Final

DIPLOMA CURRICULUM OF METALLURGICAL ENGINEERING (SECOND YEAR) (3rd Semester)

(To be implemented from 2025-26)

Prepared by;

National Institute of Technical Teachers' Training & Research Kolkata
Block – FC, Sector – III, Salt Lake City, Kolkata – 700106

Vetted by:
Domain experts from Polytechnics of Odisha

State Council for Technical Education & Vocational Training
Near Raj Bhawan, Unit-VIII, Bhubaneswar, Odisha

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Total 93 Credits and 3000 marks

PROGRAMME TITLE: METALLURGICAL ENGINEERING

(SEMESTER – III)

SL. No	Category of Course	Code No	Course Title	Teaching Scheme				Evaluation Scheme				Total Marks	Credits
				Pre-requisite	Contact Hours/ week			Theory		Practical			
					L	T	P	End Exam	Progressive Assessment	End Exam	Progressive Assessment		
1	Programme Core	MTPC201 TH:1	Introduction to materials engineering		3	0	0	70	30	-	-	100	3
2		MTPC203 TH:2	Mineral processing		3	0	0	70	30	-	-	100	3
3		MTPC205 TH:3	Fuel, furnace and refractories		3	0	0	70	30	-	-	100	3
4		MTPC207 TH:4	Metallurgical thermodynamics & kinetics		3	0	0	70	30	-	-	100	3
5		MTPC209 TH:5	Material testing		3	0	0	70	30	-	-	100	3
6		MTPC211 PR:1	Mineral processing lab		0	0	4	-	-	15	35	50	2
7		MTPC213 PR:2	Fuel testing and chemical analysis lab		0	0	4	-	-	15	35	50	2
8		MTPC215 PR:3	Material testing lab		0	0	4	-	-	15	35	50	2
9		MTPC217 PR:4	NDT Lab		0	0	4	-	-	15	35	50	2
10	Summer Internship	SI201	Summer Internship – I* (*3 - 4 weeks after 2nd Semester)		0	0	0	-	-	15	35	50	2
TOTAL					**15**	**0**	**16**	**350**	**150**	**75**	**175**	**750**	**25**

3rd SEMESTER

TH:1- INTRODUCTION TO MATERIALS ENGINEERING

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="7">Total Marks: 100</td><td colspan="2" rowspan="2">Course Code: MTPC201</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td colspan="3">Total Contact Hours</td><td colspan="2">Theory Assessment</td></tr>
<tr><td colspan="3">Theory : 45Hrs</td><td>End Term Exam</td><td>70</td></tr>
<tr><td colspan="3"></td><td>Progressive Assessment</td><td>30</td></tr>
<tr><td colspan="3">Pre Requisite : Nil</td><td colspan="2"></td></tr>
<tr><td colspan="3">Credit 3</td><td colspan="2">Category of Course : PC</td></tr>
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RATIONALE:

The rationale for an introductory course in material engineering is to provide students with a foundational understanding of materials, their properties, and how they behave under various conditions, enabling them to select and utilize materials effectively in engineering applications

Course Outcomes:

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

1. Understand material structure: Understanding how the atoms of a material are arranged.
2. Understand Crystal defects

To know the crystal defects, present in material and differentiate them.

3. Understand material properties: Understanding the properties of materials, such as strength, conductivity, and density.
4. Knowledge of Engineering Materials

To know various types of engineering materials and their application.

UNIT	CONTENT	HOURS
1	Introduction • Historical perspective • Scope of Materials engineering • Processing/Structure/Properties/ Performance Correlations Atomic structure and interatomic bonding • Fundamental concepts on atoms • Bonding Forces and Energies • Interatomic bonds (Covalent bond, Metallic bond, Ionic bond, Hydrogen bond and Van der waals bond)	10
2	The Structure of Crystalline Solids • Crystal and crystallography • Bravais lattices, unit cells • Crystal structures (SC, FCC, BCC and HCP)	15

	• Point Coordinates, Crystallographic Directions, Crystallographic Planes • Linear and Planar Densities • Close-Packed Crystal Structures • Crystal planes and directions, co-ordination number • Calculation of APF and Density Imperfections in Solids • Point defects (Vacancies and Self-Interstitials) • Dislocations—Linear Defects • Interfacial Defects • Bulk or Volume Defects	
3	Mechanical Properties • Basic concepts on stress and strain • Deformation and its types • Hooke's Law Electrical Properties • Electrical Resistivity of Metals, Ohm's Law Electrical Conductivity • Electronic and Ionic Conduction • Energy Band Structures in Solids • Electrical Characteristics of Commercial Alloys • Materials of Importance—Aluminum Electrical Wires • SEMICONDUCTIVITY (intrinsic Semiconduction and Extrinsic Semiconduction) • Factors that Affect Carrier Mobility • Piezoelectricity and its applications Magnetic Properties • Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism and Ferrimagnetism • Superconductivity Optical Properties • Electromagnetic Radiation • Light Interactions with Solids • Atomic and Electronic Interactions • Refraction, Reflection, Absorption and Transmission • Applications of optical phenomena (Luminescence, Photoconductivity, Light-Emitting Diodes, Lasers and Optical Fibers in Communications)	15
3	Engineering Materials • Fundamentals of Engineering Materials • Classification of Engineering Material (Metal, Polymer, Ceramic, Composite and Electronic material) • Material Selection	5

