Pb, Sn, Co Their Alloys Noble Metal Alloys.

UNIT-V

Special purpose alloys & Advanced Metallic alloys: Cemented Carbides & Cermets, Low-Expansion Alloys Electrical Contact Alloys & Magnetic Alloys. Mechanical Alloying & Shape Memory Alloying

MM4413 **Nuclear Metallurgy**

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

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

Course Objectives:

1. To explain and describe the basics of Nuclear technology and relevance of metallurgy to nuclear reactors.
2. To gain a working knowledge of extraction of nuclear metals like Uranium, Thorium, and Beryllium.
3. To understand principles of nucleation reactors and its safety.

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UNIT – I

ELEMENTARY NUCLEAR PHYSICS AND CHEMISTRY: Structures of nucleus, radioactivity, bending energy: nuclear interaction; fission and fusion: nuclear reaction; energy, release and chain reactions; neutron cross-section; multiplication and criticality concepts and factors.

UNIT - II

Mechanisms of moderation, radiation detection, radiation effects on fissile and non-fissile materials; radiation damage and radiation growth; thermal cycling; protection against radiations.

UNIT – III

Types of reactors and classification. Considerations in selection and properties of common materials used as fuels, their physical and chemical properties; canning materials; coolants; control rods; reflectors and shielding materials.

UNIT – IV

Occurrence and general characteristics of nuclear minerals. Flow sheets of processing of nuclear minerals for the production of nuclear grade uranium, thorium, beryllium and zirconium with emphasis on basic scientific principles involved.

UNIT – V

Production and enrichment of uranium, Fabrication fuel elements. Irradiated fuel processing for recovery of Plutonium. Nuclear power production in India and its economics.

Course outcomes: At the end of the course, student would be able:

1. Use fundamental concepts of physics and chemistry to know the basics of nuclear energy. Understand the use of nuclear energy as a major source of energy.

2. Recognize the predominant mechanisms for materials failure in radiation environments, and understand the fundamentals of radiation damage events and gain knowledge about the safety measures and control.

3. Understand the guiding principles of reactor safety and report findings including recommendations for improvement.

4. Understand materials design issues in various reactor configurations and recognize the materials used in different types of reactor applications.

5. Understand the manufacturing processes and fabrications methods used for various materials used in reactors.

6. Work and communicate effectively in diverse and multi-disciplinary teams and be aware of modern professional, ethical, and societal issues as well as recognize the need for lifelong learning.

TEXT / REFERENCE BOOKS:

1. Metallurgy in Nuclear Power Technology: Wright JC, Iliffe Book Ltd., 1962
2. Nuclear Reactor Metallurgy: Wilkinson WD and Murphy WF, Van Nostrand, 1958
3. Symposium on Rare Materials: Indian Institute of Metals.
4. Principles of Nuclear Reactor Engineering: Glasstone S and Snesonske A Macmillan, London.
5. Uranium and Thorium: Grainger L; George Newnes Ltd., London.
6. Nulcears Fuels: Gurinsky DH and Dienes JL; Macmillan.
7. Reactor Hand book Material; US Atomic Energy Commission, McGraw Hill Book Co. 1955
8. Proceedings of the symposium on Nuclear Science and Engineering – Bhabha Atomic Research Centre, Bombay.

MM4414 **Principles of Extractive Metallurgy**

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

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

Course Objectives:

* To understand the methods of metal extraction and sources of non ferrous metals
* To study the thermodynamics principles involved in metal extraction
* To study the methods of extracting non ferrous metals from their sources
* To study various methods of refining the extracted metals.
* To study reaction kinetics and transportation kinetics of exctrion.

Course Out comes:

- Students will be able to identify various resources of ferrous and non ferrous metals and understand their extraction and refining methods by applying thermodynamic concepts.
- Students will be able to clearly differentiate ferrous and non ferrous metals.
- Students will be able to understand the application of Ellingham diagrams in the extraction of metals.
- Students will be able to understand and apply the reaction kinetics and transportation kinetics during the extraction (pyro, hydro and electro metallurgical) .
- Study of extraction of metals from oxide sources, conversion of sulphide ores to oxides followed by their reduction.

