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	Steel making		3	0	0	70	30	-	-	100	3
2		MTPC303 TH:2	Heat treatment		3	0	0	70	30	-	-	100	3
3		MTPC305 PR:1	Foundry technology lab		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) PE1B (c) PE1C		3	0	0	70	30	-	-	100	3
6		MTPE303 (Any one) TH:4	a) Foundry technology (b) PE2B (c) PE2C		3	0	0	70	30	-	-	100	3
7		MTPE305 (Any one) PR:3	(a) Polymer composite lab (b) PELab1B (c) PELab1C		0	0	4	-	-	15	35	50	2
8	Open Elective	Open Elective - I OE301 (Any one) TH:5	a. Universal Human Values (OE301A) b. Leadership and Management Skills (OE301B) c. Professional Skills (OE301C)		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**

***4 – 6 weeks internship after 4th Semester;**

Note : a) In Semester- V, 5 Nos. of Theory Courses and 4 Nos. Laboratory (including Major Project) to be followed.

FIFTH SEMESTER

TH:1- STEEL MAKING

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="6">Total Marks: 100</td><td colspan="2">Course Code: MTPC301</td></tr>
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RATIONALE:

A steelmaking course is crucial for understanding the processes involved in converting ironmaking raw materials into steel products, covering everything from basic principles to advanced technologies and ensuring a well-trained workforce for a vital industry.

LEARNING OUT COMES:

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

1. Understand the Fundamentals of Steelmaking
2. Explore Raw Materials and Their Preparation
3. Introduce the various steelmaking methods, including Basic Oxygen Furnace (BOF), Electric Arc Furnace (EAF), and Ladle Metallurgy.
4. Explain the importance of slag formation, its functions, and process control techniques for achieving desired steel quality.
5. Develop an understanding of environmental considerations and modern practices for minimizing emissions and optimizing resource utilization in steelmaking.

Module 1	**Introduction to Steel Making:**	**(5hrs)**
	• Principle of steel making, role of impurity and alloying element • Overview of common grades of steel and their composition • Raw Materials for Steel Making, reactions involved in steel making, acid & basic process of steel making. • Conditions required in removal of Si, P, S, Mn and C in steel making, basic Thermodynamics and Kinetics of Steelmaking Reactions • Role of Slag in Steelmaking • Bessemer steel making, Open hearth steel making process with emphasizing their demerits	

Module 2	**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.	**(15hrs)**
	• Process Control and Automation in Primary Steelmaking **Other Steel Making Processes** Working principle, process, advantage and limitations of: • OLP process • OBM Process	

Module 3	**Electric Arc Furnace and Induction Furnace Process** • Principle, types of slags prepared by electric arc furnace, steps of electric arc furnace heating to produce steel, advantages of electric arc furnace process • Principle and process of induction furnace, advantages and limitations of induction furnace process. **De-Oxidation Practice** • De-Oxidisers and their use • Killed, semi killed and rimming steel	**(10hrs)**
Module 4	**Secondary Steel Making Process** • Objectives of secondary steel making • Principle of operation and advantages of secondary steel making processes such as: • LHF Process, VAD Process, AOD Process (stainless steel making to be emphasized) and RH-OB degassing process, Inclusion Control and Clean	**(15hrs)**

	Steel Production, Process Control and Automation in Secondary Steelmaking **Continuous Casting of Steel** • Principle and operation of continuous casting, types of casters, advantages of continuous casting, products of Continuous casting. **Pit Side Practice** • Teeming methods such as: Direct pouring , Tundish teeming and Bottom teeming • Ingot defects, their causes and remedies **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 Steel Making by R H Tupkary, Khanna publishers.
2. Steel making by A.K. Chakrabarti, PHI Learning.
3. Ironmaking and Steelmaling by A.Ghosh and A. Chatterjee, PHI Learning.
4. Manufacture of Iron And Steel Vol I & II Bashforth- Asia Publishing House, Mumbai.

REFERENCE BOOKS:

1. Principles of Secondary Processing and Casting of Liquids Steel by Ahindra Ghosh.; Pub: South Asia books.
2. First Course in Iron and Steel Making by Dipak Majumdar, University Press; IIM.
3. Secondary Steel making by A. Ghosh, CRC Press.
4. Making, Shaping and Treating of Steels, A. W. Cramb (Editor) (11th Edition, Vol. 1 & 2, AISE, Pittsburg)
5. Introduction to Physical Chemistry of Steel Making :- R.G.Ward, ELBS.
6. Steel Making; Kudrin V. Mir Publisher, Moscow, 1985

TH:2- HEAT TREATMENT

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="2">Total Marks: 100</td><td colspan="2">Course Code: MTPC303</td></tr>
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<tr><td colspan="3">Pre Requisite : Nil</td><td colspan="2" rowspan="2">Category of Course : PC</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- FOUNDRY TECHNOLOGY LABROTORY

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="8">Total Marks: 50</td><td colspan="2">Course Code: MTPC305</td></tr>
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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.