Portion for Progressive Assessment: Module:-1 &2

Primary Textbooks

1. "Materials Science and Engineering: An Introduction" – William D. Callister, Jr., Wiley

2. "Introduction to Physical Metallurgy" – Sidney H. Avner, McGraw-Hill Education
3. Phase Transformation in Metals and Alloys, D.A. Porter and K.E. Easterling 2nd ed. Chapman and Hall, 1992
4. "Materials selection in mechanical design"- M F Ashby

Reference Books

1. "Metallurgy for Engineers" – E.C. Rollason, Edward Arnold Publishers Ltd.
2. "Elements of Materials Science and Engineering" – Lawrence H. Van Vlack, Pearson Education
3. "Fundamentals of Materials Science and Engineering" – William F. Smith, McGraw-Hill Education.

TH:2- MINERAL PROCESSING

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="8">Total Marks: 100</td><td colspan="2" rowspan="2">Course Code: MTPC203</td></tr>
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<tr><td colspan="3">Theory : 45Hrs</td><td>End Term Exam</td><td>70</td></tr>
<tr><td colspan="3"></td><td>Progressive Assessment</td><td>30</td></tr>
<tr><td colspan="3">Pre Requisite : Nil</td><td colspan="2"></td></tr>
<tr><td colspan="3"></td><td colspan="2"></td></tr>
<tr><td colspan="3">Credit 3</td><td colspan="2">Category of Course : PC</td></tr>
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RATIONALE:

The rationale for a course in Mineral Processing lies in its crucial role in preparing engineers and scientists to efficiently and sustainably extract and process mineral resources, ultimately contributing to the global economy and technological advancements.

Course Outcomes

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

1. Understanding of Mineral Processing Principles

To explain the basic principles and importance of mineral dressing, including key concepts like ore, gangue, and beneficiation.

2. Mastery of Mineral Separation Techniques

To apply various mineral separation techniques (gravity separation, flotation,Tabling , magnetic separation, etc.) and explain their underlying physical and chemical principles.

3. Ability to Integrate Theory with Industrial Applications

To apply theoretical knowledge to solve practical problems in the mineral processing industry.

4. Ability to Work with Advanced Technologies

To familiar with advanced mineral processing technologies & to demonstrate knowledge of advanced separation methods and their applications in real-world metallurgy operations.

DETAILED CONTENTS:

UNIT-1	Definition and importance , Role in the metallurgy industry ,Various mineral resources of India , Mineral and Ore , Types of Ores Metallic ores (e.g., iron, copper, gold) ,Non-metallic ores (e.g., limestone, phosphate) ,scope and objective of Ore dressing ,Different physical and chemical property of ore with their application to mineral dressing	5
UNIT-1I	Size Reduction Importance of Comminution in mineral processing , Mechanisms of size reduction , Blake jaw Crusher ,Dodge jaw Crusher, Roll crusher & angle of Nip ,capacity and reduction ratio of crusher, Laws of Crushing ,Ball mill operation , open circuit grinding and close circuit grinding	15
UNIT-1II	Sizing & Concentration Methods Ro-tap Sieve Shaker Particle size analysis, Basic fundamentals & principle of jigging , operations and application of wilfley table , principle of heavy media separations , industrial process using heavy liquid and heavy suspensions (Du - Pont process & Chance process) , Principle of froth flotation , practical utility of frother, collector, modifier, activators, depressant (without physic – chemical Principle) , Magnetic and Electrostatic separator with their application to mineral dressing(Two Drum Ball-Norton Wet magnetic	20

	separator , High Tension or Huff's Electrostatic separation)	
UNIT-IV	Advanced Topics in Mineral Dressing Advanced Comminution Techniques: High-Pressure Grinding Rolls (HPGR), Ultra-Fine Grinding (UFG), Microwave-Assisted Comminution, Advanced Gravity Separation Techniques: Multi-Gravity Separator (MGS), Advanced Flotation Techniques: Microbubble & Nanobubble Flotation, Magnetic & Electrostatic Separation: High-Intensity Magnetic Separation (HIMS), Sustainable & Eco-Friendly Mineral Processing: Dry Beneficiation Technique, Zero-Waste Processing	5