UNIT-I

Introduction to extraction of metals-world scenario, quantities characterizing the state of system and its evolution, thermodynamic fundamentals of reactions, phase diagrams , Metals-oxygen/ metal-sulfur systems, activities in the intermediate phases.

UNIT-II

Ellingham-Richardson diagrams: thermodynamic data for sulfides and chlorides and its use, Metal- carbide phase diagrams and ellingham-richardson diagrams for Carbides, Metal solutions, mattes structure and properties of sulfide melts, slags-their structure and properties, slags in metallurgical systems and phase diagrams, Aqueous electrolytic solutions and thermodynamics, thermodynamics of molten salt melts

UNIT-III

Reaction kinetics: rate of chemical reactions, Homogeneous precipitation ,Kinetics and mechanisms of heterogeneous reactions, experimental rates of transport processes, Experimental rates of gas –liquid reactions, reduction rates for in situ conversion of a solid particle, Roasting, heterogynous precipitation.

UNIT-IV

Transport kinetics : Identification of rate limiting steps, Equation of change, interphase mass heat transport, heat and mass transfer problems I, heat and mass transfer problems II, mixed control- Overall kinetics of extraction process-gasification, solvent extraction, Gasification and leaching of a particle, strong exo/endothermic chemical reaction, transfer processes between two phases, one phase being dispersed in the other.

UNIT-V

Introduction to electrochemical processes, Nernst Equation, Electrochemical eqilibria and pour baix diagrams electrochemical kinetics, Redox electrochemical reactions.

Suggested References:

1. **Extractive Metallurgy I Alain vignes 2011 John wiley and sons publications.**

BM4001 Managerial Economics and Financial Analysis

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

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

Course Objectives:

- The course describes the Nature And Scope of Managerial Economics. It gives complete study on the demand and elasticity of demand and methods of demand forecasting.
- It provides a detailed structure on the pricing strategies and shows clear picture methods and sources of raising finance.
- It gives a clear cut information of preparing final accounts and capital Budgeting techniques.

Course Outcome:

After the successful completion of this course, the learner will be able to know:

* The dynamic game of demand and supply, and how the trinity of Economics i.e. Demand, Supply and Scarcity make the things move around the globe.
* Principles of Microeconomics applied to industries.
* Concept of forecasting and applying forecasting techniques to address the challenges and opportunities in the organization they work.
* Cost and Production analysis, Break-Even analysis, Opportunity Cost, how to optimize organizational resources and how to minimize cost and maximize production, revenue and profit
* Different pricing structure and discount mechanism suitable for business firms.
* Market structure and how to exploit market structure for optimizing the benefits of organization.
* Capital requirements and sources of capital.

UNIT I: Introduction to Managerial Economics:

Definition, Nature and Scope of Managerial Economics-Demand Analysis: Demand Determinants, Law of Demand and its exceptions. Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Factors governing demand forecasting, methods of demand forecasting.

UNIT II: Theory of Production and Cost Analysis:

Production Function - Isoquants and Isocosts, MRTS, Least Cost Combination of Inputs. Cobb-Douglas Production function, Laws of Returns, Internal and External Economies of Scale.

Cost Analysis: Cost concepts, Opportunity cost. Fixed vs. Variable costs, Explicit costs Vs. Implicit costs. Out of pocket costs vs. Imputed costs. Break-even Analysis (BEA)-Determination of Break-Even Point (simple problems)- Managerial Significance and limitations of BEA.

UNIT III: Markets & Pricing Policies:

Market structures: Types of competition, Features of Perfect competition, Monopoly and Monopolistic Competition. Price-Output Determination in case of Perfect Competition and Monopoly. Objectives and Policies of Pricing- Methods of Pricing: Cost Plus Pricing. Marginal Cost Pricing, Sealed Bid Pricing, Going Rate Pricing, Limit Pricing, Market Skimming Pricing, Penetration Pricing.

UNIT IV: Introduction to Financial Accounting: Introduction to Financial Accounting: Double entry Book Keeping, Journal, Ledger, Trail Balance and Final Accounts (Trading account, Profit and Loss Account and Balance sheet with simple adjustments).

UNIT V: Capital and Capital Budgeting:

Capital and Capital Budgeting: Capital and its significance. Types of Capital. Estimation of Fixed and Working capital requirements. Methods and sources of raising finance. Nature and scope of capital budgeting, features of capital budgeting proposals. Methods of Capital Budgeting: Payback Method. Accounting Rate of Return (ARR) and Net Present Value Method, Internal Rate of Return (IRR).