(Students are required to perform at least Six experiments, include at least two experiments from each modules)

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) Tostudy and observe various stages ofcastingthrough demonstration of sandcasting process b) To design and manufacture a woodenpattern 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 presentin base sand f) Determination of mould hardness and corehardness g) To determine permeability number of greensand, core sand and raw sand h) To study the various steps of investmentcasting process i) To find the distribution of sand grains using a set of sieves and obtain the averagegrain fineness number j) To prepare a pattern for given object forlost foam casting 12. Use CAD/CAM Software to design one 3D model of Pattern and Mould

TEXTBOOKS:

1. "Metal Casting: Principles and Practice" by T.V. Ramana Rao
2. "Foundry Technology"- Peter R. Beeley- Butterworth-Heinemann (Elsevier)
3. "Principles of Metal Casting"– Richard W. Heine, Carl R. Loper, and Philip C. Rosenthal- Mc Graw Hill
4. "Casting: An Introduction to the Theory and Practice of Casting"– J. D. Verhoeven- Springer
5. "ASM Handbook, Volume 15: Casting"
6. "Principles of Foundry Technology" by P.L. Jain

Resources:-

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

PR:2- Heat Treatment Laboratory

L	T	P		
0	0	4		**Course Code: MTPC307**
Total Contact Hours			**Total Marks: 50**	**Theory Assessment**
Theory		: 60Hrs		End Term Exam 15
				Progressive Assessment 35
Pre Requisite		**: Nil**		Category of Course : PC
Credit		**2**		

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.

	○ Measurement of residual stresses before and after stress relieving (if equipment available). ○ Assessment of changes in mechanical properties.
Module 2: Hardening and Tempering	5. **Hardening (Quenching):** ○ Hardening of different grades of steel using various quenching media (water, oil, brine). ○ Effect of quenching rate on hardness. ○ Jominy End Quench Test. 6. **Tempering:** ○ Tempering of hardened steel samples at different temperatures. ○ Observation of changes in hardness and microstructure with tempering temperature. ○ Development of tempering curves. 7. **Austempering /Martempering (If possible):** ○ Demonstration of austempering and mar tempering processes. ○ 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

7. **"Heat Treatment of Metals - Laboratory Handbook"**

- **Authors:** *I. M. Mundle*
- **Publisher:** Springer.

9. **"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- ADVANCED MATERIALS

L	T	P		
3	0	0		**Course Code: MTPE301**
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:4- FOUNDRY TECHNOLOGY

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="9">Total Marks: 100</td><td colspan="2">Course Code: MTPE303</td></tr>
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<tr><td colspan="2">Theory</td><td>: 45Hrs</td><td>End Term Exam</td><td>70</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 (5 Hours)** 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 (15 Hours)** 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 (15 Hours)** 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(10 Hours)** 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

PR:3- Polymer and Composite Lab

<table>
<tr><td>L</td><td>T</td><td>P</td><td rowspan="6">Total Marks: 50</td><td colspan="2">Course Code: MTPE305</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td colspan="2">Theory Assessment</td></tr>
<tr><td colspan="3">Total Contact Hours</td><td>End Term Exam</td><td>15</td></tr>
<tr><td colspan="3">Theory : 60Hrs</td><td>Progressive Assessment</td><td>35</td></tr>
<tr><td colspan="3">Pre Requisite : Nil</td><td colspan="2">Category of Course : PE</td></tr>
<tr><td colspan="3">Credit 2</td><td colspan="2"></td></tr>
</table>

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:

(Student are required to perform at least five 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*).

TH:5(a)- UNIVERSAL HUMAN VALUES

L	T	P		Course Code: OE301A	
3	0	0			
Total Contact Hours					
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>
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<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:	05

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: 6-WEEK INTERNSHIP AFTER 4TH SEMESTER

L	T	P	**Total Marks: 50**	**Course Code: MTSI301**	
0	0	0			
Total Contact Hours				**Theory Assessment**	
Theory		: 45Hrs		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="8">Total Marks: 50</td><td colspan="2">Course Code: MTPR301</td></tr>
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<tr><td colspan="3">Total Contact Hours</td><td colspan="2">Theory Assessment</td></tr>
<tr><td colspan="2">Theory</td><td>: 60Hrs</td><td>End Term Exam: 15</td><td>:</td></tr>
<tr><td colspan="3"></td><td>Progressive Assessment: 35</td><td>:</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>
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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.