Portion for Progressive Assessment: Module:-1 &2

Primary Textbooks

1. " Fundamentals of Mineral Dressing"- Chinmaya Mohapatra- JJTP
2. " Principle of Mineral Dressing "– A. M. Gaudin - Tata Mc Graw-Hill
3. " Mineral Processing " – Vandana Rao, Sonam Patel , Avinash Lele -Dreamtech Press
4. "Introduction to Mineral Processing" – R. K. Ghosh, New Age International Publishers
5. " Ore Dressing " – A. D. Turner -McGraw-Hill
6. "Mineral Processing Technology" – B. A. Wills - Pergamon Press

Reference Books

1. "Principles of Mineral Processing" – M. R. C. McLean, Society for Mining, Metallurgy & Exploration
2. "Handbook of Mineral Dressing: Ores and Industrial Minerals" – Arthur F. Taggart- Wiley
3. "Mineral Processing: A Collection of Papers" – S. Ramachandra Rao- Elsevier
4. "Modern Mineral Processing" – S. K. H. Chattopadhyay - Oxford & IBH Publishing Co.

TH:3- FUEL, FURNACE & REFRACTORIES

L	T	P	Total Marks: 100	Course Code: MTPC205
3	0	0		

Total Contact Hours		Theory Assessment	
Theory	: 45Hrs	End Term Exam	70
		Progressive Assessment	30
Pre Requisite	: Nil		
Credit	3	Category of Course : PC	

RATIONALE:

This course on Fuels, Furnaces, and Refractories is essential because it provides a foundation for understanding energy sources, their efficient utilization, and the materials that withstand high temperatures in industrial processes, crucial for various industries like iron and steel, cement, and glass production.

Course Outcomes:

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

1. Understanding of Fuels and Their Properties

To identify different types of fuels (solid, liquid, and gaseous) and their classification.

2. Proficiency in Fuel Analysis

To perform fuel analysis (proximate and ultimate analysis).

3. Understanding of Furnace Operation

To gain a solid understanding of the operation, and types of furnaces (e.g., blast furnaces, electric furnaces

4. Knowledge of Refractories and Their Properties

To classify refractories based on their composition and properties, such as acidic, basic, and neutral refractories.

DETAILED CONTENTS:

UNIT-1	Introduction to Fuels (5 Hours) Definition and classification of fuels (solid, liquid, and gaseous fuels) , Sources of fuel and their uses in	5
	industries, Calorific value: gross and net calorific value ,Proximate and ultimate analysis of fuels ,Physical and chemical properties of fuels (moisture content, ash, sulfur, carbon content)	
UNIT-1I	Types of Fuels (Solid Fuels Liquid Fuels Gaseous Fuels) (15 Hours) Origin of Coal, Coal: types, composition, and classification , coking properties and swelling index of coal, Carbonization of coal , Differentiate between H.T.C and L.T.C , Test carried out for coke(Shatter and Micum index) ,Origin and constitution of petroleum .Discuss on flash point, fire point, cloud point, pour point, aniline point, octane number and cetane number . Production and utilization of Methane, water gas, producer gas, carbureted water gas, coke oven gas, blast furnace gas, natural gas, mixed gas.	15

UNIT-III	Furnaces and Their Types (5 Hours) Overview of Furnace, Types of Metallurgical furnaces (a) heat treatment furnace (b) melting furnace (c) smelting furnace (d) refining furnaces . Heat losses in furnace .Types of waste heat recovery system such as regenerators and recuperators.	5

	Refractories – Basics and Classification (10 Hours) Introduction to Refractory materials, Classification of Refractories, properties of Refractories. Special refractories like high alumina, mullite, SIC, Zirconia . Criteria for selection and types of refractories selected for blast furnace, L.D furnace, arc furnace, coke oven.	

UNIT-IV	Recent advancements in Fuels, Furnaces & Refractory (10 Hours) Carbon Capture & Utilization (CCU) in Fuel Technologies: CO_2 Sequestration in Industrial Applications, Clean Coal Technologies, Advanced Refractory Materials: Nano-Refractories, Graphite-Based & Carbon-Composite Refractories, Ultra-High-Temperature Ceramics (UHTCs), Alternative Fuels for Industrial Heating: Waste-Derived Fuels, Hydrogen, Syngas, Carbon-Neutraland Carbon-Negative Technologies, Eco-Friendly Furnace Technologies: Hybrid & Solar-Assisted Furnaces	10

Portion for Progressive Assessment: Module:-1 &2

Primary Textbooks

1. "Fuels and Refractories"- O. P. Gupta- Khanna Publishers
2. "Fuel Technology"– S. K. Agarwal- Khanna Publishers
3. "Furnaces and Refractories"– V. D. Choudhary -Wiley Eastern Limited
4. "Introduction to Mineral Processing" – R. K. Ghosh, New Age International Publishers
5. "Principles of Fuel Technology"– R. G. Ross-john Wiley & Sons
6. "Fundamentals of Refractories"– D. J. Williams- Taylor & Francis
7. “Fuels & Combustion”- Samir Sankar -Orient Longman
8. “Elements of fuels,Furances & Refactories”- R.C.Gupta –PHI

