Final

DIPLOMA CURRICULUM OF METALLURGICAL ENGINEERING (THIRD YEAR) (5th Semester)

(To be implemented from 2026-27)

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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PROGRAMME TITLE: METALLURGICAL ENGINEERING

SEMESTER - V

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	MTPC301 TH:1	Manufacturing of Steel & Stainless Steel		3	0	0	70	30	-	-	100	3
2		MTPC303 TH:2	Heat Treatment		3	0	0	70	30	-	-	100	3
3		MTPC305 PR:1	Metallography and Characterization Laboratory		0	0	4	-	-	15	35	50	2
4		MTPC307 PR:2	Heat Treatment Lab		0	0	4	-	-	15	35	50	2
5	Programme Elective	MTPE301 (Any one) TH:3	(A)Advanced Materials (B)Failure Analysis (C)Nanomaterials		3	0	0	70	30	-	-	100	3
6		MTPE303 (Any one) TH:4	(A) Foundry Technology (B)Powder Metallurgy (C)Environmental Degradation of Materials		3	0	0	70	30	-	-	100	3
7		MTPE305 (Any one) PR:3	(A) Foundry Technology Lab (B) Polymer & Composite Lab (C) Material Chemistry Laboratory		0	0	4	-	-	15	35	50	2
8	Open Elective	Open Elective- I OE301 (Any one) TH:5	(A) Universal Human Values (B) Leadership and Management Skills (C) Professional Skills		3	0	0	70	30	-	-	100	3
9	Summer Internship	SI301	SUMMER INTERNSHIP II*		0	0	0	-	-	15	35	50	2
10	Major Project	PR301 PR:4	MAJOR PROJECT		0	0	4			15	35	50	2
TOTAL					**15**	**0**	**16**	**350**	**150**	**75**	**175**	**750**	**25**

***3 – 4 weeks internship after 4th Semester;**

***The best of 2 IA conducted in a subject out of 20 marks to be considered. Assignment/ quiz etc. of 10 marks to be treated as part of IA. Besides this, Monthly Test to be conducted for each subject. Sessional Marks shall be total of the performance of individual different jobs/ experiments in a subject throughout the semester. Club/Innovation/ Idea Tinkering Activities etc. shall be encouraged to be performed by students beyond the above stipulated hours.**

FIFTH SEMESTER

TH-1: MANUFACTURING OF STEEL & STAINLESS STEEL

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="6">Total Marks: 100</td><td colspan="2">Course Code: MTPC 301</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2"></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 Assessmen</td><td>30</td></tr>
<tr><td colspan="3">Pre-Requisite : Iron Making</td><td colspan="2">Category of Course: PC</td></tr>
<tr><td colspan="3">Credit 3</td><td colspan="2"></td></tr>
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Rationale of the Course

Steel and stainless steel are backbone materials of modern infrastructure, power, transportation, chemical, and manufacturing industries. This course provides students with **clear process-oriented understanding** of **primary and secondary steelmaking**, **stainless steel production routes**, **refining reactions**, **casting practices**, **defects**, and **quality control**, with emphasis on **industrial relevance.**

Course Outcomes (COs)

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

1. **CO1:** Explain principles, raw materials, and impurity control in steelmaking
2. **CO2:** Describe BOF/LD, EAF, and secondary steelmaking processes
3. **CO3:** Understand stainless steel classification and alloying principles
4. **CO4:** Explain AOD, VOD, induction furnace, and ladle metallurgy practices
5. **CO5:** Identify casting methods, defects, testing, and industrial applications

Content:

Units	Topics/Sub-topics	Hours
Unit-I	**Fundamentals of Steelmaking** Definition and objectives of steelmaking, Role of carbon and impurities (Si, Mn, P, S, O, N), Acid and basic steelmaking processes, Raw materials: hot metal, scrap, fluxes, Basic thermodynamics and kinetics of steelmaking reactions, Conditions for removal of Si, P, S, Mn, and C, Overview of steel grades and their composition, Brief study of obsolete processes: Bessemer process and Open-Hearth process (with limitations)	**10**
Unit-II	**Primary Steelmaking Processes** **Steel Making by LD Converter:** Raw materials of LD process, construction and operation of LD converter, emulsion and refining reactions in LD converter and sequence of elimination of impurity, Mn hump, quality of steel and composition of slag in LD process, advantages and limitations of LD process, importance of lance height, developments in LD process: multi nozzle lance, combined blowing process. **Other Steel Making Processes:** Working principle, process, advantage and limitations of: OLP process, OBM Process. **De-Oxidation Practice:** De-Oxidisers and their use**,** Killed, semi killed and rimming steel.	**10**
Unit-III	**Stainless Steel Manufacturing** **Introduction to Stainless Steels:** Definition and role of chromium (passivation)**,** Classification: Austenitic, Ferritic, Martensitic, Duplex, Precipitation hardening, Properties and applications, **Stainless Steel Making (Primary processes):** Raw Materials for stainless steel making**, Electric Arc Furnace:** Principle, types of slags prepared by electric arc furnace, steps of electric arc furnace heating to produce stainless steel, advantages of electric arc furnace process**, Induction Furnace:** Principle and process of induction furnace, advantages and limitations of induction furnace process, **Secondary Steel Making Process:** Objectives of secondary steel making, Principle of operation and advantages of secondary steel making processes such as: LHF Process, VOD Process, AOD Process and RH- OB degassing process, Inclusion Control and Clean LHF Process, VAD Process and RH- OB degassing process, Inclusion Control and Clean Steel Production, Process Control and Automation in Secondary Steelmaking**,** Stainless steel grades and their industrial selection criteria.	**15**
Unit-IV	**Casting, Defects & Green Steel** **Pit Side Practice:** Teeming methods such as: Direct pouring , Tundish teeming and Bottom teeming, Ingot defects, their causes and remedies, **Continuous Casting of Steel:** Principle and	**10**

	operation of continuous casting, types of casters, advantages of continuous casting, products of Continuous casting, **Green Steel Technology:** Brief idea on green steel, its advantages**,** Sustainable Practices in Steel Industry**,** Basic idea about Emissions and Effluent Treatment**,** Basic idea about Waste Heat Recovery and By- product Utilization	

Text Books

1. "Introduction to Modern Steelmaking" – R. H. Tupkary & V. R. Tupkary
   Publisher: Khanna Publishers
2. "Ironmaking and Steelmaking: Theory and Practice" – Ahindra Ghosh & Amit Chatterjee
   Publisher: PHI Learning Private Limited
3. "Steelmaking" – A. K. Chakrabarti
   Publisher: PHI Learning Private Limited
4. "Stainless Steel: Metallurgy and Applications" – J. Charles & J. A. Van Bennekom
   Publisher: ASM International
5. "Introduction to Physical Metallurgy" – Sidney H. Avner
   Publisher: McGraw-Hill Education
6. "Metallurgy for Engineers"E.C.Rollason
   Publisher: Edward Arnold Publishers
7. Manufacture of Iron And Steel Vol I & II – G.R.Bashforth
   Publisher : Chapman & Hall.

Reference Books

1. "The Making,ShapingandTreatingofSteel"
   Publisher: Association for Iron & Steel Technology (AIST)
2. "First Course in Iron and Steelmaking" – Dipak Mazumdar
   Publisher: Universities Press (India) Pvt. Ltd.
3. "Secondary Steelmaking" – Ahindra Ghosh
   Publisher: CRC Press / Taylor & Francis Group
4. "Physical Chemistry of Steelmaking" – R. G. Ward
   Publisher: Longman Group Limited
5. "Stainless Steels: An Introduction and Their Recent Developments" – A. K. Sinha
   Publisher: Narosa Publishing House

6. “PrinciplesofExtractiveMetallurgy–Vol.2”–TerkelRosenqvist
   Publisher: McGraw-Hill
7. “SteelMetallurgyfortheNon-Metallurgist”–JohnD.Verhoeven
   Publisher: ASM International
8. Steel Making – V. A Kudrin
   Publisher: MIR

TH:2- HEAT TREATMENT

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="5">Total Marks: 100</td><td colspan="2">Course Code: MTPC303</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">Theory Assessment</td></tr>
<tr><td colspan="3">Total Contact Hours</td><td>End Term Exam</td><td>70</td></tr>
<tr><td colspan="3">Theory : 45Hrs</td><td>Progressive Assessment</td><td>30</td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="2">Category of Course: PC</td></tr>
<tr><td colspan="3">Pre-Requisite : Nil</td><td></td></tr>
<tr><td colspan="3">Credit 3</td><td></td><td colspan="2"></td></tr>
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RATIONALE:

A course on heat treatment is crucial because it equips individuals with the knowledge and skills to understand and apply controlled heating and cooling processes to alter the properties of metals and alloys, ultimately enhancing their performance and suitability for various applications.

