O. P. Jindal University

Raigarh–Chhattisgarh

Scheme and Syllabus

of

B.Tech

School of Engineering

Session- 2025-29

O. P. JINDAL UNIVERSITY

O. P. Jindal Knowledge Park, Punjipathra, Raigarh-496109

PROGRAM OUTCOMES (POS): At graduation, students will be able to: (From AY: 24-25)

(refer next page for WK1 – WK9 (Knowledge and Attitude Profile)

PO-1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO-2	**Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO-3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

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Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM SPECIFIC OUTCOMES - At graduation, students will be able to provide:

PSO1: Applying Mechanical Engineering to Global Challenges

Develop an attitude to meet global challenges and apply the knowledge of mechanical engineering to solve problems related to thermal, design, manufacturing, and interdisciplinary fields.

PSO2: Technology-Driven Solutions for Industry & Society

Demonstrate knowledge and skill for solving social, real industrial problems using modern software and hardware tools.

PSO3: Utilizing Mechanical Engineering for Emerging Technologies

Utilizing the knowledge of Mechanical Engineering to work effectively in cutting edge technologies such as Robotics, Artificial Intelligence, Mechatronics, and Automation.

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Curriculum and Credit Framework for Undergraduate Programme (CCFUP)									
Semester	MAJOR		MINOR	AEC	SEC	Internship/ Apprentice-ship/Project/ Community outreach	VAC	MDC	Total Credits
	DSC	DSE							
I	16			2	2		2		22
II	13			2	2		2	3	22

* *Students on exit shall be Awarded Undergraduate Certificate (in the Field of Study/ Discipline) after securing the requisite 44 credits in Semesters I and II and complete one vocational course of 4 credits during the summer* [illegible]

AEC: Ability Enhancement Course **SEC: Skill Enhancement Course**

VAC: Value addition Course **MDC: Multidisciplinary Course**

Level of courses: There will be 5 level of courses on the basis of learning outcome and difficulty levels distributed across semesters in ascending order.

Level-1 (0-99), Level-2 (100-199), Level-3 (200-299), Level-4 (300-399), Level-5 (400-499) courses shall be pre-requisite, introductory, intermediate, higher level, and advanced courses respectively.

DEGREE	MAJOR		MINOR	AEC	SEC	INTERNSHIP/ PROJECT	VAC	MDC	TOTAL CREDIT
	CORE	ELECTIVE							
Honors	106	12	24	8	9	8	6	9	182
Honors with Research	94	12	24	8	9	20	6	9	182

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Course Structure for B. Tech Program (1st & 2nd Semester)-2025-29 batch

(School of Engineering, Common to all departments)

Year	Sem	Course Code	Course Category	Name of the Course	Hours per week			Scheme of Examination and Marks				Credits : L+ T+ (P/2)
					L	T	P	PRE		ESE	Total	
								MID	TA			
FIRST SEMESTER (NHEQF Level: 4.5)												
First Year	1st	MAT24-B-MJ111	MAJOR	Engineering Mathematics-I	3	0	0	15	15	70	100	3
		PHY24-B-MJ111	MAJOR	Applied Physics	2	0	0	7.5	7.5	35	50	2
		EE24-B-MJ101	MAJOR	Basic Electrical and Electronics	3	0	0	15	15	70	100	3
		ME24-B-MJ101	MAJOR	Engineering Graphics	2	0	2	15	15	70	100	3
		MME24-B-MJ101	MAJOR	Introduction to Engineering Materials	3	0	0	15	15	70	100	3
			AEC	Choose from the Pool	2	0	0	7.5	7.5	35	50	2
			SEC	Choose from the Pool	2	0	0	7.5	7.5	35	50	2
					0	0	4	-	15	35	50	
			VAC	Choose from the Pool	2	0	0	7.5	7.5	35	50	2
		EE24-B-MJ102	MAJOR	Basic Electrical and Electronics Lab	0	0	2	-	15	35	50	1
		ME24-B-MJ102	MAJOR	Innovation and Skill Development	0	0	2	-	15	35	50	1
												22

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Course Structure for B. Tech Program (1st & 2nd Semester)-2025-29 batch

