OPJU

Metallurgical and Materials Engineering

(6th Semester)

Detailed Syllabus

Srivastava.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Metallurgical and Materials Engineering

L: Lecture, T: Tutorial, P: Practical, C: Credit

Scheme of Teaching and Examination
B. Tech (Metallurgical and Materials Engineering)

Academic Semester VI

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit L+(T+P)/2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1	MME3221	MME	Non Ferrous Extractive Metallurgy	3	1	0	30	20	50	100	4
2	MME3222	MME	Materials Characterization	3	1	0	30	20	50	100	4
3	MME3223	MME	Iron Making and Steel Making	3	1	0	30	20	50	100	4
4	MME3224 (1-4)	MME	Professional Elective -I (**MME Annexure - I**)	3	1	0	30	20	50	100	4
5	MME3225	MME	Materials Characterization Lab	0	0	3	0	30	20	50	2
6	MME3226	MME	Steel Making Lab	0	0	3	0	30	20	50	2
7	MME3227	MME	Computer Applications in Metallurgical Processes Lab	0	0	3	0	30	20	50	2
8	PFD3206	Humanities	Professional Development	1	0	0	0	15	10	25	1
			TOTAL	13	4	9	120	185	270	575	23

* End Semester Examination
** Progress Review Examination

MME: Metallurgical and Materials Engineering

Professional Elective-I

(MME Annexure - I)

Sl. No	CODE	Name of the Courses
1	MME3224(1)	Engineering Polymers and Composite Materials
2	MME3224(2)	Advanced Materials and Processes
3	MME3224(3)	Surface Engineering
4	MME3224(4)	Solar Energy Materials

Srivastava.

Dean
School of Engineering
OP Jindal University

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Non Ferrous Extractive Metallurgy **Code: MME3221**

Course Description:

Non-ferrous metals are the next to steel in its use and specialized applications. Non ferrous extraction is a vast and diverse field. The knowledge of the basic processes of ore beneficiation and non-ferrous metal extraction processes will be covered along with the theoretical aspects of extraction metals. This course deals with the physico-chemical framework of non ferrous metals adhere to its related fundamental principles.

Course Objectives:

Upon Successful completion of this course, each student should be able to:

1. Overview of various processes involved in extraction of non ferrous metals from their ores;
2. To develop understanding to know the associated principles of different processes of extraction;
3. To be able to identify economical extraction process selection;
4. To be able to perform mass balance calculations associated with various extraction processes.

Syllabus:

UNIT- 1
Discovery of metals and their importance, uses of non-ferrous metals. Common non-ferrous metal production and consumption: global and Indian scenario. Sources of nonferrous metals. Exploration methods, general methods of ore beneficiation like comminution, classification and concentration, electrostatic and magnetic separations.

UNIT- 2
Principles of metals extraction; Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry. Pyro-metallurgy–calcinations roasting and smelting, Hydrometallurgy : leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy – electrolysis and electro-refining.

UNIT- 3
Extraction of metals from oxide sources; basic approaches and special features of specific extraction processes, extraction of Magnesium by PIDGEON Process, alumina by Bayer process and aluminium by Hall Heroult Process, ALCOA, Process, TOTH Process, ALCAN Process. Tin; smelting in a reverberatory furnace, pyro-refining of tin.

Srivastava.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Head
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

OP JINDAL UNIVERSITY
OP Jindal Knowledge Park, Punjipathra, Raigarh (C.G.)

UNIT- 4

Extraction of metals from sulphide ores; Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc. Concentration of copper ore and its roasting and smelting reduction and purification. Extraction of zinc from horizontal and vertical retort processes, imperials melting process. Production of other metals by ISP. Zinc from lead slag. Zinc production in India. Extraction of Lead: lead blast furnace; base bullion production. Modern developments in lead melting.

UNIT- 5

Refining of zinc by distillation in refluxing units, Refining of lead bullion by Parks process. Electro refining of copper, Nickel, Lead, Tin and Aluminum. Extraction of Precious Metals: Gold, Silver and Platinum. Secondary metals and utilization of Metallurgical Wastes. Environmental issues.