LEARNING OUT COMES:

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

1. Know the Principles of Heat Treatment
2. Explore Various Heat Treatment Processes
3. Familiarize students with different heat treatment techniques such as annealing, normalizing, hardening, tempering, and surface hardening.
4. Analyse the Influence of Heat Treatment on Material Properties
5. Study how heat treatment affects mechanical properties like hardness, toughness, strength, and wear resistance in ferrous and non-ferrous alloys.
6. Develop Practical Skills for Industrial Applications

DETAILED CONTENTS:

Module 1:	**Fundamentals of Heat Treatment and Phase Transformations (15 Hours)** • Definition, Objectives, and Industrial Applications of Heat Treatment • Phase Diagrams with Emphasis on the Iron-Carbon System • Critical Temperatures (A1, A3, Acm) and Their Metallurgical Significance • Phase Transformations: Diffusion, introduction to diffusion, fick‟s law • The formation of austenite, the mechanism of formation‟ of austenite, austenitic grain size.the methods of determination of austenitic grain size, the importance of grain size, the method of measurement of grain size, the methods of control austenitic grain size, decomposition of austenite and pearlitic transformation • The process of construction of T-T-T diagram and CCT diagram, the TTT & CCT Diagram for hypo eutectoid,	15hrs.

	eutectoid and hyper eutectoid steel, bainitic transformation, martensitic transformation.	
Module 2:	**Heat Treatment Processes for Ferrous, Non-Ferrous Alloys and Special Heat Treatment Techniques (10 Hours)** • **Annealing:** Full, Process, Stress-Relief, and Spheroidizing, Temperature range • **Normalizing:** Objectives and Microstructural Changes, Temperature range • **Hardening:** Objectives and Microstructural Changes, Temperature range, factors affecting hardening process, Quenching Media • **Tempering:** Purpose, Mechanisms, and Effects of Tempering Temperature • Thermomechanical Processing (TMP): Principles and Applications • Special Processes: Austempering, Martempering, Cryogenic Treatment	10 hrs

	• Heat Treatment of Non-Ferrous Alloys (Aluminum, Copper, Titanium Alloys)	

Module 3:	**Hardenability, Surface Hardening (10 Hours)** • Importance of hardness & hardenability, the method of determination of hardenability (Gross Man‟s critical diameter method &Jominey end quench method), the factors affecting hardenability, effect of austenitic grain size, carbon content, and alloying elements. • Surface Hardening Techniques: Objectives of surface hardening, the methods of case depth measurement of steel, carburizing : pack carburizing, liquid carburizing, gas carburizing • Nitriding, Cyaniding, Carbonitriding • post carburizing heat treatment. • Advanced Techniques: Induction Hardening, Flame Hardening, Laser Hardening	10 hrs

Module 4:	**Heat Treatment Equipment, Defects, Quality Control & industrially important Special steels (10 Hours)** • Heat Treatment Furnaces: Box, Pit, Salt Bath, and Vacuum Furnaces • Furnace Atmospheres: Neutral, Carburizing, and Nitriding Atmospheres • Heat Treatment Defects: Distortion, Cracking, Decarburization (Causes & Remedies) • **Special Steels:** Basic Idea, Consisting Elements, properties and real world application of Tool Steels, Stainless Steels (Austenitic (304, 316), Ferritic (430), Martensitic (410, 420), Duplex (2205), High-Strength Low-Alloy (HSLA) Steels, Maraging Steels, Bearing Steels, Electrical Steels (Silicon Steels), **Creep- Resistant Steels** (Heat-Resistant Steels), Duplex and Super Duplex Stainless Steels, Hadfield Manganese Steel (High-Mn Steel), TRIP and TWIP Steels (Advanced High-Strength Steels – AHSS)	10 hrs

TEXT BOOKS:-

1. **"Heat Treatment: Principles and Techniques"** – *T.V. Rajan, C.P. Sharma, and Ashok Sharma*
    a. **Publisher:** Prentice-Hall of India Pvt. Ltd. (PHI Learning)
2. **"Physical Metallurgy: Principles and Practices"** – *V. Raghavan*
    a. **Publisher:** Prentice-Hall of India Pvt. Ltd. (PHI Learning)

3. "Principles of Heat Treatment of Steel" (Metallurgy and Heat Treatment) Author: George E. Totten, Publisher: ASM International

4. "Heat Treatment of Metals" by Prof. Vijendra Singh, Standard Publishers Distributors

REFERENCE BOOKS:-

1. "ASM Handbook, Volume 4: Heat Treating" (ASM International)
2. "Metallurgy for Engineers" by E.C. Rollason.
3. "Steel Heat Treatment: Metallurgy and Technologies" by George E. Totten (CRC Press, Taylor & Francis Group).
4. "Alloy Steels and Their Heat Treatment", Author: Robert M. Brick, Robert B. Gordon, Publisher: McGraw-Hill Education
5. "Steel Metallurgy: Properties, Specifications, and Applications", Author: John D. Verhoeven, Publisher: ASM International
6. "Steels: Microstructure and Properties" Authors: Harry Bhadeshia and Robert Honeycombe, Publisher: Elsevier Butterworth- Heinemann
7. "Metallurgy and Heat Treatment of Tool Steels", Author: Bohdan N. Klopfer, Publisher: Springer
8. "Handbook of Stainless Steels", Authors: Donald Peckner and Irving Bernstein, Publisher: McGraw-Hill Education

PR:1- METALLOGRAPHY AND CHARACTERIZATION LABORATORY

L	T	P		
0	0	4	**Total Marks: 50**	**Course Code: MTPC305**
Total Contact Hours				**Practical Assessment**
Practical		: 60Hrs		End Exam 15
				Progressive Assessment 35
Pre-Requisite		**: Nil**		Category of Course: PC

RATIONALE:

Metallography is a fundamental tool in materials science that enables engineers to evaluate the microstructure of metals and alloys. It aids in understanding grain structure, phase distribution, and defect mechanisms, which directly influence mechanical and thermal properties. With rapid advances in materials and their processing, it is essential that diploma students gain hands-on experience with **both conventional and metallographic techniques**, enabling them to contribute effectively to industries like steel, aerospace, automotive, and failure analysis.

Course Outcomes:

After successful completion of this course, students will be able to:

1. **Prepare** metallographic samples of metals and alloys using standard procedures.
2. **Identify** different microstructural features using optical microscopy.
3. **Analyze** microstructures for phase composition, grain size, and defects.
4. **Apply** advanced characterization techniques (SEM/EDX, image analysis, etc.) to support industrial materials testing and research

List of Experiments

(Students are required to perform at least Seven experiments)

1. Microstructure Study to observe grain size and phase boundaries. of mild steel, stainless steel & High Speed Steel using Metallurgical Microscope.
2. Microstructure Study to identify graphite morphology of different Cast Iron using Metallurgical Microscope.
3. Microstructure Study of alpha/beta phases, solid solution structure, and eutectic structures of Non-Ferrous Alloys (Cu, Al, Zn Based) using Metallurgical Microscope.
4. Quantitative Measurement of Grain Size using ASTM Chart / Intercept Method using Image Analyzer
5. Digital imaging, contrast adjustment, and quantitative phase analysis using Image Analyzer software
6. Observe secondary electron imaging, high magnification structures using Scanning Electron Microscopy (FESEM)
7. Elemental analysis of microstructural constituents Energy Dispersive X-ray Analysis (EDX)
8. Fracture surface study using FESEM.
9. Observe grain orientation mapping, phase distribution, and texture in metals using EBSD attached to FESEM.
10. Perform Vickers/Knoop microhardness tests on multiphase regions and correlate with grain size and phases.
11. Demonstrate XRD to match diffraction patterns with standard JCPDS cards.
12. Transmission Electron Microscopy foil preparation and understand differences between bulk and thin sample characterization. (Techniques like electro-polishing or ion milling may be used)
13. Observe grain boundaries, dislocations, and phase contrast in metallic materials using TEM.