Reference Books

1. "Fuels and Combustion" – S. C. Sharma- East-West Press
2. "Fuels and Furnace" – S. C. Gupta - New Age International Publishers
3. "Introduction to Fuel Technology" – F. S. Hall - Gulf Publishing Company
4. "Refractories and Refractory Materials" – R. S. Jain - New Age International

TH:4- METALLURGICAL THERMODYNAMICS AND KINETICS

L	T	P		Course Code: MTPC207	
3	0	0			
Total Contact Hours				Theory Assessment	
Theory		: 45Hrs	Total Marks: 100	End Term Exam	70
				Progressive Assessment	30
Pre Requisite		: Nil			
Credit		3		Category of Course : PC	

RATIONALE:

The rationale for a course in Metallurgical Thermodynamics and Kinetics is to equip students with the fundamental knowledge and tools to understand and predict the behavior of materials, processes, and reactions in metallurgical contexts, enabling them to design and optimize processes and materials.

Course Outcomes:

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

1. Demonstrate an understanding of thermodynamic laws and their relevance to metallurgical systems.
2. Interpret and apply phase diagrams, Ellingham diagrams, and Gibbs free energy concepts in metal processing.
3. Analyze chemical reaction kinetics and phase transformation mechanisms in metallurgical operations.
4. Apply electrochemical principles to understand corrosion behavior and prevention techniques.
5. Utilize thermodynamic and kinetic principles for optimizing metallurgical and materials engineering processes.

Detailed contents:

UNIT-1	Basic Concepts of Thermodynamics (10 hours) Introduction: Definition of thermodynamics, system, surroundings, types of systems (open, closed, isolated), thermodynamic properties (intensive, extensive), state functions. Zeroth Law of Thermodynamics: Concept of thermal equilibrium, temperature measurement. First Law of Thermodynamics: Conservation of energy, internal energy, enthalpy, heat and work, heat capacity, specific heat. Applications: Brief idea about various processes isothermal, adiabatic, isobaric, isochoric.	10
UNIT-1I	Second and Third Law of Thermodynamics (10 hours) Entropy: Concept of entropy, entropy change in reversible and irreversible processes, entropy and disorder. Second Law Statements: Different statements of the second law Gibbs free energy: Definition of Gibbs free energy, its significance in determining spontaneity of reactions, relationship between Gibbs free energy and equilibrium constant. Third Law of Thermodynamics, Gibbs free energy (ΔG) & Helmholtz free energy (ΔA), Maxwell relations (No Derivation)	10
UNIT-1II	*Phase Equilibria & Metallurgical Applications (10 hours)* *Solutions & Phase Rule : Ideal & non- ideal solutions, Raoult's Law, Henry's Law, Phase rule (Gibbs' phase rule), unary & binary phase diagrams, Ellingham Diagrams & Applications, Concept of Ellingham diagrams, Oxide stability & reduction reactions, Predominance Area Diagram.*	*10*
UNIT-1V	Chemical Kinetics & Reaction Rate Theory (10 hours) Fundamentals of Reaction Kinetics: Rate of reaction, order & molecularity, Activation energy & Arrhenius equation, Homogeneous vs. Heterogeneous reactions, Electrochemical Thermodynamics : Electrochemical cells, Nernst equation (Basic Level)	10

UNIT-V	Thermodynamics in Metallurgical Processes (Basic level) (5 hours) Application of Thermodynamics in Extraction & Refining: Basics of Ironmaking & Steelmaking thermodynamics, Roasting, Smelting, Refining processes, Basic Concept of activity, & equilibrium constant	5

Text books

1. "Introduction to Metallurgical Thermodynamics" – David R. Gaskell (*Taylor & Francis*)
2. "Metallurgical Thermodynamics, Kinetics and Numericals" – G.S. Upadhyaya & R.K. Dube (*PHI Learning*)
3. "Problems in Metallurgical Thermodynamics & Kinetics" – G.S. Upadhyaya & R.K. Dube (*Pergamon Press*)
4. "Chemical & Metallurgical Thermodynamics" – Dutta & Chatterjee (*CBS Publishers*)
   "Physical Chemistry of Metals" – L.S. Darken & R.W. Gurry (*McGraw-Hill*)
5. Metallurgical Thermodynamics Kinetics and Numericals , Dr S.K Dutta, Prof A.B. Lele, S.Chand, 2020