Text Books:

1. Extraction of Non-ferrous Metals– HS Ray, R Shridhar and KP Abraham
2. Principles of Extractive Metallurgy-T. Rosenquist
3. Extractive Metallurgy of Copper Pargaman Press, 1980– Iswas and W. G. Davenport.

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.

2. Material Science & Engineering, W. F. Smith & Javed. Hashemi, Ravi Prakash, Tata McGrow Hill.

3. Phase Transformation in Metals and Alloys: David A. Porter, Kenneth E. Easterling and Mohamed Y. Sherif, CRC Press.

Course Outcome:

The graduates will be able to work in any non ferrous industry and able to develop newer or better processes.

Srivastava.

Head
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

OPJU

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Materials Characterization **Code: MME3222**

Course Description:

This course is aimed at introducing to basic principles and techniques of modern analytical methods for engineering materials characterization. The characterization includes analysis of microstructure and chemical compositions, using light and electron microscopy; x-ray diffraction; spectroscopic methods; and thermal analysis methods.

Course Objectives:

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

1. Characterize the structures and chemistries of materials using traditional analytical experimental techniques.
2. To introduce the working principles and instrumentation of main techniques.
3. To introduce the interpretation of the characterization technique outputs.
4. To observe operations of characterization equipment.
5. Select the proper characterization techniques to solve problems in research and/or industry, problems in research and/or industry

SYLLABUS

UNIT- 1
Classification of materials, material characterization methods, Importance of structure-property correlation in materials, levels of characterization (macro, micro and nano), chemical bonding, crystal structures, basic crystallography, diffraction, Electron-matter interactions, light interaction with materials, refraction and refractive index, reflection, absorption and transmission, Introduction to vacuum technologies for material characterization.

UNIT- 2
Definition of microstructure, grain boundary types, precipitate types, twins, optical principle of microscopy, polarized light in microscopy, related numerical, aberrations and remedies, resolution, depth of field/focus, numerical aperture, microscope construction and working applications of optical microscopy techniques, sample preparation and limitations.

UNIT- 3
Electrons: Properties and production, Introduction to Electron Microscopy, Comparison between light microscope and electron microscopy, role of electron lenses, construction and working of SEM, TEM, STEM with their merits, limitations and applications, X-Rays: Properties and production, diffraction methods, Bragg`s law, Crystal structure and phase identification by XRD. Introduction to Probe microscopy.

Srivastava.
Head
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

OP JINDAL UNIVERSITY
OP Jindal Knowledge Park, Punjipathra, Raigarh - 496109, (C.G.)
+91 7762 [illegible] www.opju.ac.in
Dean
School of Engineering
OP Jindal University

UNIT- 4
Principle, construction and working of UV-VIS, IR, FTIR, XRF, AAS, XPS and AES with their merits and applications.

UNIT- 5
Principle, construction and working details of dilatometer, DTA, TGA and DSC, and their applications. Graph analysis of the above instruments.

Text Books:

1. Materials Characterization, Metals Handbook, Vol 10, ASM
2. Kaufman E.N., Characterization of Materials, Wiley Publishers
3. Cullity B.D., Elements of X-ray Diffraction, Addison-Wesley, 1978
4. Phillips Victor A. Modern Metallographic Techniques and their application.

Reference Books:

1. Barett, C.S. and Massalski, T.B., Structure of Metals, Pergamon Press, Oxford.
2. Williams, D.B. and Barry Carter C., Transmission Electron Microscopy, Plenum Press.
3. Goldstein J.I., Lyman C. E., Scanning Electron Microscopy and X-Ray Microanalysis.
4. Machenzie R.C., Differential Thermal Analysis.

Course Outcomes:

- Students will be able to identify suitable techniques for specific materials characterization;
- Students will be able to use light microscopy for characterization;
- Students will be able to understand the basic microscopy images of materials;
- Students will be able to read the basic spectra of materials characterizations.

Dean
School of Engineering
Jindal University RAIGARH (C.G.)