SAFETY CONSIDERATIONS:

General Safety:

1. Wear **safety glasses, gloves, and lab coat** when performing grinding, polishing, or etching operations.
2. Keep hair tied and avoid wearing synthetic or flammable clothing near machines.
3. Do not operate any equipment unless **trained and authorized**.

Equipment Handling:

4. Use **guards and clamps** when operating cutting or grinding machines.
5. Never leave **rotating or polishing machines unattended**.

6. Keep hands away from moving parts; use sample holders wherever possible.
7. Handle **hot-mounted samples** with tongs or heat-resistant gloves.

Chemical Safety (Etching):

8. Always perform **etching in a fume hood** or well-ventilated area.
9. Use only the specified amount of etchant; **never mix etchants** without guidance.
10. Store acids and peroxides properly and tightly closed.

Waste and Clean-Up:

11. Dispose of **metallic debris and abrasive waste** in designated bins.
12. Wipe machines after use and **drain polishing water** if applicable.
13. Rinse and dry etched specimens before discarding or storage.

Emergency Protocols:

14. Know the location of **emergency shut-off switches, fire extinguishers, and eye wash stations**.
15. Report **equipment malfunctions, chemical exposure, or injuries** to the Laboratory Assistant/ Faculty In Charge without delay.

Text Books

1. **"Metallography: Principles and Practice"** – George F. Vander Voort
   Publisher: ASM International
2. **"Practical Physical Metallurgy and Materials Characterization"** – Andreas Mortensen
   Publisher: Elsevier
3. **"Physical Metallurgy Laboratory Manual"** – A. K. Mallick
   Publisher: PHI Learning Pvt. Ltd.
4. **"Engineering Metallurgy Lab Manual"** – S. K. Hajra Choudhury
   Publisher: Indian Book Distributing Company

Reference Books

1. **"ASM Handbook Volume 9: Metallography and Microstructures"**
   Publisher: ASM International

2. **"Principles of Materials Characterization and Metrology"** – S. Raghavan
   Publisher: PHI Learning Pvt. Ltd..
3. **"Material Characterization: Introduction to Microscopic and Spectroscopic Methods"** – Yang Leng
   Publisher: Wiley

"Structure and Properties of Engineering Materials" – Henkel & Pense
Publisher: Tata McGraw-Hill

PR:2- Heat Treatment Laboratory

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="6">Total Marks: 50</td><td colspan="2">Course Code: MTPC307</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td colspan="2">Practical Assessment</td></tr>
<tr><td colspan="3">Total Contact Hours</td><td>End Term Exam</td><td>15</td></tr>
<tr><td colspan="3">Practical : 60Hrs</td><td>Progressive Assessment</td><td>35</td></tr>
<tr><td colspan="3"></td><td colspan="2" rowspan="2">Category of Course: PC</td></tr>
<tr><td colspan="3">Pre-Requisite : Nil</td></tr>
<tr><td colspan="3">Credit 2</td><td colspan="3"></td></tr>
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RATIONALE:

A heat treatment laboratory course is to provide hands-on experience in manipulating the properties of metals and alloys through controlled heating and cooling, enabling students to understand the relationship between microstructure, heat treatment processes, and resulting mechanical properties.

LEARNING OUT COMES:

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

1. Familiarize students with heat treatment equipment and procedures.
2. Develop practical skills in performing heat treatment processes.
3. Identify the relationship between heat treatment, microstructure, and properties.
4. Learn to analyse and interpret results from heat treatment experiments.
5. Develop skills in metallographic sample preparation and analysis.

Experiments:

Module 1: Introduction to Metallography and Basic Heat Treatments	1. **Metallographic Sample Preparation:** o Cutting, mounting, grinding, polishing, and etching of metallic samples. o Microscope usage and metallographic observation. 2. **Annealing:** o Full annealing of steel samples. o Observation of microstructural changes and hardness measurements. o Comparison with as-received condition. 3. **Normalizing:** o Normalizing of steel samples. o Observation of microstructural changes and hardness measurements. o Comparison with annealed and as-received conditions. 4. **Stress Relieving:** o Stress relieving of a pre-stressed component.

	o Measurement of residual stresses before and after stress relieving (if equipment available). o Assessment of changes in mechanical properties.

Module 2: Hardening and Tempering	5. **Hardening (Quenching):** o Hardening of different grades of steel using various quenching media (water, oil, brine). o Effect of quenching rate on hardness. o Jominy End Quench Test. 6. **Tempering:** o Tempering of hardened steel samples at different temperatures. o Observation of changes in hardness and microstructure with tempering temperature. o Development of tempering curves. 7. **Austempering /Martempering (If possible):** o Demonstration of austempering and mar tempering processes. o Comparison of microstructures and properties with conventionally hardened and tempered samples.

Module 3: Surface Hardening	8. **Carburizing (Demonstration):** o Demonstration of pack carburizing or gas carburizing. o Microstructural examination of the carburized layer. o Hardness profile measurement. 9. **Nitriding (Demonstration if possible):** o Demonstration of the nitriding process. o Microstructural examination of the nitride layer. o Hardness profile measurement.
Module 4: Special Treatments and Analysis	11. **Heat Treatment of Non-Ferrous Alloys:** • Photomicrography of aluminum or copper alloys o Heat treatment of aluminum or copper alloys. o Study of precipitation hardening (if applicable). o Virtual Lab on Age Hardening in Aluminium Alloys

	12. **Microscopy and Image Analysis:** o Micro hardness measurement of various heat treated steel samples. o Image Analysis of various heat treated steel samples. o Advanced microscopy techniques (if available). o Quantitative metallography using image analysis software. 13. Compositional Analysis of various materials using spectroscopic method. (Students are required to perform at least 8 experiments with at least 2 experiment from each module)

SAFETY CONSIDERATIONS:

- Always wear protective gear (gloves, goggles, lab coat) when handling hot samples.
- Follow all safety guidelines when using furnaces and quenching media.

- Ensure that proper ventilation is in place when using gases in the carburizing process.

SUGGESTED BOOKS:

1. **"Materials Science and Engineering Laboratory Manual"**

- **Authors:** *V. Raghavan*
- **Publisher:** Prentice-Hall of India (PHI Learning)

2. **"Metallurgical Laboratory Manual"**

- **Authors:** *K.K. Bansal*
- **Publisher:** Laxmi Publications

3. **. "Laboratory Manual in Physical Metallurgy"**

- **Authors:** *Ravindra K. Gupta*
- **Publisher:** Prentice-Hall of India (PHI Learning)

4. **"Physical Metallurgy Lab Manual"**

- **Authors:** *B. S. Murthy*
- **Publisher:** University Science Press

5. **"Metallurgical and Materials Testing Laboratory Manual"**
- **Authors:** *R. K. Rajput*
- **Publisher:** S. Chand Publishing

6."Heat Treatment of Metals - Laboratory Handbook"
- **Authors:** *I. M. Mundle*
- **Publisher:** Springer.

7"Experimental Techniques in Materials and Metallurgical Engineering"
- **Authors:** *A.K. Koul*

- **Publisher:** New Age International Publishers

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

TH:3(A)- ADVANCED MATERIALS

L	T	P		**Course Code: MTPE301(A)**	
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: PE	

RATIONALE:

A course on advanced materials is crucial because these materials are essential for driving innovation and solving real-world problems across various industries, from healthcare to energy and transportation, by enabling lighter, stronger, and more efficient products and processes

LEARNING OUT COMES:

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

1. Know the classification and significance of advanced materials used in modern industries, including metals, ceramics, polymers, and composites.

2. Analyse the properties, processing techniques, and applications of corrosion-resistant alloys, super alloys, and nanomaterials.