(School of Engineering, Common to all departments)

Year	SEM	Course Code	Course Category	Name of the Course	Hours per week			Scheme of Examination and Marks				Credits: L+ T+ (P/2)
					L	T	P	PRE		ESE	Total	
								MID	TA			
				SECOND SEMESTER (NHEQF Level: 4.5)								
First Year	IInd	MAT24-B-MJ112	MAJOR	Engineering Mathematics-II	3	0	0	15	15	70	100	3
		CHE24-B-MJ111	MAJOR	Applied Chemistry	2	0	0	7.5	7.5	35	50	2
		ME24-B-MJ103	MAJOR	Fundamentals of Mechanics	3	0	0	15	15	70	100	3
		CSE24-B-MJ101	MAJOR	Python Programming	3	0	0	15	15	70	100	3
			AEC	Choose from the pool	2	0	0	7.5	7.5	35	50	2
			SEC	Choose from the pool	2	0	0	7.5	7.5	35	50	2
					0	0	4	-	15	35		
			VAC	Choose from the pool	2	0	0	7.5	7.5	35	50	2
			MDC	Choose from the pool	3	0	0	15	15	70	100	3
		ME24-B-MJ104	MAJOR	Mechanics Lab	0	0	2	-	15	35	50	1
		CHE24-B-MJ112	MAJOR	Applied Science Lab	0	0	2	-	15	35	50	1
												22

Exit option to qualify for Undergraduate Certificate (after completion of 1st year)

1. An exit option is available for students those who have earned the total 44 credits at the End of Second Semester.
2. Student who wants to avail the exit option after first year have to earn additional 4 credits from the list of courses shown below.
3. These courses student have to complete within summer vacation after 1st Year.
4. After fulfillment as mentioned in 1 to 3 above, Students can earn U.G Certificate and same will be issued by the University.

List of Exit Courses (Choose Any *TWO* Skill-based Courses)

S. N.	Courses Code	Name of the Courses	L	T	P	Credit	Scheme of Examination and Marks			
							PRE		ESE	Total
							MID	TA		
1	CE24-B-EC101	Computer-Aided Drawing with AutoCAD	0	0	4	2	-	15	35	50
2	CSE24-B-EC101	Basic Computer Skills	0	0	4	2	-	15	35	50
3	CSE24-B-EC102	Computer Hardware Skills	0	0	4	2	-	15	35	50
4	EE24-B-EC101	Electrical Wiring & Testing	0	0	4	2	-	15	35	50
5	ME24-B-EC101	Advanced Mechanical Workshop	0	0	4	2	-	15	35	50

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Program:	B. Tech.	Semester:	After 1st Year
Name of the Course:	Advanced Mechanical Workshop	Course Code:	ME24-B-EC101
Credits:	2	No of Hours:	4 hrs. / week
Max Marks:	50		

Course Descriptions:

This course provides hands-on training and practical exposure to basic manufacturing processes and advanced mechanical workshop practices essential for mechanical and production engineering students. The course is designed to familiarize students with the operation of hand tools, machines, and manufacturing techniques used in fitting, carpentry, welding, foundry, and machining shops. Students will perform a series of structured practical tasks to understand the material properties, working principles, and safety procedures of various fabrication and machining processes. The course aims to build foundational technical skills and promote confidence in handling real-world engineering problems related to fabrication, assembly, and component production.

Course Outcomes:

After Completion of the course, Students will be able to:

CO Number	Course Outcome
CO1	Create wooden components and joints (like mortise and tenon) and develop simple wooden products using carpentry tools.
CO2	Create wooden components and joints (like mortise and tenon) and develop simple wooden products using carpentry tools.
CO3	Perform basic welding operations including butt-joint, lap-joint, and fabrication of components using arc welding and spot-welding techniques.
CO4	Apply the foundry process by preparing molds using patterns and casting non-ferrous metals and complex shapes.
CO5	Operate basic machine tools like lathe, shaper, and milling machines to produce parts with eccentric, dovetail, and pocketing operations.

Experiments to be performed (Minimum Ten experiments)

Fitting Shop

1. Making a V- groove job using fitting tools.
2. Making a step cutting job using fitting tools.
3. Making a male-female joint using fitting tools.