Reference Books:

1. Aryasri: Managerial Economics and Financial Analysis, TMH,2009.
2. Varshney & Maheswari : Managerial Economics, Sulthan Chand,2009.
3. Raghunatha Reddy & Narasimhachary: Managerial Economics& Financial Analysis, Scitech. 2009.
4. V.Rajasekarn & R.Lalitha. Financial Accounting, Pearson Education. New Delhi. 2010
5. Suma Damodaran, Managerial Economics, Oxford University Press. 2009.

MM4421 **FATIGUE CREEP AND FRACTURE**

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

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

Course Objectives:

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

Course Out comes:

- Establishing a connection between mechanical behavior of metals specific to high temperature, strain rates and repetitive alternating stresses.
- Developing a sound understanding on the real life situations leading to failures under real time situations and analyses of their prevention.
- Understand the differences in the classification of fracture mechanics (LEFM and EPFM) and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service
- Appreciate the theoretical basis of the experimental techniques utilized for fracture and failure analysis

Unit 1:

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

Part 2: Fatigue of metals:

Stress cycles, S-N curve, effect of mean stress on fatigue, cyclic stress-strain curve, low-cycle fatigue, strain-life equation, structural features of fatigue, fatigue crack propagation, effect of stress concentration on fatigue, size and surface effects on fatigue, fatigue under combined

stresses, design for fatigue, corrosion fatigue, effect of temperature, sample size and metallurgical factors on fatigue.

Part 3: Creep and stress rupture:

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

Part 4: Fracture:

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

Part 5: Analyses and case studies:

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

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Suggested References:

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

MM4423 **SUPER ALLOYS**

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

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

Course Objectives:

* To provide an introduction to super alloys
* To understand the physical metallurgy and heat treatments of super alloys
* To analyze the structure property relations of super alloys
* To study their processing
* To know the applicable methods of quality assessment and heat treatments.

Course Outcomes:

- Study about the processing of different super alloys and their applications in structural materials.
- Understanding the difference between different super alloys and their physical metallurgy.
- Logical analyses of different thermo-mechanical treatment situations and designing experiments to obtain the desired structures and properties.
- Understand the heat treatment processes and quality control of super alloys.

Unit 1: Introduction

Introduction to super alloys, Guide to selection of super alloys, wrought super alloys, heat Resistant castings.

Unit 2: Physical metallurgy:

Microstructure of wrought heat-resisting alloys, microstructure of Ni-base & Co-base alloys, temperature and time-dependent transformation, application to heat treatment of high temperature alloys.

Unit 3: Structure property relations:

Relationship of properties to microstructure in super alloys, fracture properties of super alloys, high temperature corrosion and use of castings for protection, effect of Physical Metallurgy and process variables on the microstructure of wrought super alloys, process and metallurgical factors affecting on superalloys and other high temperature materials.

Part 4: Processing:

Melting process: melting of super alloys: principles and practices of vacuum induction melting and vacuum arc melting.

Casting methods: improving turbine blade performance by solidification control-the development of single crystal turbine blades.

Forming methods: forming and fabrication of super alloys: recent developments in p/m of super alloys-production of components by hot-isostatic pressing.

Part 5:

Quality of super alloy castings, heat treating of heat resistant alloys.

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Suggested References:

2. Campbell, I, E., High temperature materials, John wiley and sons Inc., 1956
3. Donachie, M, J., Super alloys: Source book (2nd edition), SAE international, 2002

List of Free-electives :

SUBJECT CODE	SUBJECT NAME	L-T	P	C
BM4402	Production and Project Management	4	0	3
BSBE4401	BIOINFORMATICS	4	0	3
BSBE4402	INDUSTRIAL BIOTECHNOLOGY	4	0	3
BSBE4403	BIOMEDICAL ENGINEERING	4	0	3

BSBE 4401 BIOINFORMATICS

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

Course Objectives: To give an overview of the existing methodologies adopted in computational analysis of biological data. The main objective of the course is to stress the need for algorithm and data processing technologies for analysis and decoding the information processing of biological systems.