3. Explain the classification and properties of advanced materials such as super alloys, smart materials, and composites

CONTENTS:

Module 1: Introduction to Advanced Materials	**(5 Hours)** • Definition and classification of advanced materials. • The driving forces behind advanced materials research and development. • Comparison between conventional and advanced materials • Applications of advanced materials in various fields (aerospace, automotive, electronics, biomedical, etc.).
Module 2: Metallic Advanced Materials & Applications	(15 Hours) • High-performance alloys (Nickel, Titanium, and Cobalt-based alloys) • Corrosion Resistant Alloys: Stainless Steels(304,316), Magnesium-aluminum alloys (5000 Series (e.g., 5052, 5083), Cobalt-Based Alloy • Superalloys: Types, manufacturing methods (Directionally solidified casting, Single-crystal casting) properties, and applications • Shape Memory Alloys (SMA) – Nitinol, Cu-Al-Ni alloys

	• Metallic Glasses (Amorphous Metals): Formation and properties of metallic glasses, Applications of metallic glasses.
Module 3: Polymer Matrix Composites & Ceramic Matrix Composites	**(10 Hours)** Introduction to Polymers and types • **Polymer Matrix Composites (PMCs):** o Types of reinforcing fibers (glass, carbon, aramid). o Manufacturing techniques (lay-up). o Properties and applications of PMCs.
	Introduction to ceramics • **Ceramic Matrix Composites (CMCs):** o Reinforcement of ceramic matrices with fibers or particles. o High-temperature applications of CMCs.
Module 4: Nanomaterials, Smart Materials & Emerging Trends in Advanced Materials	**(15 hours)** • **Nanomaterials:** o Introduction to Nanomaterials o Classification of nanomaterials (0D, 1D, 2D, 3D). o One Synthesis method each of 0D, 1D, 2D & 3D nanomaterials.

	• **Carbon Nanotubes (CNTs) and Graphene:**
	  o Structure, properties, and applications of CNTs and graphene.
	• **Smart Materials:**
	  o Definition and classification of smart materials.
	• **Piezoelectric Materials:**
	  o Piezoelectric effect and applications.
	• Energy storage materials (batteries, fuel cells).
	• Materials for sustainable development.

SUGGESTED TEXT BOOKS:

1. "Materials Science and Engineering: An Introduction" – William D. Callister, Jr. & David G. Rethwisch
2. "Advanced Materials: Principles and Applications" by V. Raghavan: (PHI Learning Pvt. Ltd.)
3. "Engineering Materials: Properties and Applications of Metals and Alloys" – R.A. Higgins (Butterworth-Heinemann)
4. Polymer Science by V R Gowariker, N V Viswanathan, Jaydev Sreedhar- New Age International Publisher
5. "Introduction to Materials Science for Engineers" by James F. Shackelford: (Pearson)

Suggested Reference Books:

1. "The Science and Engineering of Materials" – Donald R. Askeland & Wendelin J. Wright- Cengage Learning
2. "Handbook of Advanced Ceramics: Materials, Applications, Processing, and Properties" – M. R. Ramesh-Academic Press

(Elsevier)

3. "Composite Materials: Science and Engineering" – Krishan K. Chawla-Springer
4. "Nanomaterials: An Introduction to Synthesis, Properties, and Applications" – Dieter Vollath- Wiley-VCH
5. "Nanomaterials: Synthesis, Properties and Applications" by A.S. Edelstein and R.C. Cammarata: (CRC Press)
6. “Nanostructures & Nanomaterials”- Guozhong Cao-Imperial College Press, London 2004
7. “ Nanoscale Science & Technology”- Robert K, Ian H, Mark G- John Wiley & Sons Ltd, 2005
8. "Smart Materials and Structures" by M.V. Gandhi and B.S. Thompson: (Chapman & Hall)

TH:3(B)- FAILURE ANALYSIS

L	T	P	Total Marks: 100	Course Code: MTPE301 (B)
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: PE

RATIONALE:

In engineering applications, understanding the causes of material failure is vital to improving safety, reliability, and performance. Failure analysis investigates why materials fail in service and guides the development of improved materials, design practices, and manufacturing methods. This subject equips diploma students with the fundamental tools to analyze failures and recommend corrective actions, especially in sectors like automotive, aerospace, power, and infrastructure.

Course Outcomes:

After completing this course, students will be able to:

1. **Identify** common failure modes in metallic and non-metallic materials.
2. **Apply** basic methods of failure analysis, including fracture surface examination.
3. **Understand** the root causes of fatigue, corrosion, and creep failures.
4. **Recommend** preventive measures through better design, materials selection, and processing.

UNIT-I	Fundamentals of Failure (10 periods) • Introduction to failure analysis and its importance • Types of failures: ductile, brittle, fatigue, corrosion, creep • Overview of service conditions leading to failure • Steps in failure analysis: visual inspection to final report • Case histories from industry	10 Hrs.

UNIT-II	Fracture and Fatigue Failures (12 periods) • Fracture mechanics: crack initiation and propagation • Brittle vs ductile fracture characteristics • Stress concentration and fracture toughness • Fatigue: low-cycle and high-cycle fatigue • S-N curves and fatigue testing • Beach marks and striations	12 Hrs.
UNIT-III	Creep and Corrosion Failures (12 periods) • Definition and stages of creep: primary, secondary, tertiary • Mechanisms of creep in metals and alloys • Materials used in high-temperature service • Corrosion-related failures: pitting, stress corrosion cracking (SCC), intergranular • Synergistic effects: corrosion + fatigue, corrosion + wear	13 Hrs.

UNIT-IV	Failure Analysis Techniques and Prevention (11 periods) • Visual, macroscopic, and microscopic examination • Non-destructive testing (NDT) overview • Fractography using optical microscopy and SEM • Material testing: hardness, tensile, impact • Preventive strategies: materials selection, design improvements, quality control • Failure reporting and documentation	10 Hrs

Text Books

1. **"Practical Fracture Mechanics and Structural Integrity"** by Alexander Blake – CRC Press (Taylor & Francis)
2. **"Metallurgical Failure Analysis"** by A.K. Das – Tata McGraw Hill Publishing Co.

Reference Books

1. **"Failure of Materials in Mechanical Design"** by Jack A. Collins – Wiley India
2. **"Fracture and Fatigue Control in Structures"** by John M. Barsom and Stanley T. Rolfe – ASTM International
3. **"Metals Handbook: Failure Analysis and Prevention, Vol. 11"** – ASM International
4. **"Fractography in Failure Analysis"** by ASM International – ASM Handbook Series

TH:3(C)- Nanomaterials

L	T	P	Total Marks: 100	Course Code: MTPE301 (C)
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: PE

RATIONALE:

Nanomaterials, due to their extremely small size and large surface area, exhibit unique mechanical, electrical, thermal, optical, and magnetic properties. These materials are revolutionizing industries like electronics, energy, medicine, aerospace, and materials processing. This subject introduces diploma students to the basic concepts, synthesis techniques, properties, and applications of nanomaterials, enabling them to understand their significance in modern engineering and manufacturing sectors.

Course Outcomes:

After completing this course, students will be able to:

1. **Understand** the fundamental principles and size effects associated with nanomaterials.
2. **Describe** various synthesis and characterization techniques for nanomaterials.
3. **Relate** structure-property relationships at the nanoscale.
4. **Identify** applications of nanomaterials in various industries and recognize safety aspects.

UNIT-I	Introduction to Nanomaterials (10 periods) • Definition and classification: Nanoparticles, nanowires, nanotubes, thin films • Difference between bulk and nanomaterials • Historical development and significance • Surface area to volume ratio and quantum effects • Types of nanomaterials: metallic, ceramic, polymeric, and composite nanostructures	10 Hrs.

UNIT-II	**Synthesis of Nanomaterials (12 periods)** • **Top-down** approaches: Mechanical milling, nanolithography, laser ablation • **Bottom-up** approaches: Chemical vapor deposition (CVD), sol-gel, precipitation, self-assembly • Flame-assisted ultrasonic pyrolysis • Green synthesis methods • Overview of scalability and industrial synthesis	12 Hrs.
UNIT-III	Characterization Techniques (10 periods) • Overview of characterization principles • X-ray diffraction (XRD) for phase and size determination • Scanning Electron Microscopy (SEM) • Transmission Electron Microscopy (TEM) • Atomic Force Microscopy (AFM) • BET surface area measurement	10 Hrs.

UNIT-IV	Properties, Applications & Safety (13 periods) • Mechanical, thermal, electrical, magnetic, and optical properties at nanoscale • Applications in metallurgy, energy storage (batteries, supercapacitors), coatings, sensors, and medicine • Role in environmental and green technologies • Health, safety, and ethical concerns in nanotechnology • Introduction to regulatory standards and material handling precautions	13 Hrs.

Text Books

1. **"Introduction to Nanoscience and Nanotechnology"** by K.K. Chattopadhyay & A.N. Banerjee – PHI Learning Pvt. Ltd.
2. **"Nanoscience and Nanotechnology: Fundamentals to Frontiers"** by M.S. Ramachandra Rao & Shubra Singh – Wiley India Pvt. Ltd.