Carpentry Shop

1. Making a two-piece pattern using carpentry tool.
2. Making a mortise and tenon joint using carpentry tools.
3. Making a laptop stand using carpentry tools (Combined job).

Welding Shop

1. Making a Butt-Joint using virtual welding 2.O.
2. Making a Lap-joint using spot welding.
3. Fabricating a steel chair using electric arc welding (Combined Job).

Foundry Shop

1. Preparing a mold using a two-piece pattern.
2. Casting of a non-ferrous metals using two-piece pattern.
3. Casting of a sculpture using metal pattern (Combined job).

Machine Shop

1. Preparing an eccentric job on a lathe machine.
2. Performing dovetail cutting operation on a shaper machine.
3. Performing circular pocketing operation on a milling machine.

List of Tools/Equipment/Machines Required:

1. Fitting tools.
2. Carpentry tools
3. Welding machines (MMAW/Virtual 2.0/Spot) and equipment.
4. Muffle furnace.
5. Lathe Machine.
6. Shaper Machine.
7. Milling Machine.

CO, PO, & PSO Correlation

CO Number	Program Outcome											PSOs		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	3	1	2	1	1	2	2	1	2	3	2	-
CO2	3	2	3	1	2	1	1	2	2	1	2	3	2	-
CO3	3	2	3	2	3	2	1	2	2	2	2	3	3	-
CO4	3	2	3	3	3	2	2	2	2	2	2	3	3	-
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	-

Note: 1: Low 2: Moderate 3: High

O.P. Jindal University

School of Engineering

Department of Metallurgical Engineering

Board of Studies (BoS)

Minutes of Meeting

- **Meeting Title:** Board of Studies Meeting
- **Date:** April 25, 2025
- **Time:** 3:00 PM – 4:00 PM
- **Location / Platform:** Online – Zoom Platform

5. Dr. M. Kalyan Phani
   Head – Metallurgical and Mining Engineering, O.P. Jindal University
6. Dr Guru Prakash
   Associate Professor, Metallurgical Engineering, O.P. Jindal University
7. Dr Neeraj Verma
   Associate Professor, Metallurgical Engineering, O.P. Jindal University
8. Prof. Nandalal Acharjee
   Sr. Assistant Professor, Metallurgical Engineering, O.P. Jindal University
9. Dr Trinath Talapaneni
   Sr. Assistant Professor, Metallurgical Engineering, O.P. Jindal University
10. Dr Vatsala Chaturvedi
    Sr. Assistant Professor, Metallurgical Engineering, O.P. Jindal University
11. Dr Prasenjit Biswas
    Sr. Assistant Professor, Metallurgical Engineering, O.P. Jindal University
12. Dr Nidhi Khobragade
    Assistant Professor, Metallurgical Engineering, O.P. Jindal University
13. Dr Deepak Patel
    Assistant Professor, Metallurgical Engineering, O.P. Jindal University

At the outset, the Chairman of the Board of Studies (BoS), **Dr. M. Kalyan Phani**, extended a warm welcome to all members and formally commenced the meeting by presenting the department's **vision and mission**. He highlighted the recent strategic initiatives and significant achievements of the department, reflecting its continuous efforts toward academic excellence [illegible]

The agenda of the BoS meeting was:

1. To review the proposed scheme and syllabus of Diploma 5th and 6th Semesters (Batch 2023–26).
2. To review the proposed scheme and syllabus of Diploma 3rd and 4th Semesters (Batch 2024–27).
3. To review the proposed scheme and syllabus of Diploma 2nd Semester (Batch 2025–28).
4. To review the proposed scheme and syllabus of B.Tech. 3rd and 4th Semesters (Batch 2024–28) as per NEP.
5. To review the proposed scheme and syllabus of B.Tech 5th and 6th semester (Batch 2023-2027).
6. To review the proposed scheme and syllabus of B. Tech 7th and 8th semester (Batch 2022-2026)
7. To review the proposed scheme and syllabus of M.Tech in MST and MMT (Batch 2025- 2027) as per NEP.