Head
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University, RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Iron Making & Steel Making **Code: MME3223**

Course Description:

This courses 'Iron makes and Steel making' is principally aimed to introduce the students about basic concept of different types of raw materials needed to produce iron form conventional and secondary iron making process. This course also comprises different techniques of primary and secondary steel making, casting of steel by ingot and continuous casting routes.

Course Objectives:

1. To students will become familiar with iron making and steel making;
2. To become conversant with the role of thermodynamics and kinetics in iron making and steel making;
3. To get the idea of producing iron and steel through different route;
4. To acquire idea what is happening in iron and steel industries.

Syllabus:

UNIT- 1
Raw materials for iron making like Iron ores, Coal, Coke, Lime stone etc, Classification of furnaces, construction and design aspects of blast furnace (B/F), accessories of blast furnace, Coke making, gas cleaning system and stoves and cooling systems, agglomeration of iron ore fines, sintering and pelletizing.

UNIT- 2
Blast furnace reactions; Reactions in Tuyers, Hearth, Bosh and stack zones, partitioning of solute elements between the metal and the slag, blast furnace slag, Blast furnace aerodynamics, Irregularities in BF operation and their remedies, mass balance and heat balance calculations.

UNIT- 3
Recent trends of blast furnace raw material ; super-flux sinter, pellets, and cold bonded pellets, auxiliary fuel injection, high temperature blast, humidified and oxygen enriched blast, high top pressure, Alternate routes of iron making: DRI process, HYL process, Shaft furnace, Corex, Midrex process etc.

UNIT- 4
Raw materials for steel making, Earlier steelmaking processes; Bessemer, Open Hearth, Kaldo, Rotor processes, thermodynamics of steel making; BOF process, accessories, vessel and nozzle design, slag metal interaction and numerical problems; foaming slag; removal of C, Si, Mn, S and P. EAF and its accessories.

UNIT- 5
Degassing and alloying techniques, Stream degassing, Stirring, Ladle Degassing (Degassing and alloying addition), VAD, VOD, RH degassing and injection metallurgy. Ingot casting and continuous casting, Tundish, Mould, SEN, Mould flux.

Srivastava.

OP JINDAL UNIVERSITY
Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Secondary Cooling zone and their design and functions; energy, environmental and quality considerations

Text Books:

1. Principles of Blast Furnace Iron Making– Dr. A. K Biswas.
2. Iron making and steel making; theory and practice- Ahindra Ghosh and Amit Chatterjee.
3. The manufacture of Iron– G.R. Bashforth.
4. An Introduction to modern Iron making by R H Tupkary.
5. An Introduction to modern Steel making by R H Tupkary.

Reference Books:

1. Physical chemistry of iron and manufacture steel–Bodsworth C.H and S. Bell.
2. The reduction of iron– Boadandy L.V. and S. J. Engell.
3. Converter and open hearth steel manufacture, G. Oike, Mir Publishers.
4. Oxygen steel making for steel Makers, Jackson A, George Newries Ltd., London.

Course Outcome:

The course on 'Iron Making and Steel Making' will help the students to understand the different types of furnaces used for iron making and steel making. They will know about the concept of reduction of iron ore in B/F, working principle of B/F and irregularities arises during operation period and its remedies. They will also know the concept for removal of different constituent during steel making process and different casting mechanism.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Engineering Polymers and Composite Materials (Prof. Elect.-1)
Code: MME 3224 (1)

Course Description:

Engineering Polymers and Composites focus on the theoretical basic knowledge of polymers and composites and its application to engineering systems. It is an extension and deepening of the prerequisite engineering concepts at UG level which is one of the core courses for Metallurgy & Materials Engineering graduates. This course provides a systematic study of polymers and composites fundamentals, principles, methods and applications. Topics include measure the mechanical properties and the thermal properties of a polymers with an array of characterization techniques and above all, the fabrication process parameters of composites along with related mechanics. This course helps for material selection and engineering design principles of polymers and composites.

Course Objectives:

1. To learn the topics of Polymers and Composites with emphasis on basic concepts;
2. To understand the significance of related laws and principles;
3. To understand the key processing parameters;
4. To understand the key processing methods for fabricating;
5. To solve the problems using the laws and principles and related applications.