Reference Books

1. **"Nanomaterials: Synthesis, Properties and Applications"** by A.S. Edelstein & R.C. Cammarata – CRC Press
2. **"Nanotechnology: Principles and Practices"** by Sulabha Kulkarni – Springer India
3. **"Introduction to Nanoscale Science and Technology"** by Di Ventra, Evoy & Heflin – Springer
4. **"Textbook of Nanoscience and Nanotechnology"** by B.S. Murty et al. – Universities Press

TH:4(A)- FOUNDRY TECHNOLOGY

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="7">Total Marks: 100</td><td colspan="2">Course Code: MTPE303</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2"></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:

Foundry technology is to equip individuals with the knowledge and skills necessary for the production of metal castings, a critical process in various industries, by covering topics like mould making, melting, pouring, and post-treatment processes.

LEARNING OUT COMES:

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

1. Apply the basic principles of metal casting, including sand casting, investment casting, die casting, shell moulding, and centrifugal casting.
2. Learn how to select the right materials for specific casting applications and understand the factors that influence material performance.
3. Study the importance of mould materials, gating systems, risers, and other components that affect the casting quality.
4. Identify the types of defects that can occur during the casting process (e.g., porosity, cold shuts, shrinkage, etc.)
5. Provide exposure to advanced and modern foundry technologies.

DETAILED CONTENTS:

Module 1:	**Introduction to Foundry Technology** Definition, Scope, and Applications of Foundry Technology, principles of casting **, basic steps involved in making a casting , advantages &disadvantages of metal casting ,** different types of pattern and different pattern materials , different types of pattern allowances	**5 hrs**

Module 2:	**Foundry Materials & Testing of moulding sand** Types of moulding sand , classification of moulding sand based upon grain size & grain shape , properties desired for moulding sand , facing sand and backing sand , Testing of moulding sand (moisture content test of molding sand , AFS grain fineness number of moulding sand , clay content test of moulding sand , mould hardness test, permeability number of moulding sand, compression strength of moulding sand) , functions of binder & types of binders , Discuss on core , different functions of core & essential characteristics of core	**15 hrs**

Module 3:	**Methods of Pouring and Feeding Melting Practice, Special Casting Techniques** Gating system , function of riser & different types of riser , importance of size and shape of riser in metal casting , directional solidification , Chvorinov's rule , the construction and operation of cupola used for cast iron melting, Gravity die casting , Pressure die casting ,Cold chamber process , Hot chamber process, True centrifugal casting , Semi centrifugal casting , Centrifuging , investment casting process, Real World Application Areas of Various Casting Methods	**15 hrs**

Module 4:	**Casting Defects Foundry Automation and Modern Trends** Types of casting defects with their remedies (Mismatch or Mold shift , Blow holes ,Pin Holes , Hot tears , Shrinkage defects , Misrun , Coldshut , Porosity , Swell , warpage **Automation in Foundries :** CNC Machines in Pattern Making **,** Automated Sand Mixing and Moulding Machines **Advanced Casting Techniques :** Rapid Prototyping and 3D Printing for Foundries , Thin Wall Casting, Single-crystal casting	**10 hrs**

TEXT BOOKS:

1. **"** Foundry Technology**"-** Lal & Khanna - Khanna Publishers
2. **"** Principle at Metal casting**"–** Heine and Rosenthal - Mc Graw Hill
3. **"** Foundry Technology **"** – O. P Khanna –Dhanpat Rai Publication
4. "Principles of Foundry Technology" – P. C. Rao, Tata McGraw-Hill Education
5. "Foundry Engineering" – Richard L. Little - CBS Publishers & Distributors
6. "CBS Publishers & Distributors "– W. L. Smeltzer - Prentice-Hall

REFERENCE BOOKS:

1. "The Theory and Practice of Metal Casting" – L. A. Davies - Vikas Publishing House
2. "Casting: The Complete Technology Guide" – Stephen A. Peterson - Elsevier Science
3. "Principles of Metal Casting" – Richard W. Heine, Carl R. Loper Jr., Philip C. Rosenthal - McGraw-Hill Education

TH:4(B)- POWDER METALLURGY

L	T	P		Course Code: MTPE303(B)
3	0	0		

Total Contact Hours	Total Marks: 100	**Theory Assessment**
Theory: 45Hrs		End Term Exam 70
		Progressive Assessment 30
Pre-Requisite: Nil		
Credit 3		Category of Course: PE

RATIONALE:

Powder metallurgy (PM) is a cost-effective and versatile manufacturing process used to produce precision components with complex geometries, especially where conventional methods are uneconomical. It plays a key role in the automotive, aerospace, biomedical, electronics, and tool industries. This subject introduces diploma students to the fundamental principles, techniques, and applications of powder metallurgy, including powder production, compaction, sintering, and quality control.

Course Outcomes:

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

1. **Understand** the principles and steps involved in powder metallurgy processing.
2. **Identify** various methods of metal powder production and their characteristics.

3. **Explain** the compaction and sintering processes and how they affect product properties.
4. **Apply** knowledge to select suitable PM processes for real-world industrial applications.

UNIT-I	**Introduction and Powder Production (12 periods)** • Introduction, advantages, limitations, and scope of powder metallurgy • Characteristics of powders: particle size, shape, and distribution • Powder production methods: mechanical (milling), chemical (reduction, precipitation), physical (atomization) • Influence of powder morphology on flowability and compaction behavior • Gas, water, and ultrasonic atomization comparison • Role of powder purity and surface oxide layers in sintering behavior • Nano-powder synthesis using plasma, sol-gel, and spark discharge methods • Use of recycled powders from additive manufacturing waste in PM	12

UNIT- II	**Powder Characterization and Conditioning (10 periods)** • Flow rate, compressibility, apparent and tap density • Blending, mixing, heat treatment, and powder annealing • BET surface area analysis • Role of lubricants and binders in PM mix design • Granulation and spheroidization processes	10
UNIT- III	**Compaction and Sintering (12 periods)** • Uniaxial and isostatic pressing, hot pressing, die design • Sintering stages, solid state and liquid phase sintering, sintering atmospheres • Cold spray and spark plasma sintering (overview) • Defect mechanisms during compaction: lamination, cracking • Activated sintering and pressure-assisted sintering • Microwave sintering and field-assisted sintering technologies (FAST/SPS) • Sintering in controlled microenvironments for nanomaterials	12

UNIT- IV	Secondary Operations and Applications (11 periods) • Coining, sizing, infiltration, impregnation, machining • Industrial applications in automotive, electronics, and tools • PM-based porous filters, bearings, and biomaterials • Mechanical property testing of PM parts (hardness, tensile, fatigue) • Challenges in dimensional tolerances and post-processing • *Metal injection molding (MIM) and binder jetting for precision parts* • *PM in additive manufacturing: hybrid processes (AM + PM sintering)*	11

Text Books

1. **"Powder Metallurgy: Science, Technology and Applications"** by P.C. Angelo & R. Subramanian – PHI Learning Pvt. Ltd.
2. **"Introduction to Powder Metallurgy"** by A.K. Sinha – New Age International Publishers
3. **"Powder Metallurgy: Science, Technology and Applications"** by P.C. Angelo & R. Subramanian – PHI Learning
4. **"Metal Additive Manufacturing"** by John O. Milewski – Springer

Reference Books

5. **"Powder Metallurgy Science"** by R.M. German – Metal Powder Industries Federation (MPIF), USA
6. **"Fundamentals of Powder Metallurgy"** by W.D. Jones – Cambridge International Science Publishing
7. **"Powder Metallurgy: Processing and Applications"** by P. Ramakrishnan – Indian Society for Powder Metallurgy

TH:4(c)- ENVIRONMENTAL DEGRADATION OF MATERIALS

L	T	P		Course Code: MTPE303(C)
3	0	0		

Total Contact Hours	Total Marks: 100	**Theory Assessment**
Theory: 45Hrs		End Term Exam 70
		Progressive Assessment 30
Pre-Requisite: Nil		
Credit 3		Category of Course: PE

RATIONALE:

Environmental degradation of materials significantly affects the durability, reliability, and safety of engineering components. This subject introduces students to the mechanisms of material degradation in different environments, with a focus on corrosion, oxidation, and wear. Understanding these mechanisms and learning preventive methods helps diploma engineers select appropriate materials and surface treatments for prolonged service life, especially in industries such as automotive, chemical processing, infrastructure, and power generation.

Course Outcomes:

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

1. **Understand** various environmental factors that cause degradation of metals and non-metals.
2. **Describe** corrosion mechanisms and differentiate between different corrosion types.
3. **Identify** degradation mechanisms such as oxidation, erosion, and wear.
4. **Recommend** suitable material selection, design, and protection techniques to minimize degradation.