Reference books

1. "Fundamentals of Metallurgical Processes" – J.D. Gilchrist (*Pergamon Press*)
2. "Textbook of Materials and Metallurgical Thermodynamics" – Ahindra Ghosh (*PHI Learning*)
3. "Principles of Extractive Metallurgy" – Terkel Rosenqvist (*McGraw-Hill*)
4. "Electrochemistry & Corrosion Science" – N. Sato (*Springer*)
5. "Metallurgical Process Engineering" – Ruiyu Yin (*Springer*)

TH:5- MATERIAL TESTING

L	T	P	Total Marks: 100	Course Code: MTPC209
3	0	0		
Total Contact Hours				Theory Assessment
Theory		: 45Hrs		End Term Exam 70
				Progressive Assessment 30
Pre Requisite		: Nil		
Credit		3		Category of Course : PC

RATIONALE:

The rationale behind a course on material testing is to equip students with the knowledge and skills to ensure the safety, reliability, and performance of materials used in various applications, from construction to manufacturing.

Course Outcomes:

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

1. Understand Material Behavior: To comprehend the mechanical, physical, and chemical properties of materials and how they respond to various forces, environments, and conditions.
2. Master Testing Techniques: To gain proficiency in conducting different material tests, including destructive and non-destructive methods, and interpreting the resulting data accurately.
3. Apply Testing Principles: To utilize material testing knowledge for material selection, quality control, product design, failure analysis, and ensuring safety and reliability in engineering applications.

UNIT-1	(10 Hours) Introduction to Material Testing • Importance & objectives of material testing • Classification of materials: Metals, ceramics, polymers, composites • Standard organizations: ASTM, ISO, IS, DIN Mechanical Properties of Materials • Elastic and Plastic Deformation • Stress-strain behavior, Hooke's Law • Yield strength, ultimate tensile strength (UTS), fracture strength • Ductility, brittleness, toughness, and resilience • Fatigue and creep	10
UNIT-1I	(20 Hours) Destructive Testing (DT) Methods • Tensile Test: stress-strain behavior, yield strength, tensile strength, ductility, and toughness , stress-strain curve, modulus of elasticity, proof stress, true stress and true strain curve, Relationship between True stress vs Engineering Stress, True Strain vs Engineering Strain.	20

	• Compression Test: Compressive strength and plastic deformation
	• Hardness Testing:
	  o Brinell Hardness Test (BHN)
	  o Rockwell Hardness Test (RHN)
	  o Vickers Hardness Test (VHN)
	  o Mohs Hardness Test
	• Impact Testing: Charpy and Izod tests, Discuss about transition temperature, factors affecting transition temperature, ductility, brittle fracture
	• Fatigue Testing: Different stress cycles, S-N curves, endurance limit, procedure of fatigue testing and fatigue testing machine, Mention different metallurgical factors that affect fatigue behavior
	• Creep Testing: Stages of creep, effect of temperature and stress, creep rate, creep rupture strength, engineering creep curve, constant stress creep curve and Andrade concept equi-cohesive temperature, State various factors that affect creep, creep testing machine, stress rupture test
	• Fracture mechanics: Types of fractures: Ductile, brittle, fatigue, creep
	• Crack initiation and modes of Crack propagation
	• Case studies of real-world material failures	

UNIT-1II	(10 Hours) Non-Destructive Testing (NDT) Methods • Visual Inspection: Surface defects, cracks, surface roughness • Liquid Penetrant Test (LPT): Surface crack detection • Magnetic Particle Testing (MPT): Detection of surface & subsurface defects • Ultrasonic Testing (UT): Internal defect detection using high-frequency waves • Radiographic Testing (RT): X-ray and gamma-ray testing for welds and castings • Eddy Current Testing (ECT): Conductivity & defect detection in metals	10
UNIT-1V	Advanced Material Testing Techniques & Industrial Applications & Case Studies (5 hours) • Nanoindentation • Advanced NDT techniques (phased array ultrasound technique) • Quality control and material selection	5

Primary Textbooks

1. "Mechanical Metallurgy" – George E. Dieter, McGraw-Hill Education
2. "Materials Science and Engineering: An Introduction" – William D. Callister, Jr., Wiley
3. "Introduction to Physical Metallurgy" – Sidney H. Avner, McGraw-Hill Education
4. "Testing of Metallic Materials" – A.V.K. Suryanarayana, Prentice-Hall of India (PHI Learning)
5. "Non-Destructive Testing Handbook" – ASNT (American Society for Nondestructive Testing)
6. Mechanical Testing of Engineering Materials- C. Mohapatra, JJTP Bhubaneswar

Reference Books

1. "Metallurgy for Engineers" – E.C. Rollason, Edward Arnold Publishers Ltd.
2. "Elements of Materials Science and Engineering" – Lawrence H. Van Vlack, Pearson Education
3. "Fundamentals of Materials Science and Engineering" – William F. Smith, McGraw-Hill Education
4. "Materials Testing Laboratory Manual" – L.M. Gambhir, McGraw-Hill Education

PR:1- MINERAL PROCESSING LABROTORY

L	T	P		Course Code: MTPC21 1
0	0	4		
Total Contact Hours				Theory Assessment
Theory		: 60Hrs	Total Marks: 50	End Term Exam 15
				Progressive Assessment 35
Pre Requisite		: Nil		
Credit		2		Category of Course : PC

RATIONALE:

The rationale for a Mineral Processing Laboratory course is to provide practical, hands-on experience in the techniques and equipment used to separate valuable minerals from ore, complementing theoretical knowledge and preparing students for careers in mining and extractive metallurgy.