Syllabus:

UNIT- 1
Polymer Materials:
Types of polymer, properties of polymers, degree of polymerization, mechanism of polymerization, mechanical and thermal behaviour of polymers, plastics, elastomers, thermo-setting and thermoplastics, volcanization, polymer foams, liquid crystal polymers and applications of polymers.

UNIT- 2
Composite of Materials:
Types, advantages of composites, role of plasticizers, colorants, laws of mixtures, effects of fiber length, transverse modulus, stress-strain diagram of composites, concept of discontinuous and aligned fiber composites, related numerical.

UNIT- 3
Composite Phase:
Fiber and matrix phases, role of matrix and reinforced materials, concept of particulate reinforced composites, fiber reinforced composites, polymer matrix composites, ceramic matrix composites and metal matrix composites, strengthening mechanism.

Srivastava.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

UNIT- 4

Manufacturing Methods:

Stir casting, injection process, spray deposition, in-situ fabrication techniques, diffusion bonding, Hand layout process, autoclave process, filament winding process, solid state bonding.

UNIT- 5

Behavior of Composites:

Mechanical behavior of composites materials related numerical, application of composites.

Text Books:

1. Mishra, Introductory Polymer Chemistry, V.R. Gowariker, Polymer Science, Wiley Eastern, 1995 New Age International (Pvt) Limited, 1996.
2. Textbook of Polymer Science, F. N. Billmeyer, Wiley Inter science, 1971.
3. Fundamentals and Polymer Science and Engineering, Kumar and S. K. Gupta, Tata McGraw-Hill, 1978
4. Engineering Plastics, Engineering Materials Handbook, Epel, J.N.: ASM International 1988.

Reference Books:

1. Plastics Materials, Brydson, A.J. Princeton, N.J., 1966.
2. Composite Materials: Engineering and Science" by F.L. Matthews and R.D. Rawlings.
3. Engineering Materials: Polymers, Ceramics and Composites" by A. K. Bhargava.
4. Mechanical Behavior of Engineering Materials: Metals, Ceramics, Polymers, and Composites" by Martin Baeker.

Course Outcomes:

- 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;
- Able to understand the basic knowledge of engineering of components and products made of composites;
- Able to understand the preliminary material selection, material evaluation, simple mechanical analysis using fundamental relations for the materials and structures;
- Able to suggest and evaluate relevant manufacturing methods. able to communicate technological topics related to polymer and composite;
- Aware of the importance of polymers and composites for the modern society.

Srivastava.

Dean
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Advanced Materials and Processes (Prof. Elect.-1)
Code: MME3224 (2)

.....

Course Description:

The course 'Advanced Materials and Processes' provides a broad and deep understanding of the processing, nature and properties of a range of engineering materials. By understanding these, materials can be truly designed for purpose. This course introduces the core principles of advanced materials and a depth of core knowledge and skills allowing making informed choices concerning applications, selection and design of advanced materials. This course focuses on the introduction to mechanical manufacturing methods by which materials are processed into different shapes. The overall goal is to develop an understanding of functionality of materials required of a product.

Course Objective:

The objectives of this course are to develop an understanding of the principles, capabilities, limitations and applications of advanced materials processing technologies along with an in-depth knowledge.

Syllabus:

UNIT- 1
Atomic structure and bonding, crystal structures lattices, indices etc with examples of atomic structures and bonding types, order and disorder, diffusion mechanisms, deformation mechanisms, classes of metals, point defects, line defects, surface and volume defects, strengthening mechanisms, simple alloys and inter metallic.

UNIT- 2
Porous matrix ceramics- composites, Metallic foam, Nano tubes, Nano wires. Mechanically alloyed oxide dispersion strengthened super alloys, High strength and ductile bulk quasi crystalline alloys and their composites. Processing of Ni- base super alloys for turbine engine discs, Gamma- Titanium aluminades.