UNIT-I	Introduction to Environmental Degradation (10 periods) • Types of degradation: corrosion, oxidation, wear • Effect of environmental parameters on material behavior • Introduction to environmentally induced cracking (e.g., hydrogen embrittlement) • Classification of degradation in metals, polymers, ceramics, composites • Case studies: failures in marine, aerospace, and nuclear sectors • *Material degradation in renewable energy systems (wind turbines, solar panels)* • *Integration of digital twins and sensors for in-service degradation monitoring*	10 Hrs.

UNIT-II	Corrosion and its Control (13 periods) • Corrosion types: pitting, galvanic, crevice, SCC • Electrochemical principles and prevention techniques • Anodic and cathodic protection in pipelines and ships • Coating types: metallic, polymeric, conversion coatings • Use of corrosion inhibitors in process industries • *Nano-coatings and smart corrosion inhibitors* • *AI-based corrosion prediction systems and real-time monitoring tools*	13 Hrs.
UNIT-III	High Temperature Oxidation and Reactions (10 periods) • Oxide scale formation and kinetics • Protective vs non-protective oxides • Hot corrosion and carburization • Role of alloying elements in high-temperature oxidation resistance • Multilayer oxide systems • Materials for gas turbines, boilers, and heat exchangers • *High-entropy alloys (HEAs) for oxidation resistance* • *Protective ceramic coatings via thermal spray and CVD techniques*	10 Hrs.

UNIT-IV	Mechanical and Environmental Interaction (12 periods) • Wear mechanisms: abrasive, adhesive, erosive • Corrosion-wear synergy • Effect of environment on fatigue and creep • Tribocorrosion and fretting corrosion • Failure analysis of mechanically degraded components • *Surface texturing and laser hardening for wear resistance* • *Hybrid surface engineering (e.g., laser + PVD coatings)*	12 Hrs.

Text Books

1. **"Corrosion Engineering"** by M.G. Fontana – Tata McGraw Hill Publishing Co.
2. **"Introduction to Corrosion Science"** by E. McCafferty – Springer.

Reference Books

1. **"Principles and Prevention of Corrosion"** by D.A. Jones – Pearson Education.
2. **"Oxidation of Metals and Alloys"** by G.C. Wood – Institute of Metals, London.
3. **"Wear of Materials"** by I.M. Hutchings – Cambridge University Press.
4. **"Corrosion and Corrosion Control"** by R.W. Revie and H.H. Uhlig – Wiley India.
5. **"Tribocorrosion of Passive Metals and Coatings"** by D. Landolt – Woodhead Publishing

PR:3(A)- FOUNDRY TECHNOLOGY LABROTORY

L	T	P		
0	0	4		**Course Code: MTPC305(A)**
Total Contact Hours				**Practical Assessment**
Practical		: 60Hrs	**Total Marks: 50**	End Term Exam 15
e				Progressive Assessment 35
Pre-Requisite		**: Nil**		
Credit		**2**		Category of Course: PC

RATIONALE:

The Foundry Technology Laboratory course aims to provide hands-on experience and practical skills in metal casting processes, equipping students with the knowledge and abilities needed for careers in the foundry industry, from pattern making to finishing.

LEARNING OUT COMES:

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

1. Know the Casting Processes

2. Familiarize with various casting methods such as sand casting, shell moulding, die-casting, and investment casting.
3. Learn how to select appropriate materials for casting based on their properties
4. Develop practical skills in pattern design, mould preparation, and the use of core boxes.
5. Gain experience with pouring molten metal into moulds.
6. Appreciate the importance of surface finish and dimensional accuracy in cast parts.

Module-1	1. To determine the tensile strength of the given sand sample by Universal Sand Testing Machine 2. To find the green compression strength of the sand sample by Universal Sand Testing Machine 3. To find the green shear strength of the sand sample by Universal Sand Testing Machine 4. To determine the percentage of clay present in the given sand sample. 5. To determine the permeability number of the given sample of sand. 6. To determine the mould hardness 7. To determine of Grain Fineness Number of given Sand.
Module-2	8. Study of the use of foundry tools and other equipments. 9. To prepare a mould in a sand mould using given pattern 10. To prepare at least one ferrous or non ferrous casting. 11. Vitual Lab on (10 Experiments)

	a) To study and observe various stages of casting through demonstration of sand casting process b) To design and manufacture a wooden pattern for a given casting c) To study core and core making d) To perform strength tests on sands e) To determine the percentage of clay present in base sand f) Determination of mould hardness and core hardness g) To determine permeability number of green sand, core sand and raw sand h) To study the various steps of investment casting process i) To find the distribution of sand grains using a set of sieves and obtain the average grain fineness number j) To prepare a pattern for given object for lost foam casting 12. Use CAD/CAM Software to design one 3D model of Pattern and Mould

TEXTBOOKS:

2. "Metal Casting: Principles and Practice" by T.V. Ramana Rao

3. "Foundry Technology"- Peter R. Beeley- Butterworth-Heinemann (Elsevier)

4. "Principles of Metal Casting"**–** Richard W. Heine, Carl R. Loper, and Philip C. Rosenthal- Mc Graw Hill

5. "Casting: An Introduction to the Theory and Practice of Casting"– J. D. Verhoeven- Springer

6. "ASM Handbook, Volume 15: Casting"

7. "Principles of Foundry Technology" by P.L. Jain

Resources:-

https://msvs-dei.vlabs.ac.in/ajay/mpfclab.html

PR:3(B)- Polymer and Composite Lab

L	T	P		
0	0	4		**Course Code: MTPE305(B)**
Total Contact Hours				**Practical Assessment**
Practical		: 60Hrs	**Total Marks: 50**	End Term Exam 15
Pre-Requisite		**: Nil**		Progressive Assessment 35
Credit 2				Category of Course: PE

RATIONALE:

A polymer composite lab course is to provide practical, hands-on experience in the design, fabrication, and characterization of polymer composites, equipping students with the skills needed for research, development, and industry applications in materials science and engineering.

LEARNING OUT COMES:

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

1. Familiarize students with the basics of polymers and their behavior.
2. Get the students a hands-on experience on fabrication of various composites and their characterization techniques and effects of various constituents' on the mechanical behavior of the resulting composite material.
3. Study Mechanical behaviour of various composites.

List of Experiments:

1. Fabrication of polymer test specimen using injection moulding technique.
2. Tensile testing of polymer specimen fabricated in the laboratory using UTM.
3. Preparation of multi layered glass fiber reinforced composite using hand laying method.
4. Determination of tensile strength of polymer matrix composite material using UTM.
5. Determination of compressive strength of polymer matrix composite material using UTM.
6. Fabrication of a metal matrix composites (Cu-Al_2O_3).
7. Determination of green and sintered densities of metal matrix composite.
8. Hardness measurement and microstructure analysis of pure Cu and Cu-Al_2O_3 composites.

TEXTBOOKS:

1. “Composite Materials: Science and Engineering”, K K Chawla, Springer.
2. Polymer Science by V R Gowariker, N V Viswanathan, Jayadev Sreedhar, New Age International Publisher
3. “Fiber reinforced Composites: Materials, Manufacturing, and Design”, P K Mallick, CRC Press.
4. “A text book for polymer chemistry”, M S Bhatnagar, S.Chand publications.
5. "Mechanical Metallurgy" – *George E. Dieter* (*McGraw-Hill Education*).
6. "Testing of Metallic Materials" – *A.V.K. Suryanarayana* (*BS Publications*).

REFERENCE BOOKS:

6. "Materials Science and Engineering: An Introduction" – William D. Callister, Jr., Wiley.
7. “Fundamentals of polymer science”, Paul C Painter, CRC press.
8. "Mechanical Behaviour of Materials" – W.F. *Hosford* (*Cambridge university press*).
9. "Fundamentals of Materials Science and Engineering" – *William F. Smith* (*McGraw-Hill Education*).

PR:3(C)- MATERIAL CHEMISTRY LABORATORY

L	T	P		Course Code: MTPE305 (C)	
0	0	4			
Total Contact Hours				**Practical Assessment**	
Practical		: 60Hrs		End Term Exam	15
				Progressive Assessment	35
Pre-Requisite		**: Nil**	**Total Marks: 50**	Category of Course: PC	

RATIONALE:

Material Chemistry Laboratory provides hands-on exposure to chemical analysis and synthesis techniques relevant to materials science and metallurgy. This lab complements theoretical understanding by allowing students to experimentally determine properties like composition, corrosion resistance, pH behavior, and reactions related to metals, alloys, ceramics, and polymers. It enhances their skills in handling chemicals, laboratory instruments, and developing an analytical approach to solve engineering problems.