Prof. Nandalal Acharjee was invited by the Chairman, Board of Studies (BoS) to present the

Multidisciplinary Courses. During the review of the list of minor courses offering by Metallurgical Engineering department for the 3rd year, the committee recommended to change Iron and Steel Making (MME24-B-MN302) course as Iron Making and to replace Mechanical behaviour of Materials (MME24-B-MN401) with Steel Making course. Also, the committee has recommended to rename the Mineral Dressing (MME24-B-MJ202) course as Mineral Beneficiation in the 3rd semester and to incorporate global scenario of extraction and making process for 4th semester in Ancient Metallurgy (MME24-B-MJ209) course for the Batch 2024-2028. For the B.Tech. 5th and 6th semesters (Batch 2023–2027), the committee recommended to mention about NPTEL credit transfer process under the heading of NOTE in the 6th sem for the NPTEL Transferred course (SOE-B-MME610). Subsequently, the proposed teaching scheme for the B.Tech 8th semester (Batch 2022-2026) was examined by committee and suggested to add financial part in the syllabus Entrepreneurship Development (SOE-B-MME-802) course.

Further, Dr. Guru has proposed teaching scheme and syllabus for the M.Tech all semesters for the Batch 2024–26 and 2025-27 (NEP based). The committee members expressed satisfaction and recommended no changes. Followed by the discussions, the committee was appreciated the introduction of new M.Tech specialization i.e. Metallurgy and Materials Technology in the department and also cherished the efforts of faculty in implementing and designing the curriculum aligned with NEP. The members reviewed the proposed scheme and syllabus, satisfied and recommended no changes for the M.Tech all semesters (Batch 2025–2027).
In conclusion, the committee approved all proposed teaching schemes and syllabi across various program levels, finding them satisfactory with no further revisions necessary. The meeting was concluded with the vote of thanks proposed by Dr. Neeraj Kumar Verma to all members for their insightful suggestions and active participation.

Approved online	Approved Online
Dr. Arghya Majumder	Dr. Debasis Chaira
Director, School of Mines & Metallurgy, Kazi Nazrul University	Professor & Head, Metallurgical and Materials Engineering, NIT-Rourkela

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Approved Online

Dr Manoj Kumar Chopkar

Associate Professor

Metallurgical Engineering, NIT-Raipur

Approved Online

Mr. Sharad Shrivastava

AVP, Nalwa Steels and Power Ltd.

Dr. M. Kalyan Phani

Head–Metallurgical and Mining Engineering,

O.P. Jindal University

Guru Prakash

Dr Guru Prakash

Associate Professor, Metallurgical Engineering,

O.P. Jindal University

Dr Neeraj Verma

Associate Professor, Metallurgical Engineering,

O.P. Jindal University

Dr Trinath Talapaneni

Sr. Assistant Professor, Metallurgical Engineering,

O.P. Jindal University

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Dr Vatsala Chaturvedi

Sr. Assistant Professor, Metallurgical Engineering, O.P. Jindal University

Dr Prasenjit Biswas

Sr. Assistant Professor, Metallurgical Engineering,

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Dr Nidhi Khobragade

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Dr Deepak Patel

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O.P. Jindal University

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The newly introduced courses and the percentage changes in subjects for the *Diploma, B. Tech and M.Tech* programs are outlined below:

Diploma Teaching Scheme

Academic Semester – II (Session 2025-28)

S.No	Course code	Name of Course	Revision %	Remarks
1	SOE-25-D-201	Introduction to Physical Metallurgy	--	--
2	SOE-25-D-202	Fuels, Furnaces and Refractory	--	--
3	SOE-25-D-203	Mineral Dressing	--	--
4	SOE-25-D-204	Physical Metallurgy Lab.	--	--
5	SOE-25-D-205	Fuels, Furnaces and Refractory Lab.	--	--
6	SOE-25-D-206	Mineral Dressing Lab.	--	--
7	MAT-25-D-201	Mathematics-II	--	--
8	HUM-25-D-201	Communication English- II	--	Course Introduced
9	HUM-25-D-202	Yoga and Meditation	--	Course Introduced

Academic Semester – III (Session 2024-27)