Course Outcome: This course improves the critical intellectual faculty required for handling and analyzing large data sets. It also stresses the need for integrating information to solve problems. The gap in resolving biological problems with the aid of core domain knowledge of different disciplines can be curtailed with the help of this course since it embarks the student with the skills to gather and integrate the required biological information. Students interested in developing algorithms and data processing technologies for analyzing biological information have huge demands since the applications of this branch play a vital role in alleviating bottlenecks in drug development.

UNIT-1: Biological Data Bases

1. Introduction to Bioinformatics -History of Bioinformatics- Internet and Bioinformatics

2. Introduction – Data base definition, data, Biological databases- Types of databases- conventions for databases indexing and specification of search terms

3. Contents and formats of database entries – retrieval of data using text based search tools – sources of data (Ex. Sequencing projects, Patent office's etc.), Method for deposition of data to databases.

4. Nucleic acid sequence databases – Genbank, EMBL, DDBJ

5. Protein sequence database – Primary sequence database. Introduction to protein information Resource (PIR)- Martinsried institute of Protein Sequence (MIPS), SWISS- PROT , Structure of SWISS- PROT Entries, Translated EMBL (TrEMBL)

6. Secondary sequence Database- Introduction to PROSITE, PROFILE, PRINTS, BLOCK, pfam and IDENTITY databases.

7. Genome Databases at NCBI, EBI, TIGR, SANGER.

8. Structural and Related Databases – PDB, NDB, CCSD, Prosite, PRODOM, Pfam, CATH, SCOP, DSSP, FSSP, DALI

UNIT-2: Sequence Analysis

9. Various file formats for Bio – molecular sequences – Genbank, FASTA, GCG, MSF, NBRF-PIR. Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, Paralogues

10. Scoring matrices- Basic concept of a scoring matrix- matrices for nucleic acid and protein sequences – PAM and BLOSUM matrices – Principles based on which these matrices are derived

11. Sequence – based Database searches- What are Sequence based database searches, BLAST and FASTA algorithms. Various versions of Basic BLAST and FASTA. Use of these methods for sequence analysis

12. Pairwise sequence Alignments- Basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for Pair wise alignments – use of pair wise alignments for analysis of nucleic acid and protein sequences

13. Sequence Patterns and profiles – Basic concept and definition of sequence patterns, motifs and profiles, various types of pattern representations- namely consensus, regular expression and profiles.

14. Profile based database searches using PSI- BLAST, analysis and interpretation of profile – based searches

UNIT-3: Phylogenetic Analysis

15. Introduction – Evolution, definition of phylogenetic tree – nodes, internodes , root , tree , styles, cladogram, Phenogram, curvogram

16. Steps involved in construction of Phylogenetic tree

17. Methods of Phylogenetic analysis – Distance method, character based method

18. Tree Evaluation – Jumbling sequence addition order, Boot strap method.

19. Problems in Phylogenetic analysis- Phylogenetic analysis tool (Phylip, Clustalw,Tree view)

Unit 4: Applications of Bio Informatics

20. Chemi informatics in Biology- conventions for representing molecules – Chemi informatics, resources.

21. Bioinformatics in Pharmaceutical industries and Medical Sciences, Immunology, Agriculture, Forestry, Geo Informatics, Bio sensing.

22. Legal, Ethical and commercial ramifications of bioinformatics

REFERENCES

1. *David E. Mount. Textbook of Bioinformatics. Cold Spring Harbor (CSH) publication.*
2. *D. Baxavenis, and B. F. F. Ouellette, Bio informatics- A Practical guide to the analysis of Genes and Proteins, 2nd ed., John Wiley and Sons Inc., 2001.*
3. *A.R Leach, Molecular Modeling: Principles and Applications, Addisons-Wesley Pub Co.1997.*
4. *P.E.Bourne and H.Weissig, Structural Bioinformatics, WILEY, 2003.*
5. *T.Lenguer, Bioinformatics-From Genome to Drug, Vols 1 and 2,Wiley-VCH,2002.*
6. *B.Brayn, Bioinformatics computing: the comlete practical guide to bioinformatics for life scientists,Prentice Hall, 2000.*
7. *Misner and S.A. Krawetz, Bioinformatics: methods and protocols,Hanuma Press,2000.*
8. *S.A. krawetz and D.D. Womble, Introduction to Bioinformatics: a theoretical and practical approach, Hanuma Press,2003.*
9. *D.Higgins and W.Taylor (ed), Bioinformatics: sequence ,structure and databanks-a practical approach, Oxford, 2000.*
10. *Prof. P.B. Kavi Kishor and L.N. Chavali, Principlesof Biological Databases, Himalaya Publishers, 2013.*

BSBE 4402 INDUSTRIAL BIOTECHNOLOGY

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

Course Objectives:

-Discuss the significance of industrial biotechnology.

