Metallurgical and Materials Engineering

Course Structure and Detailed Syllabus of Engineering 3rd Year Semester-II

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

MM3201 MATERIALS JOINING PROCESSES

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

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

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

INTRODUCTION TO CERAMIC TECHNOLOGY

MM3202

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

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.

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.

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

MM3203 **CORROSION ANDENVIRONMENTALDEGRADATION OF MATERIAL**

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

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

Chapter -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.

Chapter -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.

Chapter -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.

Chapter -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.

Chapter -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.

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MM3204 **POWDER METALLURGY**

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

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

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

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OBJECT ORIENTED PROGRAMMING THROUGH JAVA (CS3001)

	L	T	P	C
III Year B.Tech.	**4**	**0**	**1**	**4**

Prerequisites

1. A course on "Programming in C & Data Structures".

Objectives

1. Introduces object oriented programming concepts using the Java language.
2. Introduces the principles of inheritance and polymorphism; and demonstrates how they relate to the design of abstract classes.
3. Introduces the implementation of packages and interfaces.
4. Introduces exception handling, event handling and multi threading.
5. Introduces the design of Graphical User Interface using applets and swings.

Outcomes

6. Develop applications for a range of problems using object-oriented programming techniques.
7. Design simple Graphical User Interface applications.

UNIT-I

OOP concepts - Data abstraction, encapsulation, inheritance, benefits of inheritance, polymorphism, classes and objects, Procedural and object oriented programming paradigms.

Java programming - History of Java, comments, data types, variables, constants, scope and life time of variables, operators, operator hierarchy, expressions, type conversion and casting, enumerated types, control flow block scope, conditional statements, loops, break and continue statements, simple java stand alone programs, arrays, console input and output, formatting output, constructors, methods, parameter passing, static fields and methods, access control, this reference, overloading methods and constructors, recursion, garbage collection, building strings, exploring string class.

UNIT-II

Inheritance - Inheritance hierarchies, super and sub classes, Member access rules, super keyword, preventing inheritance: final classes and methods, the Object class and its methods.

Polymorphism - dynamic binding, method overriding, abstract classes. **Interfaces -** Interfaces vs. Abstract classes, defining an interface, implementing interfaces, accessing implementations through interface references, extending interfaces.

Inner classes - uses of inner classes, local inner classes, anonymous inner classes, static inner classes, examples. **Packages -** Defining, Creating and Accessing a Package, Understanding CLASSPATH, importing packages.

UNIT-III

Exception handling - Dealing with errors, benefits of execution handling, the classification of exceptions- exception hierarchy, checked exceptions and unchecked exceptions, usage of try, catch, throw, throws and finally, re throwing exceptions, exception specification, built in exceptions, creating own exception sub classes.

Multithreading - Difference between multiple processes and multiple threads, thread states, creating threads, interrupting threads, thread priorities, synchronizing threads, inter-thread communication, procedure consumer pattern.

UNIT-IV

Event Handling : Events, Event sources, Event classes, Event Listeners, Delegation event model, handling mouse and keyboard events, Adapter classes.

The AWT class hierarchy, user interface components- labels, button, canvas, scrollbars, text components, check box, check box groups, choices, lists panels – scrollpane, dialogs, menubar, graphics, layout manager – layout manager types – border, grid, flow, card and grid bag.

UNIT-V

Applets – Concepts of Applets, differences between applets and applications, life cycle of an applet, types of applets, creating applets, passing parameters to applets.

GUI Programming with Java - Introduction to Swing, limitations of AWT, Swing vs AWT, MVC architecture, Hierarchy for Swing components, Containers - JFrame, JApplet, JDialog, Jpanel.
Overview of some swing components Jbutton, JLabel, JTextField, JtextArea, simple swing applications.

TEXT BOOKS:

1. Java the complete reference, 7th editon, Herbert Schildt, TMH.
2. Understanding OOP with Java, updated edition, T. Budd, Pearson Eduction.

HS3201 Soft Skills-II

Externals:	**L-T-P-C***
Internals:	**6-0-0-1**

Objectives:

- To implement practically the skills needed for employment.
- To deal with the society in an acceptable way maintaining ethical standards.
- To make them competent to attempt and qualify in various tests.

UNIT-I

Self Introduction- Formal – Contextual introductions - **Body language** – Facial Expressions – Gestures – Postures – Kinds of Body Language - **Corporate Ethics – Ethical communication –** Why EC is important? – Values and ethics in communication – Ethical perspectives – Ethical issues involved in Business Communication

UNIT-II

PPTs – Introduction - Oral presentation – Power point Presentation – Individual presentation – Group presentation

UNIT-III

Group Discussions - Speaking in Group Discussions - Discussing Problems and Solutions - Creating a Cordial and Cooperative Atmosphere - Using Persuasive Strategies - Being Polite and Firm - Turn-taking Strategies - Effective Intervention - Reaching a Decision - **Organizational GD** - Brainstorming - Nominal Group Technique - Delphi Technique - **GD as Part of Selection Process** - Characteristics - Evaluation and Analysis - Approach to Topics and Case Studies

UNIT-IV

Interviews – Types of interviews – Body language – Fluency – Ettiquettes – Mock interviews

UNIT-V

Formal Letters and Email - Introduction - Formats of Written Correspondence - Types of Messages - **Letter Writing** - The Seven Cs of Letter Writing - Purpose - Structure - Layout - Principles - Planning a Letter - **Cover Letters** - Writing the Cover Letter - Academic and Business Cover Letters - Cover Letters Accompanying Résumés - **Emails** - Advantages and Limitations - Style, Structure, and Content - Email Etiquette - Effectiveness and Security

Suggested References:

1. Business Communication – Meenakshi Raman
2. Presenting to Win - Jerry Weissman
3. Boring to Bravo - Kristin Arnold
4. Advanced Presentations by Design- Andrew Abela

MM3801 MATERIALS JOINING TECHNOLOGY LAB

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

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

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.

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MM3802 Corrosion and Environmental Degradation of Materials (CEDM) Lab

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

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.

– 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.

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MM3902 **SEMINAR-III**