Course Outcomes:

After completing this lab course, students will be able to:

1. **Demonstrate** basic experimental skills in analytical and synthesis techniques of materials.
2. **Analyze** the chemical behavior and composition of metallic and non-metallic materials.
3. **Correlate** chemical properties with performance and degradation of materials.
4. **Apply** safety, accuracy, and standard practices in a metallurgical chemistry laboratory.

List of Experiments

1. Gravimetric Estimation of Iron

- Aim: To estimate the percentage of iron using the precipitation method.

2. Volumetric Estimation of Copper by Iodometry

- Aim: To determine the amount of copper in a given alloy sample.

4. Determination of Chromium Content in Stainless Steel

- Aim: To estimate Cr content through redox titration using potassium permanganate.

5. Preparation of Sol-Gel Derived Ceramic Oxide (e.g., ZnO, TiO_2)

- Aim: To understand sol-gel synthesis and observe nanoparticle formation.

6. Corrosion Rate Measurement of Mild Steel in Acidic Media

- Aim: Weight loss method to determine corrosion rate under controlled conditions.

7. Determination of pH and Conductivity of Industrial Electrolytes

- Aim: Use of pH meter and conductivity meter for metallurgical solutions.

8. Electroplating of Metals (Copper/Nickel Coating on Steel Substrate)

- Aim: To study deposition process and observe uniformity and thickness.

9. Synthesis of a Coordination Complex (e.g., $[Fe(SCN)_6]^{3-}$)

- Aim: To understand complexation reactions used in analytical chemistry.

10. Preparation and Characterization of a Polymer Composite (e.g., Epoxy + Filler)

- Aim: To prepare and observe changes in mechanical/visual properties.

11. Flame Test and Colorimetric Detection of Metal Ions

- Aim: Identification of elements based on flame color and reaction color changes.

12. Fabrication of Activated Carbon Electrode for Supercapacitor

- **Aim**: To prepare and coat activated carbon slurry on a current collector (e.g., graphite foil or nickel) for supercapacitor application.

13. Preparation of Zinc or Manganese Dioxide Electrode for Alkaline Battery

- **Aim**: To fabricate a metal oxide-based electrode (e.g., MnO_2 cathode) and test its open circuit potential (OCP).

14. Cyclic Voltammetry (CV) of Supercapacitor Electrode

- **Aim**: To characterize fabricated supercapacitor electrodes using cyclic voltammetry.

15. Galvanostatic Charge-Discharge (GCD) Testing of Battery or Supercapacitor Electrode

- **Aim**: To evaluate electrode performance using charge-discharge cycling at constant current.

16: Fabrication of Lithium Battery Electrode Using Air-Sensitive Material (e.g., $LiFePO_4$ or LTO) in Glove Box

- **Aim**:
  To fabricate lithium-ion battery electrodes inside a glove box to prevent oxidation or moisture contamination of sensitive materials like $LiFePO_4$ (cathode) or LTO (anode).

17: Electrochemical Testing of Supercapacitor Electrodes in Glove Box Using Organic Electrolyte

- **Aim**:
  To test activated carbon electrodes for supercapacitor applications using organic electrolyte (e.g., $TEABF_4$ in acetonitrile) under inert atmosphere.

SAFETY CONSIDERATIONS:

General Safety:

1. Always wear **lab coat, safety goggles, and gloves** during experiments.
2. Tie back long hair and avoid loose clothing or accessories.
3. **No eating, drinking, or chewing** is permitted in the lab.
4. Familiarize yourself with the **location and use of fire extinguishers, eye wash stations, and chemical spill kits**.

Chemical Handling:

5. Handle **acids, bases, and organic solvents** with extreme care; use a **fume hood** when necessary.
6. Never directly inhale fumes from reagents—use **wafting technique** if smell identification is needed.
7. **Label all containers** clearly before use.
8. **Always add acid to water**, not the reverse, to avoid exothermic splashes.

Waste Disposal:

9. Dispose of **chemical waste** in labeled containers—never pour down the sink without instruction.
10. Segregate organic and inorganic wastes as per lab protocols.

Glassware & Instruments:

11. Inspect **glassware for cracks** before using; dispose of broken glass in the designated container.
12. Turn off **hot plates, pH meters, and balances** after use.
13. Clean all equipment and **wipe bench tops** before leaving.

Emergency Preparedness:

14. In case of skin/eye contact with chemicals, rinse immediately with plenty of water and report to the instructor.
15. Report all accidents, spills, or injuries **immediately** to the Laboratory Assistant/ Faculty In Charge.

Text Books

1. **"Engineering Chemistry (with Laboratory Manual)"** – Jain & Jain
   Publisher: Dhanpat Rai Publishing Co.
2. **"Laboratory Manual on Engineering Chemistry"** – S.S. Dara
   Publisher: S. Chand & Company Ltd.
3. **"Electrochemical Methods: Fundamentals and Applications"** – Allen J. Bard, Larry R. Faulkner
   Publisher: Wiley
4. **"Practical Electrochemistry: A Laboratory Manual"** – N. S. Gajbhiye
   Publisher: Narosa Publishing

Reference Books

1. **"Analytical Chemistry for Technicians"** – John Kenkel
   Publisher: CRC Press
2. **"Nanomaterials for Energy Conversion and Storage"** – Qingyi Lu et al.
   Publisher: Springer
3. **"Materials Chemistry"** – Bradley D. Fahlman
   Publisher: Springer
4. **"Green Chemistry: Theory and Practice"** – Paul Anastas, John Warner
   Publisher: Oxford University Press

TH:5(A)- UNIVERSAL HUMAN VALUES

L	T	P		
3	0	0		**Course Code: OE301A**
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: OE

RATIONALE:

The Universal Human Values (UHV) course is designed to help diploma students develop a strong ethical foundation, nurturing responsible individuals who contribute positively to society. In an era driven by rapid technological advancements, it is crucial for

students not only to gain technical expertise but also to cultivate values that promote harmony, respect, and sustainability.

LEARNING OUTCOMES:

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

- Identify fundamental human aspirations such as happiness and prosperity.
- Differentiate between the self and the body and understand their respective needs.
- Practice self-reflection to improve decision-making, emotional balance, and personal growth.
- Develop respectful and trustworthy relationships within family, friends, and society.
- Explain the role of values like trust, respect, and love in building strong social bonds.
- Promote cooperation and harmony within communities through ethical practices.

DETAILED COURSE CONTENTS:

Unit No.	Topic/Sub-Topic	Allotted Time (Hours)
I	**Introduction to Value Education and Human Values:** Concept and Need for Value Education - Understanding the importance of value education in personal and professional life, Differentiating between values and skills. Basic Human Aspirations - Exploring fundamental human aspirations: happiness and prosperity, Methods to achieve these aspirations through right understanding and relationships.	8
II	**Harmony in the Human Being:** Understanding the Self - Differentiating between the 'Self' (I) and the Body, Understanding the needs of the Self and the Body, Harmony of the Self with the Body - Ensuring the harmony of 'I' with the Body, Practices for mental and physical well-being.	8
III	**Harmony in the Family and Society:** Family as the Basic Unit of Society - Understanding values in human relationships, Trust and respect as the foundational values in relationships, Harmony in Society - The concept of an undivided society, Universal human order and world family.	8
IV	**Harmony in Nature and Existence:** Interconnectedness in Nature - Understanding the four orders of nature: material, plant, animal, and human, Mutual fulfillment among these orders, Co-existence in Existence - Holistic perception of harmony in existence, Role of human beings in maintaining environmental balance.	8
V	**Professional Ethics:** Ethical Human Conduct - Integrating values into professional life, Concept of professional ethics and accountability, Case Studies in Professional Ethics - Analyzing real-life scenarios to understand ethical dilemmas, Developing solutions based on universal human values.	8
VI	**Personal Development and Social Responsibility:** Self-Reflection and Self-Exploration - Techniques for self-assessment and personal growth, Setting personal goals aligned with universal values, Social Responsibility - Understanding one's role in society, Participating in community service and social initiatives.	5
Total		45

REFERENCES:

1.	R. R. Gaur, R. Asthana, G. P. Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019.
2.	R. R. Gaur, R. Asthana, G. P. Bagaria, Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019.
3.	A. Nagraj, JeevanVidya: EkParichaya, Amarkantak, 1999.
4.	A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.
5.	Moral Thinking: An Introduction To Values And Ethics, Vineet Sahu, IIT Kanpur: https://onlinecourses.nptel.ac.in/noc23_hs89/preview

TH:5(B)- LEADERSHIP AND MANAGEMENT SKILLS

L	T	P		
3	0	0		**Course Code: OE301B**
Total Contact Hours				**Theory Assessment**
Theory		: 45Hrs		End Term Exam 70
			Total Marks: 100	Progressive Assessment 30
Pre-Requisite		**: Nil**		
Credit		**3**		Category of Course: OE

RATIONALE:

This course/subject on Leadership and Management Skills for students undergoing Diploma programmes is an exploration in leading and managing people, majorly in education based on sound and acceptable principles and theories for effective leadership. The leadership skills will enable them to take initiative, guide team efforts, motivate peers, and ensure effective collaboration. They'll learn how to delegate tasks, resolve conflicts, and foster a positive team environment. The management skills will help them in organizing tasks, setting timelines, and ensuring efficient workflow within a team.