-Explain the large-scale production of biomolecules using bioreactors.

-Discuss the types of fermenters and their applications.

-Discuss upstream an downstream process for biotechnology products.

-Explain biosafety issues and automation of industrial plants.

-Discuss product validation and regulation of biotechnology products.

-Discuss industrial applications of microbes, plants, mammalians cells in biotechnology development.

UNIT-1: INTRODUCTION TO INDUSTRIAL BIOPROCESS

Fermentation - Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and modern Biotechnology, A brief survey of organisms, processes, products. Basic concepts of Upstream and downstream processing in Bioprocess, Bioreactors - design and types.

UNIT 2 : PRODUCTION OF PRIMARY AND SECONDAR METABOLITES

Primary Metabolites – Production of commercially important primary metabolites Like organic acids, amino acids and alcohols. Secondary Metabolites – Production processes for various classes of secondary metabolites, antibiotics, vitamins and steroids.

UNIT 3 : ENZYME BIOTECHNOLOGY AND OTHER BIOPRODUCTS

Industrial use and production of Enzymes (Cellulases, proteases Lipases etc.), immobilization of Enzymes and applications. Biosensors, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers, biofuels – biogass, biodiesel, bio hydrogen, bio ethanol, microbial fuel cell technology. Biodegradable plastics, biorefineries to generate electricity.

UNIT 4: FOOD BIOTECHNOLOGY

Food preservation through canning, sterilization, pasteurization, chemicals, radiations drying and packing. Food spoilage-Biotechnology process for prevention of food spoilage. Fermented foods and pro-biotics. Microbial foods- SCP.

UNIT 5 : PRODUCTION OF MODERN BIOTECHNOLOGY PRODUCTS

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines, monoclonal antibodies. Gene therapy, Bioprocess strategies in Plant Cell,Animal and microbial cell cultures.

REFERENCES:

1. *Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.*
2. *Kuma, H.D."A Textbook on Biotechnology" Edition. Affiliated East West Press Pvt. Ltd., 1998.*
3. *Balasubramanian, D. etal. , "Concepts in Biotechnology" Universities Press Pvt.Ltd., 2004.*
4. *Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" 2 nd Edition Cambridge University Press, 2001.*
5. *Dubey , R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd. , 2006.*
6. *Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.*
7. *Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios India), 2005.*
8. *Microbiology", 2 nd Edition, Panima Publishing, 2000.*
9. *Moo – Y oung, Murrey, "Comprehensive Biotechnology", 4 Vols. Ergamon Press, (An Imprint of Elsevier) 2004.*
10. *Stanbur y, P . F ., A. Whitaker and S.J. Hall "Principles of Fermentation T echnology", 2 nd Edition, Butterworth-Heinemann (an imprint of Elsevier), 1995.*
11. *C. F. A Brycean d EL.Mansi, Fermentation microbiology & Biotechnology, 1999.*
12. *K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.*

BSBE 4403 BIOMEDICAL ENGINEERING

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

Course Objectives:
The students will be able to
1. Interpret technical aspects of medicine.
2. Solve Engineering Problems related to medical field.
3. Understand medical diagnosis and therapy.

Course Outcomes:

On completion of this module students will be able to analyze a problem from both an engineering and biological perspective; they can anticipate the special difficulties of technological intervention in working with living systems and to evaluate a wide range of possible approaches.

Students will be able to apply their engineering domain knowledge with a biological perspective to solve the problems at the interface of engineering and biology.

Addressing the problems associated with the technological interface with living systems, students would be enabled to design a variety of electronic and/or computer-based devices and software for applications including biomedical instrumentation, medical imaging, physiological measurement, biomedical signal processing, rehabilitation engineering and medical informatics.