Course Outcomes:

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

1. Proficiency in Mineral Dressing Techniques

To apply various mineral dressing methods (e.g., flotation, gravity separation, magnetic separation, comminution) to process ore samples and extract valuable minerals.

2. Knowledge of Mineral Processing Equipment

To gain hands-on experience with the operation and maintenance of various mineral processing equipment used in the laboratory (e.g., flotation cells, crushers, mills, magnetic separators).

3. Ability to Conduct Comminution and Liberation Studies

To perform comminution (crushing and grinding) experiments to liberate valuable minerals from the ore and evaluate the efficiency of particle size reduction.

4. Technical Report Writing and Data Presentation

To effectively communicate the results of their experiments through clear and comprehensive technical reports, including data analysis, conclusions, and recommendations.

(Students are required to perform at least seven experiments)

1. Study of Laboratory Jaw Crusher and to perform a crushing test on the given sample and calculate reduction ratio.
2. Study of Laboratory Ball Mill and to perform a grinding test on the given sample, and to analyze size distribution in the product by sieve analysis and to calculate grindability index.
3. Machine Study of Wilfley Table and to perform a gravity separation test on the given sample.

4. To study the principle and operation of Laboratory Flotation Machine, and to perform a froth flotation test on a coal sample .
5. Crushing of Ore in a roll crusher, and Determination of average size by sieving.
6. Crushing of Ore in the Jaw Crusher, and Determination of average size by sieving.
7. Study of magnetic separator, and effect of field on efficiency of the process.
8. To determine and analyze the size distribution of a fixed granular solid by using a Test Sieve Stack.
9. Jigging: Separation of coarse particles based on differential settling.
10. Electrostatic Separator – Separation of conductors vs. non-conductors (rutile, zircon).

Primary Textbooks

1. "Textbook of Mineral Processing" - D.V.S. Rao- Scientific Publishers
2. " Ore Processing"– S.K. Jain- Mc Graw Hill
3. " The Engineering Science of Mineral Processing: A Fundamental and Practical Approach" – Concha A. and Bascur O.A- Routledge

PR:2- FUEL TESTING & CHEMIICAL ANALYSIS LAB

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="7">Total Marks: 50</td><td colspan="2" rowspan="2">Course Code: MTPC213</td></tr>
<tr><td>0</td><td>0</td><td>4</td></tr>
<tr><td colspan="3">Total Contact Hours</td><td colspan="2">Theory Assessment</td></tr>
<tr><td colspan="3">Theory : 60Hrs</td><td>End Term Exam</td><td>15</td></tr>
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<tr><td colspan="3">Pre Requisite : Nil</td><td colspan="2"></td></tr>
<tr><td colspan="3">Credit 2</td><td colspan="2">Category of Course : PC</td></tr>
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RATIONALE:

This course is to provide practical, hands-on experience in the techniques and equipment used to separate valuable minerals from ore, complementing theoretical knowledge and preparing students for careers in mining and extractive metallurgy.

Course Outcomes:

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

1. Ability to Conduct Fuel Tests

To perform various standardized fuel testing procedures (e.g., flash point, fire point,viscosity, calorific value) using equipments and methods.

2. Understanding of Fuel Properties and Performance

To relate fuel characteristics to performance metrics and combustion behavior.

3. Proficiency in Analyzing and Interpreting Test Results

To interpret laboratory results accurately, identifying fuel quality and performance characteristics, and use the data to evaluate fuel suitability for specific applications.