It is expected that the students will be able to handle projects with better project outcomes and a earn a more productive learning experience. This will benefit their academic journey, future careers, and overall professional development:

LEARNING OUTCOMES:

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

- Explain the principles of management
- Collaborate across cultures for effective team work
- Communicate with people for a positive work culture
- Demonstrate personal dispositions, skills & abilities of a leader
- Undertake the process of change management
- Design training for staff development
- Adapt suitable leadership style for improved work efficiency.

DETAILED COURSE CONTENT:

Unit No.	Topic/Sub-Topic	Allotted Time (Hour)
I	**Leadership & Management, concept, principles.** • Definition of leadership, management • Leadership theories • Leadership characteristics • Principles of management • Managerial functions • Leader v/s Manager, Leader/Manager traits and character • Leadership Styles	10
II	**Human Resource Management in Organizations** • Human Resource Management: Meaning, Nature, Objectives, Scope • Job & Job analysis. • Staff Development: Need and Objectives of Staff Development, Approaches • Training & development • Organizational Development: Components of OD process. • Learning organization	10

III	**Personal disposition, skills & abilities of leaders** • Self-awareness • Leadership characteristics, traits • Leadership skills & abilities • Emotional intelligence & its components, importance in leadership • Communication skills for effective leadership, barriers to effective communication, Active Listening, Mindful listening. • Leading & Mentorship – Influencing & mentoring	09
IV	**Leader's role in Motivating, Inspiring and Transformative leadership, nurturing team-work** • Goal setting & leadership • Transformative Leadership, vision & envisioning • Motivational role of leader in people management • Group & team • Team dynamics • Conflict management, strategies in managing conflicts	08
V	**Change Management & Leadership** • Models of change • Forces driving change • Change Management – process, goal, importance • The process of change happening in an organization • Key aspects of leadership in change management – responsibilities of a change leader.	08

SUGGESTED ACTIVITIES:

- Group/individual presentation on the basic principles of leadership and management, Discussion on readings - Individual or group presentation of assigned topics in class on leadership and management principles and theories.
- Activities on Envisioning, Goal setting
- ACTION PLAN to be prepared

REFERENCES:

1.	Theories of Educational Leadership and Management (3rd ed.), by Bush, Tony (2003). SAGE Publications, Ltd.
2.	The inspiring leader: unlocking the secrets of how extraordinary leaders motivate. By Zenger, John, Joseph Folkman, and Scott Edinger (2009). New York: McGraw Hill Press.
3.	Knowing yourself. On becoming a leader: the leadership classic. By Bennis, Warren (2009). New York: Basic Books.
4.	Leading Change. By P. Kotter, Harvard Business, 2012.
5.	The Fifth Discipline. By Peter M. Senge, Crwon Currency, 2006.
6.	The Leadership Sutra: An Indian Approach to Power. By Devdutt Pattanaik, – Penguin Random House, 2017.
7.	Leadership and Management. By Dr. A. Chandra Mohan. Himalaya Publishing House, 2010.

TH:5(C)- PROFESSIONAL SKILLS

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="7">Total Marks: 100</td><td colspan="2">Course Code: OE301C</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>
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RATIONALE:

The term, “Professional skills” carries significant weight in the job market and career development. This open elective course explores various types of professional skills, their significance, and how they can be cultivated and harnessed for career progression. By understanding the landscape of professional skills, student can better position himself or herself for success in the competitive job market. It is crucial to continuously update and adapt the professional skills to stay ahead in a rapidly changing work environment. By investing in professional development, one can enhance employability and open doors to new opportunities.

LEARNING OUTCOMES:

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

- Demonstrate Self-competency and Confidence
- Practice Emotional Competency
- Work in a team work or in collaboration
- Demonstrate problem solving and decision making skills
- Apply time management strategies and techniques effectively
- Apply professional ethics and integrity in professional and personal life

UNIT NO.	CONTENT	ALLOTTED TIME (HOURS)
I Communication Skills:	• Active listening • Verbal and non-verbal communication • Written communication • Presentation skills • Conflict resolution	08
II Teamwork and Collaboration:	• Building trust within a team • Effective collaboration strategies • Role delegation and responsibility sharing • Conflict resolution within a team	08
III Problem-Solving:	• Identifying root causes of issues • Generating solutions and evaluating options • Decision-making under pressure • Critical thinking skills • Triple constraint issues	08
IV Time Management:	• Prioritization and task management • Setting realistic deadlines • Effective time planning and organization	06
V Emotional Intelligence:	• Self-awareness and emotional regulation • Empathy and understanding others' emotions • Managing interpersonal relationships • Motivation • Social skills • Emotional Intelligence (EQ) • Stress management	08
VI Professional Ethics and Integrity:	• Workplace ethics and code of conduct • Confidentiality and data privacy • Professional accountability- • Important Considerations:	07

REFERENCES:

1. Dr. Vitthal Gore: Professional Skills for 21st Century: A Key to Success: Blue Rose- ACADEMIC
2. The ACE of Soft Skills: Attitude, Communication and Etiquette for Success: PEARSON
3. The essence of Leadership: S. Manikutty: Bloomsbury

SUMMER INTERNSHIP II: 3 to 4-WEEK INTERNSHIP AFTER 4TH SEMESTER

L	T	P		
0	0	0		**Course Code: MTSI301**
Total Contact Hours			**Total Marks: 50**	**Internship Assessment**
Internship :				End Term Exam 15
				Progressive Assessment 50
Pre-Requisite : Nil				
Credit 2				Category of Course: SI

PR:4- MAJOR PROJECT

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="7">Total Marks: 50</td><td colspan="2">Course Code: MTPR301</td></tr>
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<tr><td colspan="3">Project : 60Hrs</td><td colspan="2">Progressive Assessment: 35 :</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: PR</td></tr>
</table>

RATIONALE:

Mini-projects help students in different ways like the formation of groups, understanding group behavior, improving communication skills, learning in-depth with minimum time, interaction with the guide and outside agencies, thinking about final year projects, etc. it is observed that students are always excited to work on "something new topic in Engineering" because of their interest in learning in the implementation of knowledge in actual fields rather than classes. It will be appreciated if students involve some experimental works, case studies, site visits, and industrial projects, if possible.

The procedure of Evaluation: Normally, evaluation of mini-projects is done through presentations by a group of students in front of two or more faculty, and assessment of the individual student is done by faculty and the average of marks is worked out.

LEARNING OUTCOMES:

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

- Integrate their knowledge and skills to develop prototype models in their field.
- Develop professional values and ethical standards.
- Handle real life challenges by making effective decisions to complete a project work.
- Show skills in developing real world applications

STUDENT'S ACTIVITY:

Students will do their project work as per guidance from their guide (faculty member).

A suggestive criterion for assessing student performance by the external (preferably person from industry) and internal (teacher) examiner is given in table below:

Sl. No.	Performance Criteria
1.	Selection of project assignment
2.	Planning and execution of considerations
3.	Quality of performance
4.	Providing solution of the problems or production of final product
5.	Sense of responsibility
6.	Self expression/ communication/ Presentation skills
7.	Interpersonal skills/human relations
8.	Report writing skills
9	Viva voce

The teachers are free to evolve other criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organizations to such an exhibition.