UNIT-3
Low dielectric constant materials, optoelectronic materials. Glassy and Nano crystalline materials for soft and hard magnetic properties and their applications. Shape memory alloys. : Band model of semiconductors, Hall effect - Hall coefficients for intrinsic and extrinsic semiconductors – Hall effect devices

UNIT-4
Concept of nano materials, Advantages and limitations at the nano level, thermodynamic aspects at the nano level, influencing factors at elevated temperatures, various stages of creep, effect of stress, temperature and strain rate. Design of transient creep, age hardening, strain hardening, Monkman-Grant relationship.

Srivastava.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Metallurgical and Materials Engineering
School of Engineering
OP Jindal University RAIGARH (C.G.)

UNIT- 5

Solid state sintering, densification and coarsening processes, grain boundary mobility, porosity evolution (stability/entrapment). Composite Interfaces, bonding mechanisms, other interfacial properties, Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Composite Strengths; Fibers as reinforcements, Refractory linings for primary and secondary steel making operations, Use of non oxide ceramic materials industries.

Text Books:

1. Introduction to Materials Science and Engineering, William J Callister, John Wiley & Sons, Inc.
2. Smart Materials and Structures, Gandhi, M.V., Thompson, B.S., Chapman and Hall
3. Advanced Materials, Ray, A.K. Allied publishers.
4. Advances in Materials and their applications, Rama Rao, Wiley Eastern Ltd.
5. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2007.
6. Composite Materials: Engineering and Science - F. L. Matthews and R. D. Rawlings, Chapman & Hall
7. Ceramic Processing and Sintering - M.N. Rahman, Marcel Dekker, Inc. 11.Handbook of Advanced Ceramics Vol.II, Processing and Their Applications - Shigeyuki Somiya, Elsevier Acadmic press.
8. Poole, C.P and Owens, J.F, Introduction to Nano Technology, Wiley

Reference Books:

1. Raj, R., Flow and Fracture at elevated temperatures, American society for metals. Courtney, T.H, Mechanical behavior of materials, McGraw Hill
2. Hertzberg, T.H, Deformation and Fracture Mechanics of Engineering Materials, John Wiley
3. Physical Metallurgy Principles Reed-Hill - R. E., and R. Abbaschian, 3rd ed. Boston: PWS-Kent, 1992.
4. Structure and Properties of Engineering Alloys - Smith, W. F., McGraw Hill, 1981.

Course Outcome:

After completion of the course, students will be able to know or expected to do

1. Able to understand and apply the various processing and manufacturing
2. Techniques of advanced materials;
3. Able to understand the basic properties of materials and apply these properties to a specific related outcome;
4. Able to differentiate advanced mechanical manufacturing processes e.g. micro-scale and nano-scale technologies.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

Professor & Head
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Surface Engineering (Prof. Elect.-1) **Code: MME3224 (3)**

Course Description:

The course surface technology is aim to conceptual sound on various surface treatment such electroplating, electrode less coating methods will be discussed in broadly.

Course Objectives:

The Students are expected to be familiar with basic role of surface cleanliness, with the relationship between metal and atmosphere. Knowledge of basic setup for electroplating and equipments for coating and their application in industry.

Syllabus:

UNIT -1
Scope and application of surface engineering, classification of surface engineering methods. Typical thickness and various surface engineering methods. Substrate and pretreatment processing, role of surface cleanliness and surface finish, criteria for selection of cleaning process.

UNIT -2
Principles of electroless and electroplating. Setup for electroplating, baths for electroless plating, Baths for electroplating, role of bath constituents, structure of coating, Plating practices for electroplating of non-ferrous metals and alloys, multi-layer, alloy plating etc. Electroless plating of non-ferrous metals and alloys. Electroless plating of industrial alloys.

UNIT -3
Principle of hot-dip method, structure of hot-dip coating, batch process and continuous process, its scope and limitations,coating Zn, ZnAl and Sn by hotdip met hod, pre and post surface treatment.

UNIT-4
Phosphatizing, chromatizing, ceramic coatings/linings and anodizing, baths and role of their constituents.

UNIT -5
Principle and equipment for coating methods like thermal spray coating, chemical vapour deposition (CVD), plasma assisted CVD, physical vapour deposition (PVD), sputtering, arc deposition, diffusion coatings and Pulse Laser deposition. Industrial applications: Surface engineering of polymers, metals and alloys.