(Students are required to perform at least seven experiments)

1 Proximate analysis of coal

2. To determine the flash and fire point of petrol using Pensky Marten's apparatus
3. To determine the flash and fire point of diesel using Pensky Marten's apparatus
5. Determination of Fe in iron ore
6. Determination of Mg in Dolomite ore
7. To determine the calorific value of coal using Bomb Calorimeter
8. Determination of Cu, Zn in Brass
9. Determine Micum Index of given coal/coke sample
10. Determine Shatter Index of given coal/coke sample

Primary Textbooks

1. "Fuels & Combustion" - Samir Sankar - Orient Longman
2. " Elements of fuels,Furances & Refactories"– R.C.Gupta - PHI
3. " A Manual for the Chemical Analysis of Metals " – Thomas R. Dulski - ASTM International
4. " Elements of Fuels, Furnaces and Refractories"- O.P. Gupta- Khanna Publishers

PR:3- MATERIAL TESTING LAB

L	T	P		Course Code: MTPC215	
0	0	4			
Total Contact Hours				Theory Assessment	
Theory		: 60Hrs	Total Marks: 50	End Term Exam	15
				Progressive Assessment	35
Pre Requisite		: Nil			
Credit		2		Category of Course : PC	

RATIONALE:

Material Testing Lab course is to provide practical knowledge and hands-on experience in evaluating material properties like ductility, surface roughness, and mechanical behavior, crucial for informed material selection and design in various engineering disciplines

Course Outcomes (COs):
Upon successful completion of the Material Testing Laboratory course, students will be able to:

1. Conduct mechanical tests (tensile, compression, impact, and hardness) on different materials and interpret the results to assess material properties like strength, ductility, and toughness.
2. Evaluate the performance of materials under various loading conditions (e.g., fatigue, creep) and understand the influence of these conditions on material behavior and failure.

List of Experiments

(Student are required to perform at least 7 experiments including experiments from both modules)

UNIT-1	Mechanical Testing of Materials 1. Tensile Testing of Metallic Materials ○ Determination of yield strength, ultimate tensile strength (UTS), percentage elongation, and fracture behaviour ○ Virtual Lab on Tensile Test and Stress Strain Curve of Steel 2. Compression Testing of Materials ○ Stress-strain behavior of ductile and brittle materials under compressive loading 3. Hardness Testing ○ Brinell, Rockwell, and Vickers hardness, Microhardness testing on different metals ○ Virtual Lab on Bulk and Micro Hardness Test of Materials

	○ Virtual Lab on Instrumented Indentation of Materials 4. Impact Testing (Charpy & Izod Tests) ○ Study of toughness and fracture behavior under dynamic loading conditions ○ To establish the ductile - brittle transition temperature of the material. ○ Virtual Lab on Charpy and Izod Impact Testing of Materials
UNIT-1I	Special Testing Techniques 5. Creep Testing (Demonstration only, if available) • Study of time-dependent deformation of materials under constant load and temperature • Virtual Lab on Creep High Temperature Test of Materials 6. Fatigue Testing • Observation of crack initiation and propagation under cyclic loading • Virtual Lab on Fatigue Cyclic Load Test of Materials

Textbooks:

1. "Materials Science and Engineering: An Introduction" – *William D. Callister Jr.* (*Wiley*)
2. "Mechanical Metallurgy" – *George E. Dieter* (*McGraw-Hill Education*)
3. "Testing of Metallic Materials" – *A.V.K. Suryanarayana* (*BS Publications*)
4. "Material Testing Laboratory Manual" – *L.M. Gambhir* (*McGraw-Hill Education*)
5. "Mechanical Testing of Materials" – *Adrian P. Mouritz* (*Woodhead Publishing*)

Reference Books:

6. "Non-Destructive Testing Handbook" – *ASNT (American Society for Nondestructive Testing)*
7. "Mechanical Testing of Engineering Materials" – *K.H. Hoffmann* (*Springer*)
8. "Metallurgy for Engineers" – *E.C. Rollason* (*Edward Arnold Publishers*)
9. "Introduction to Physical Metallurgy" – *Sidney H. Avner* (*McGraw-Hill Education*)
10. "Fundamentals of Materials Science and Engineering" – *William F. Smith* (*McGraw-Hill Education*)

Resources

https://mec-met-iitk.vlabs.ac.in/List%20of%20experiments.html

PR:4- NDT LAB

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="8">Total Marks: 50</td><td colspan="2" rowspan="2">Course Code: MTPC217</td></tr>
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<tr><td colspan="3">Total Contact Hours</td><td colspan="2">Theory Assessment</td></tr>
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RATIONALE:

Non-Destructive Testing (NDT) lab course is to equip students with the skills and knowledge to inspect materials and structures without causing damage, ensuring their integrity, safety, and reliability across various industries.

Course Outcomes (COs)
Upon successful completion of the Material Testing Laboratory course, students will be able to:

(Student are required to perform at least 5 experiments)

1. Apply Various NDT Techniques: Demonstrate proficiency in conducting Visual Inspection (VI), Dye Penetrant Testing (DPT), Magnetic Particle Testing (MPT), Ultrasonic Testing (UT), and Eddy Current Testing (ECT) for detecting material defects.
2. Interpret NDT Results for Quality Control: Analyze and interpret test results to assess material integrity, identify defects, and recommend corrective actions in manufacturing and maintenance applications.
3. Ensure Safe and Effective NDT Practices: Follow safety protocols, equipment handling guidelines, and industry standards (ASNT, ASTM, ISO) to perform NDT procedures efficiently in real-world industrial settings.