S.No	Course code	Name of Course	Revision %	Remarks
1	SOE-D-MT301	Metallurgical Thermodynamics	--	--
2	SOE-D-MT302	Heat Treatment of Materials	--	--
3	SOE-D-MT303	Metal Joining Process	--	--
4	SOE-D-MT304	Testing of Materials	40%	--
5	SOE-D-MT305	Heat Treatment of Materials Lab.	--	--
6	SOE-D-MT306	Metal Joining Process Lab.	--	--
7	SOE-D-MT307	Testing of Materials Lab	20%	--
8	SOE-D-MT308	Industrial Training – I*	--	--

Academic Semester – IV (Session 2024-27)

S.No	Course code	Name of Course	Revision %	Remarks

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1	SOE-D-MT401	Iron and Steel Making	--	--
2	SOE-D-MT402	Foundry Technology	--	--
3	SOE-D-MT403	Powder Metallurgy	--	--
4	SOE-D-MT404	Foundry Technology Lab.	--	--
5	SOE-D-MT405	5 S Management Lab	--	--
6	SOE-D-MT406	Industrial Training – II*	5%	--

Academic Semester – V (Session 2023-26)				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	SOE-D-MT501	Non-Ferrous Metallurgy	--	--
2	SOE-D-MT502	Metal Working Process	--	--
3	SOE-D-MT503	Industrial Management and Entrepreneurship	--	--
4	SOE-D-MT504	Industrial Training – III*	--	--

Academic Semester – VI (Session 2023-26)				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	SOE-D-MT 601	Alloy their Properties and Selection	--	--
2	SOE-D-MT 602	Corrosion and Protection methods	--	--
3	SOE-D-MT 603 (1)	Energy and Environmental Control	--	--
4	SOE-D-MT 603 (2)	Quality Management	--	--
5	SOE-D-MT 603 (3)	Non-Metallic Materials	--	--
6	SOE-D-MT 604	Corrosion and Protection Methods Lab.	--	--
7	SOE-D-MT 605	Project and Report **	--	--
8	HUM-D-SOE601	Professional Development-II	--	Course Introduced

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B.Tech Teaching Scheme

Academic Semester –III (Session 2024-28) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME24-B-MJ201	Introduction to Physical Metallurgy	--	Course Code Change
2	MME24-B-MJ202	Mineral Dressing	--	Course Code Change
3	MME24-B-MJ203	Metallurgical Thermodynamics and Kinetics	--	Course Code Change
4	MME24-B-MJ204	Physical Metallurgy Lab	--	Course Code Change
5	MME24-B-MJ205	Mineral Dressing Lab	--	Course Code Change
6	MME24-B-MN201	Fundamentals of Metallurgy	--	Course Introduced
7	MME24-B-AE201	Materials Science and Technology	--	Course Introduced
8	MME24-B-SE201	Material Science Lab	--	Course Introduced
9	MME24-B-MD201	Materials Informatics	--	Course Introduced

Academic Semester –IV (Session 2024-28) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME24-B-MJ206	Deformation Behavior & Testing of Materials	--	Course Code Change
2	MME24-B-MJ207	Heat Treatment of Materials	--	Course Code Change
3	MME24-B-MJ208	Iron Making	--	Course Code Change
4	MME24-B-MJ209	Ancient Metallurgy	--	Course Introduced
5	MME24-B-MJ210	Deformation Behavior & Testing of Materials Lab	--	Course Code Change
6	MME24-B-MJ211	Heat Treatment of Materials Lab	--	Course Code Change
7	MME24-B-MN202	Extraction of Metals	--	Course Introduced
8	MME24-B-SE202	Metallurgical Practices	--	Course Introduced

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9	MME24-B-AE202	Computational Metallurgy	--	Course Introduced

Academic Semester –V (Session 2023-27)				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	SOE-B-MME501	Melting and Casting Technology	--	--
2	SOE-B-MME502	Steel Making	--	--
3	SOE-B-MME503	Principles of Extractive Metallurgy	--	--
4	SOE-B-MME504	Phase Transformation	--	--
5	SOE-B-MME505	Melting and Casting Technology Lab	--	--
6	SOE-B-MME506	Process Metallurgy Lab	--	--
7	SOE-B-MME507	Industrial Training and Seminar	--	--

* Note: Students are encouraged to opt for the above subjects through NPTEL wherever possible. Upon successful completion, the corresponding credits may be transferred.