Text Books:

1. Surface Engineering & Heat Treatment Past, present and Future, Edited by P. H. Morton, Published by the Institute of Metals, London, 1991.

Srivastava.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Metallurgical and Materials Engineering
School of Engineering
OP Jindal University RAIGARH (C.G.)

2. Electroplating and other surface treatments, A Practical Guide, CD Varghese, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.

Reference Books:

1. ASM Handbook Volume V- Surface Engineering, Published by ASM International, 1995.

Course Outcomes:

Students will acquire a brief review of the surface technology-taking place in the various industries.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Solar Energy Materials (Prof. Elect.-1) **Code: MME3224 (4)**

Course Description:

This course is intended to educate students in the design and applications of solar energy engineering. It will focus on fundamentals of solar energy conversion, photovoltaic and photo thermal engineering, optical systems, photo electrochemical cells for hydrogen generation and energy storage and distribution systems. The course covers solar energy installation and global energy needs, current trends in solar plants, thin film solar cells, and solar cell material science. Design and installation of solar panels for residential and industrial applications and connections to the national grid and cost analysis will be discussed. In addition, basic manufacturing processes for the production of solar panels, environmental impacts, and the related system engineering aspects will be included to provide a comprehensive state-of-the art approach to solar energy utilization.

Course Objectives:

1. Learn the fundamentals of solar energy conversion systems, available solar energy and the local and national needs, photovoltaic and photothermal engineering applications, emerging technologies;
2. Understand the interdisciplinary approach for designing stand-alone PV systems, predicting performance with different systems, Implementing design with cost analysis;
3. Gain system engineering expertise related to photovoltaic energy conversion: generation, storage, and grid connection processes for residential and industrial applications;
4. Learn how to advance the current technology of the solar energy systems for making the process economical, environmentally safe and sustainable. Be able to serve industries or academia involved in sustainable energy engineering.

Syllabus:

UNIT -1
Solar energy-definitions, its intensity distribution, variation and spectrum, thermodynamics of solar energy spectrum, mechanism of heat losses, efficiency.

UNIT -2
Photothermal conversion materials and their preparation and characterization. Design and materials for solar collectors, selective surface, composite semiconductors, solar reflectors and concentrators, thermo-electric conversion - figure of merit and efficiency.

UNIT -3
Chalcogenide and alloy semiconductors, photovoltaic conversion, criteria for material selection, spectral response, efficiency and cost. Types of PV cells ; p-n homo and heterojunction, Schottky barrier MOS, MINP and photo-electro-chemical cells.

OP JINDAL UNIVERSITY
OP Jindal Knowledge Park, Punjipathra, Raigarh - 496109, C.G.
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

UNIT -4

PV materials: silicon - single crystalline, polycrystalline, ribbon, amorphous; CdS, CuInSe2, CdTe, GaAs, InP. AR coatings, Ohmic contacts, inter-connection and sealing; energy and cost considerations for terrestrial applications.

UNIT -5

Photo-electrochemical hydrogen production, photo-electrochemical cells, solar-to-hydrogen efficiency; Hydrogen storage, hydrogen economy, Electrochemical Storage of energy, Current developments in energy storage.

Text Books:

1. Photovoltaic Science and Engineering Handbook, Antonio Luque and Steven Hegedus, Second Edition, John Wiley and Sons, 2012.
2. Thin film Solar Cells, Jeff Poortmans and Vladimir Arkhipov (Ed) John Wiley and Sons Ltd. 2006.
3. Photovoltaic Engineering Handbook, F. Lasnier and T. G. Ang, IOP Publishing UK. (Adam Hilger USA) 1990, ISBN 0-85274-311-46.

Reference Books:

1. Solar Cell Device Physics, Stephen J. Fonash, Elsevier, Second Edition, Inc., 2010.
2. Solar Electricity, Thomas Markvart (Editor), John Wiley and Sons Ltd., Second Edition, 2000.