Following experiments to be conducted:

Non-Destructive Testing (NDT) Methods

1. Visual Inspection (VI) – Surface defects detection using magnifiers, borescopes, and optical instruments.
2. Liquid Penetrant Test (LPT)

- Detection of surface defects in ferrous and non-ferrous metals

3. Magnetic Particle Testing (MPT)
    - Inspection of cracks and surface discontinuities in ferromagnetic materials
4. Ultrasonic Testing (UT)
    - Evaluation of internal defects using ultrasonic waves
    - Basics of ultrasonic waves and transducers used in Ultrasonic Testing (UT).
5. Radiographic Testing (RT) *(Demonstration only, if available)*
    - Introduction to X-ray & Gamma-ray Radiographic Testing.
    - X-ray and gamma-ray inspection for defect detection in welded joints
6. Eddy Current Testing (ECT) *(Demonstration only, if available)*

- Identification of material defects and surface cracks using electromagnetic induction

7. Case study on NDT applications in aerospace, automotive, and manufacturing.

Reference Books & Standards:

Textbooks:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu – *"Practical Non-Destructive Testing,"* Narosa Publishing House.
2. R. Halmshaw – *"Non-Destructive Testing,"* Edward Arnold Publications.
3. Paul E. Mix – *"Introduction to Nondestructive Testing: A Training Guide,"* Wiley.

Reference Books:

1. American Society for Nondestructive Testing (ASNT) – *"NDT Handbook Series" (Various Volumes).*
2. J. Prasad & C. G. Krishnadas Nair – *"Non-Destructive Test and Evaluation of Materials,"* McGraw Hill.
3. Louis Cartz – *"Non-Destructive Testing,"* ASM International.
4. B. Raj, C.V. Subramanian, T. Jayakumar – *"Non-Destructive Testing of Welds,"* Narosa Publishing House.

Summer Internship-4 weeks after 2nd Semester

SUMMER INTERNSHIP – I

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="8">Total Marks: 50</td><td colspan="2">Course Code: SI201</td></tr>
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Duration: 3-4 weeks during summer vacation after 2nd Semester.

RATIONALE

Summer Internship – I
I to offer a structured and practical learning experience that prepares individuals for their future careers, helps them make informed career choices, and equips them with the skills and knowledge necessary to succeed in their chosen field. This course provides opportunities to students for hands-on industry experience.

LEARNING OUTCOMES

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

- Apply theoretical knowledge gained in their academic coursework to real-world situations.
- Enhance specific skills relevant to their field.
- Gain hands-on experience in a professional network by interacting with mentors and industry professionals.
- Manage time effectively.
- Clarify career goals.

DETAILED COURSE CONTENTS

SUGGESTED ACTIVITIES:

I Orientation:

- Introduction to the organization's mission, values, and culture.
- Familiarization with workplace policies, procedures, and safety guidelines.
- Orientation to the team and organizational structure.

II Project-Based Learning:

- Description of the main project or tasks the intern will be working on during the internship.
- Detailed project goals and objectives.
- Training and guidance on project-specific tools, technologies, or methodologies.

III Technical and Skill Development:

- Training sessions or workshops to enhance technical skills relevant to the internship role (e.g., programming languages, software tools, laboratory techniques).

- Soft skills development, including communication, teamwork, problem solving, and time management

IV Mentorship and Supervision:

- Regular meetings with a designated mentor or supervisor for guidance, feedback, and support.
- Mentorship objectives and expectations.

V Professional Development:

- Sessions on professional etiquette, networking, and building a personal brand
- Resume writing and interview preparation workshops.

VI Industry and Field-Specific Knowledge:

- Lectures, seminars, or presentations on industry trends, best practices, and emerging technologies.
- Guest speakers from the field to share insights and experiences.

VII Reporting and Documentation:

- Training on how to document project progress, results, and findings.
- Practice in creating reports, presentations, or other deliverables.

VIII Ethics and Professionalism:

- Discussions on ethical considerations within the field.
- Scenarios and case studies related to ethical decision-making

IX Feedback and Evaluation:

- Regular performance evaluations and feedback sessions.
- Self-assessment and goal-setting exercises.

X Networking and Industry Exposure:

- Opportunities to attend industry conferences, webinars, or networking events.
- Encouragement to connect with professionals in the field.

NOTE

As per AICTE guidelines, in Summer Internship-I, students are required to be involved in Inter/ Intra Institutional Activities viz;

- Training with higher Institutions;
- Soft skill training organized by Training and Placement Cell of the respective institutions;
- contribution at incubation/ innovation /entrepreneurship cell of the institute;
- participation in conferences/ workshops/ competitions etc.;
- Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop;
- Working for consultancy/ research project within the institutes and
- Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.