They will be able to make physical measurements and gather data to reflect biological activity from living systems; and aid in the analysis of biological systems, design of biomedical instruments, and the technological advancement for health care.

UNIT I: HUMAN ANATOMY & PHYSIOLOGY.

Structure and function of Cell & cellular components – Membrane Potential – Action Potential – Generation and Conduction; Overview of Cardiovascular system, Nervous System, Muscular-Skeletal System, Respiratory system, Excretory system.

UNIT 2: PRINCIPLES OF DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS
Normal and abnormal ECG waveform, diagnosis interpretation, cardiac pacemaker, heart lung machines - need for the unit, spirometer, respiratory volume measurement, pnemograph, artificial respirator –ipr type, functioning, pulse oximetry, basic principles of echo technique,

display techniques a, b, m, d modes, echo cardiograms, echo encephalogram, ultrasonic applied as diagnostic tool in ophthalmology, obstetrics and gynaecology. Principles of dialysis – Hemodialys.

UNIT 3: MEDICAL IMAGING

Introduction to medical imaging and different medical imaging modalities. Review of Signals and system, Fourier transform, Transfer functions, Hankel transform, Sampling theorem, Projection Radiography (Mammography, Fluoroscopy, Angiography etc), Nuclear Medical Imaging, Ultrasound Imaging, Magnetic Resonance Imaging.

UNIT 4: MEMS & BIOMEMS

Introduction, MEMS, micro system, sensor, actuator Material for MEMS Sensing and actuation Fabrication of MEMS, Material for MEMS, Sensing and actuation, Fabrication of MEMS and MEMS packaging.

UNIT 5: BIOSENSORS

Sensor architecture and Classification; Medically significant measurands, functional specifications of medical sensors; Sensor characteristics: linearity, repeatability, hysteresis, drift; Sensor models in the time & frequency domains. Sensors for physical measurands: strain, force, pressure, acceleration, flow, volume, temperature and biopotentials. Sensors for measurement of chemicals: Electronic eye,electronic nose and electronic tongue and their use in fermentations and breweries. Potentiometric sensors, ion selective electrodes, ISFETS; Amperometric sensors, Clark Electrode; Biosensors, Catalytic biosensors, Immunosensors.

References:

1. William R. Hendee, E. Russell Ritenour Medical Imaging Physics.
2. Jerry L. Prince, Jonathan M., Medical Imaging Signals and Systems. Pearson
3. Khandpur R.S., Hand book of Biomedical instrumentation, TMH.
4. Carr & Brown, Introduction to Biomedical Equipment,PHI.
5. J. G. Webster (Ed.): Medical Instrumentation - Application and Design; Houghton Mifflin Co., Boston, 1992.
6. R. Aston: Principles of Biomedical Instrumentation and Measurement, Merril Publishing Co., Columbus, 1990.
7. Manz and H. Becker, Eds. Microsystem Technology in Chemistry and LifeSciences Spronger-Verlag, New York, 1999.
8. Guyton and Hall, “Textbook of Medical Physiology”, Elsever

BM4402 PROJECT AND PRODUCTION MANAGEMENT

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

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

Course Objective:

- To make students learn about holistic approach of Project Management
- To make students learn about optimizing Production to increase the return while reducing the risk
- This course aims at helping the students to learn operations management systems and analyze issues pertaining to management of productivity, technology and facilities.
- The objective of the course is to impart the concepts, tools & techniques in formulation and analysis of projects as well as in planning, scheduling & controlling of projects.

Course Outcomes:

1. After learning this, the students will be in the position to understand and practice the process of project management and its application in delivering successful IT projects.
2. Evaluate a project to develop the scope of work, provide accurate cost estimates and to plan the various activities.
3. After learning this, students understand and use risk management analysis techniques that identify the factors that put a project at risk and to quantify the likely effect of risk on project timescales.
4. Identify the resources required for a project and to produce a work plan and resources schedule.
5. The learner will have a deep knowledge of the fundamental theory and mathematical principles involved in the Learning Curve, Line Balancing, Forecasting, Material Requirement Planning, Capacity Management, Line Balancing, Inventory, Scheduling, Staffing and Control in order to optimize operating systems.
6. The learner will have a range of skills which can be applied to any production or service system. This module will also enhance the professional and technical skills of the student Competence.