Course Outcomes:

- Gain an understanding of the available solar energy and the current solar energy conversion and utilization processes;
- Have a working knowledge of semiconductor physics, optical systems, load matching, and storage and grid connections related to photovoltaic engineering;
- Be able to comprehend the challenges in sustainable energy processes, perform cost analysis, design photovoltaic systems for different applications meeting residential and industrial needs, predict and test performance;
- Understand the manufacturing processes involved environmental challenges that need to be solved, economic aspects, and future potentials of solar energy utilization.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

Metallurgical & Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Materials Characterization Lab **Code: MME3225**

Objectives:

- Fully qualified as entry-level materials engineers, with an ability to adapt and progress in a rapidly changing field.
- Well-rounded individuals who both understand the principles and can undertake the practice of the engineering materials.
- Able to operate as effective engineers or scientists in materials industries, academia, or related fields with respect to advanced level equipment.

Syllabus:

(At least six experiments are to be performed by each student)

1. Sample preparation for micro-structural study.
2. Determination of the Rockwell Hardness of the given samples.
3. Determination of the Vickers Hardness Number of the given Samples.
4. Study the constructional arrangement of SEM.
5. Study the X-ray powder diffraction Techniques.
6. Lattice parameter and crystalline size determination by XRD method.
7. Study the AAS.
8. Study the constructional arrangement of DTA, TGA and DSC
9. Study the hysteresis loss by tracing B-H curves.
10. Study the wear behaviour of materials.

Reference Books:

1. Experimental Techniques in Physical Metallurgy, V.T. Cherepin & A.K. Malik, I.I.T., Bombay.
2. SEM and X-Rat microanalysis- Joseph I. Goldstein
3. Physical Methods for Metal Characterization, Pej Flewitt (Institute of Physics Pub.)

Course Outcomes:

- Knowhow the basic principles of the advanced equipment;
- Conduct and analyze a problem from an industry or Institute with an inspiration/problem;
- Select and redesign the problem;
- Perform of the problem through experiments to reach the sustainable solution;
- Explain and demonstrate the solution developed.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

Metallurgical and Materials Engineering
School of Engineering
OP Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Steel Making Lab **Code: MME3226**

Objectives:

This course deals the various steel making furnace like Bessemer, OH, Kaldo, Rotor processes Twin Hearth, Electric Arc Furnace steel making. The course also makes aware the students to simulate the different furnace working principle.

List of Experiments:

(At least six experiments are to be performed by each student)

1. Study the Iron Making Process in the Blast Furnace.
2. Study the Steel Making in the Basic Oxygen Furnace.
3. Study the Secondary Steel Making Process.
4. Study the Electric Arc Furnace for Steel Making.
5. Study of Different Steel Grades and their Importance.
6. Study the Effect of Impurities on Steel.
7. Study the Effect of Carburization on Steel.
8. Study the Direct Reduced Iron (DRI).
9. Study the New Oxygen Furnace (NOF).
10. Study the Effect of Chemical Compositions on various heat treatment processes.

Reference Books:

1. Iron making and steel making; theory and practice- Ahindra Ghosh and Amit Chatterjee.
2. Making shaping and treating of steel – US. Steel.

Course Outcomes:

After completing this laboratory, students will be able to practically solve the problems related to steel making.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

Metallurgical and Materials Engineering
School of engineering
O.P. Jindal University RAIGARH (C.G.)

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Computer Applications in Metallurgical Processes Lab
Code: MME3227

Course Description:

This course contains computer application part related to metallurgical applications especially in the area of metallurgical computer programming. This course aims to build logic and programming skill through FORTRAN programming language.

Course Objective:

To skill the students with the basic programming languages which will help them in working out with various metallurgical processes like heat flow, thermodynamic calculations etc.

List of Experiments:

(At least six experiments are to be performed by each student)

1. Simple Addition of two no using FORTRAN language.
2. Calculate the area of circle by using Fortran.
3. Find the largest from given two no by using Fortran.
4. Find the largest from given three no by suing Fortran.
5. Find the sum of first n natural no by suing Fortran.
6. Find the factorial of any input n by using Fortran.
7. Find the sum of series = 1+x+x2+x3..... N terms by suing Fortran.
8. Red &I write the 1D subscript variable.
9. Find the sum of all elements of 1D subscript variable.
10. Find the largest& their position and arrange the elements of subscript variable in increasing order.
11. Read & Write 2d subscript variable.
12. Find the sum of two 2d subscript variable.
13. Calculate three roots of quadratic equation by sub programs.
14. Calculate the area of circle by function.
15. Numerical problem based on Metallurgical Ind.