Unit I:
Introduction: Project management: an overview, Project Selection: Project Identification and Screening, Project Appraisal: Part I, Project Appraisal: Part II, Project Selection. (6 modules)

Unit II:
Project Planning and Implementation: Development of Project Network, Project Representation, Consistency and Redundancy in Project Networks, **Project Scheduling:** Basic Scheduling with A-O-A Networks, Basic Scheduling with A-O-N Networks, Project Scheduling with Probabilistic Activity Times. Project Implementation: Project Monitoring and Control with PERT /Cost, Project Completion, Review and Future Directions. (8 Modules)

Unit III:

Production Management: Introduction to Production Systems and a Generalized Model of Production, Life cycle of a Production System and Major managerial Decisions, **financial evaluation of production related decisions,** Performance Measures of a Production System, Financial Evaluation of Capital Decisions, Decision Trees and evaluation of risk. (6 Modules)

Unit IV:

Product Design, Facility Location and Layout: Introducing New Products and Services, Product Mix Decisions, **Facility location and layout:** Plant Location, Process Layouts, Product Layouts and Assembly Line Balancing, Cellular Layouts, Layouts for Advanced Manufacturing Systems. (8 Modules)

Unit V:

Production Planning: Production Planning over medium term: Demand Forecasting, Aggregate Production Planning. Operational Decisions over Short term: .Inventory related Decisions, Material Requirements Planning and Scheduling of Job Shops. (8 Modules)

REFERENCE BOOKS:

1. Elements of Production Planning and Control / Samuel Eilon.

2. Modern Production/ operation managements / Baffa & Rakesh Sarin

3. Operations Management – S.N. Chary.

4. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

5. Reliability Engineering & Quality Engineering by Dr. C. Nadha Muni Reddy and Dr. K. Vijaya Kumar Reddy, Galgotia Publications, Pvt., Limited.

6. Operations Management / Joseph Monks.

7. Project Management, Prasanna Chandra.

Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus

IV YEAR
II SEMESTER

Subject Code	SUBJECT NAME	L-T-P	Credits	Category
	Free Elective-II	4-0-0	3	
MM4800	Project		16	
MM4000	Comprehensive Viva-II		1	
Total		**4-0-0**	**20**	

List of Free-electives:

BM4501	FOUNDATIONS OF MANAGEMENT
BM4502	ENTREPRENEURSHIP AND NEW VENTURES
BM4503	INTELLECTUAL PROPERTY RIGHTS
BSBE4501	SUSTAINABLE TECHNOLOGY
BSBE4502	PHARMACEUTICAL TECHNOLOGY
BSBE4503	BIO MATERIALS
CH4504	Computational Fluid Dynamics

BM4501 **FOUNDATIONS OF MANAGEMENT**

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

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

Course Objective:

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

Course Contents:

1. **Development of Management Thought:** Learning objectives, Concept of management, Scientific Management-Taylor, Henry Fayol contributions, Human Relations approach-Hawthorne experiments, Approaches to Management, Ethics in management.

2.

2. **Functions of Management:** Management Processes and function: Nature and description of management process, Managerial functions: Planning, Organizing, Directing, Coordinating and Controlling. Communication process, Theories of motivation and leadership, (14 Modules)

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

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

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

Suggested Reference Books:

1. Weirich, Koontz & Aryasri, *Principles of Management,* TMH, New Delhi, (2004).

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

BM4502 ENTREPRENEURSHIP AND NEW VENTURES

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

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

Course Objective:

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

Course Objective:

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

Course Contents:

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

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

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

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

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

Suggested Reference Books:

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

BM4503 **INTELLECTUAL PROPERTY RIGHTS**

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

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

Course Objective:

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

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

Course Contents:

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

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

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

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

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

Suggested Readings:

1. Cornish.W.R, "Intellectual Property Patents", Copy Right and Trademarks and Allied rights, Sweet&Maxwell 1993.
2. P. Narayanan: Intellectual Property Law, Eastern Law House, 2nd edn 1997.

3. Roy Chowdhary, S.K. & Other:Law of Trademark, Copyrights, Patents and Designs, Kamal Law House, 1999.
4. Dr. G.B. Reddy,Intellectual Property Rights and the Law 5th Ed. 2005 GogiaLaw Agency.
5. B.L. Wadhera: Intellectual Property Law, Universal Publishers, 2nd Ed. 2000.

BSBE 4501 SUSTAINABLE TECHNOLOGIES

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

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

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

UNIT 1: DRAW BACKS OF CURRENT TECHNOLOGIES

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

UNIT 2: ENVIRONMENT REMEDIATION

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

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

UNIT 3: SUSTAINABLE TECHNOLOGIES

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

UNIT 4: BIOMIMICRY

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

UNIT 5: BIOLOGICAL RESOURCES FOR SUSTAINABILITY

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

Reference:

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

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

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

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

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

6. Sustainable Communities Design Handbook - Woodrow W. Clark

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

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

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

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

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

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

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

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

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

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

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

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

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

BSBE 4502 **PHARMACEUTICAL TECHNOLOGY**

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

Course Objectives:

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

Course Outcomes:

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

-Apply in-depth knowledge and practical skills for formulation and process manufacturing of

chemical and biological drugs into a range of pharmaceutical dosage forms, ranging from tablets to injectables.

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

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

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

-Demonstrate their ability to conduct healthcare related research.

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

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

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

UNIT 1: PREFORMULATION STUDIES

Introduction, Consideration of physicochemical properties of new drug molecules for different dosage forms. Aqueous solubility, organic solubility, intrinsic solubility, methods of enhancement of solubility-surfactants, pH, co-solvency, solid dispersion, complexation. Techniques for the study of crystal properties and polymorphism - DSC, TGA, PXRD, Optical microscopy, hot stage microscopy.

UNIT 2: PHARMACEUTICAL EXCIPIENTS & POLYMERS

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

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

UNIT 3: FORMULATION TECHNOLOGY

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

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

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

UNIT 4: STABILITY TESTING - DRUGS AND DOSAGE FORMS

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

UNIT 5: CONCEPTS OF CONTROLLED RELEASE DRUG DELIVERY SYSTEMS

Introduction, concept, advantages & disadvantages. Factors to be considered for designing controlled release dosage forms. Dissolution, Diffusion, Combination of dissolution and diffusion controlled drug delivery systems. Classification of rate-controlled drug delivery systems. Rate-programmed release, activation-modulated and feedback regulated drug delivery

systems. Effect of system parameters on controlled drug delivery. Hydrodynamically balanced systems, Osmotic pressure controlled, pH controlled, ion exchange controlled systems

REFERENCE BOOKS

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

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

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

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

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

BSBE 4503 **BIOMATERIALS**

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

Course Objectives:

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

1. Understand the fundamental principals in biomedical engineering, material science and chemistry, and how they contribute to biomaterial development and performance.

2. Understand the material selection and structure-function relationships

3. Lists the different strategies to modify and/or design materials that are biocompatible.

Course Outcomes

On completion of this course students should be able to:

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

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

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

- Describe the methods of testing for biomaterials biocompatibility.

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

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

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

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

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

Concepts of cells, proteins and their interaction with the biomaterial, Structure and properties of different classes of biomaterials; Interactions of materials with the human body; Criteria for selection of biomaterials for specific medical applications, Concepts of Biocompatibility, mechanical properties of biomaterials, corrosion and biodegradation, evaluation of biomaterials.

UNIT 2. METALS AND ITS COMPOSITES.

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

UNIT 3. CERAMICS AND ITS COMPOSITES.

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

UNIT 4. POLYMERS AND ITS COMPOSITES.

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

UNIT 5. BIOMEDIACAL APPLICATIONS OF BIO MATERIALS.

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

.**Texts & References**

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

CH4504 COMPUTATIONAL FLUID DYNAMICS

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

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

Course Objective:

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

Unit-1 Conservation Laws And Turbulence Models

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

Unit-2 Finite Differnce Approximation

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

Unit-3 Finite Volume Method

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

Unit-4 Flow Field Computation

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

Unit-5 Grid Generation

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

grid generation by algebraic mapping.

Text Books:

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

References:

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

MM4800 **PROJECT**

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

Internals: 40 Marks **0-0-0-16**

Student has to do literature review on the chosen/allotted area of project work and must submit a report.

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