Reference Books:

1. Suresh Dua – Simply "C"– Simply C

Course Outcome:

Students will learn to write programs for various processes which will simplify their task in tedious calculations.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)

OPJU

Semester: VI **Branch: Metallurgical and Materials Engineering**
Subject: Professional Development **Code: PFD3206**

Course Description:

Employability is a course for engineering students, designed to develop the knowledge and skills necessary to prepare for the career development. Knowledge of the factors involved in these roles is vital for preparing students to make informed and competent decisions regarding career and family life. This course focuses on the development of the transferable skills students need in job and life situation tasks. These skills include: basic academic skills, thinking skills, personal qualities, use of resources, interpersonal skills and using information.

Course Objectives:

The objectives of this course are:

- Analyzing interest, aptitudes and skills to make informed career goals.
- Using job shadowing to research careers of interest and identify career preferences.
- Demonstrating job seeking and job keeping skills to gain immediate or future employment.
- Identify entrepreneurial characteristics and skills.

Course Content:

UNIT -1
Career Exploration:

a. Career Clusters
b. Interest inventory-Career Cruising
c. Career Cruising – My Portfolio.

UNIT -2
Finding a Job:

a. Job Sources
b. Networking and Personal Contacts
c. Entrepreneurship.

UNIT -3
Job Search Skills:

a. Resume Writing
b. Letter of Application
c. Job applications d. Interviews e. Professional Dress.

UNIT -4
Employer/Employee Relationships:

a. Communication skills b. Transferable work skills
c. Positive work skills
d. Conflict resolution
e. Workplace legal issues
f. Work ethic.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

UNIT -5

Small Business:

a. Small business types
b. Entrepreneurship
c. Business plan.

Text Book:

1. "Soft Skills" by Hariharan S, S. N. Sundararajan, and S. P. Shanmugapriya, Mjp Publishers.
2. "Soft Skills: Know Yourself and Know the World" by Alex.
3. "Making Work for the Highly Sensitive Person" by Beverly Jaeger, McGraw-Hill Education.
4. "Enhancing Soft Skills" by Dipali Biswas, Shroff; First edition.
5. "Soft Skills – Enhancing Employability: Connecting Campus with Corporate" by M. S. Rao, I K International Publishing House Pvt. Ltd.

Reference Books:

1. " Enhancing Employability @ Soft Skills" by Shalini Verma, Pearson Education; First edition.
2. "Get your First Job: A companion for getting your first job – A Guide to Employability Skills and Career Planning" by A J Balasubramanian and Dr J Sadakkadulla, Amazon Asia-Pacific Holdings Private Limited.
3. "Soft Skills at Work: Technology for Career Success" by Beverly Amer, Course Technology Inc.
4. "BEST: Basic Employability Skills Training" Volume 1, by Sally J. Vonada and JoAnn Brunner, CreateSpace Independent Publishing Platform.
5. "Personal Transferable Skills in Accounting Education RPD " by Kim Watty and Beverley Jackling, Routledge; 1 edition "How to develop a pleasing personality" by Atul John Rego, Better yourself bools, Mumbai, 2006.

Course Outcome:

After completion of the course, students will be able to:

- Explore their values and career choices through individual skill assessments;
- To make realistic employment choices and to identify the steps necessary to achieve a goal;
- To develop and practice self management skills for the work site;
- To explore and practice basic communication skills;
- To learn skills for discussing and resolving problems on the work site;
- To assess and improve personal grooming;
- To promote safety awareness including rules and procedures on the work site.

Dean
School of Engineering
OP Jindal University RAIGARH (C.G.)

Srivastava.

Professor
Metallurgical and Materials Engineering
School of Engineering
O.P. Jindal University RAIGARH (C.G.)