Academic Semester –VI (Session 2023-27)				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	SOE-B-MME601	Metal Forming Processes	--	--
2	SOE-B-MME602	Materials Characterization	--	--
3	SOE-B-MME603	Transport Phenomena in Metallurgical Processes	--	--
4	SOE-B-MME604	Metal Joining Processes	--	--
5	SOE-B-MME605 (1)	Advanced Materials and Processes	--	--
6	SOE-B-MME605 (2)	Solar Engineering Materials	--	--
7	SOE-B-MME605 (3)	Surface Engineering	--	--
8	SOE-B-MME605 (4)	Fracture Mechanics and Failure Analysis	--	--
9	SOE-B-MME606	Materials Characterization Lab	--	--
10	SOE-B-MME607	Welding Metallurgy Lab	--	--

11	SOE-B-MME608	Transport Phenomena in Metallurgical Processes Lab	--	--
12	SOE-B-MME609	Professional Development	--	--

* Note: Students are encouraged to opt for the above subjects through NPTEL wherever possible. Upon successful completion, the corresponding credits may be transferred.

Academic Semester –VII (Session 2022-26)				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	SOE-B-MME701	Alloys their Properties and Selection	--	--
2	SOE-B-MME702 (1)	Design and Selection of Materials	--	--
3	SOE-B-MME702 (2)	Introduction to Nano-Science and Nano-Technology	--	--
4	SOE-B-MME702 (3)	Ceramics and Powder Metallurgy	--	--
5	SOE-B-MME702 (4)	Light Weight Materials	--	--
6	SOE-B-MME703	Internship*	--	--
7	HUM-B-SOE701	Professional Development-I	--	Course Introduced
8	SOE-B-MME704 (1)	Skill Development Course from MOOCs# -		Course Introduced
9	SOE-B-MME704 (2)	Skill Development Course from MOOCs# -		Course Introduced
10	SOE-B-MME704 (3)	Skill Development Course from MOOCs# -		Course Introduced
11	SOE-B-MME704 (4)	Skill Development Course from MOOCs# -		Course Introduced

Academic Semester –VIII (Session 2022-26)				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	SOE-B-MME801	Corrosion Engineering	--	--
2	SOE-B-MME-802	Entrepreneurship Development	--	Open elective course brought into regular major Course
3	SOE-B-MME803 (1)	Introduction to Stainless Steel	--	--
4	SOE-B-MME803 (2)	Advance Materials Processing	--	--

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5	SOE-B-MME803 (2)	Nuclear Materials	--	--
6	SOE-B-MME804 (4)	Energy Storage Materials	--	--
7	SOE-B-MME804	Corrosion Engineering Lab	--	--
8	SOE-B-MME805	Major Project	--	--

M.Tech Teaching Scheme

Material Science and Technology

Academic Semester –I (Session 2025-27) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME25-M-MST101	Iron Making	--	Course Code Change
2	MME25-M-MST102	Physical Metallurgy of Steel	--	Course Code Change
3	MME25-M-MST103	Thermodynamics and Kinetics	--	Course Code Change
4	MME25-M-MST104	Advances in Materials Characterization	--	Course Code Change
5	MME25-M-MST105 (1-5)	Program Elective-I	--	Course Code Change
	MME25-M-MST105 (1)	Surface Engineering	--	Course Code Change
	MME25-M-MST105 (2)	Material Recycling and Waste Management	--	Course Code Change
	MME25-M-MST105 (3)	Powder Materials and Processing	--	Course Code Change
	MME25-M-MST105 (4)	Six Sigma in Manufacturing Industry	--	Course Code Change
	MME25-M-MST105 (5)	Fracture Mechanics	--	Course Code Change
6	MME25-M-MST106	Material Characterization Laboratory	--	Course Code Change
7	MME25-M-MST107	Metallography & Heat Treatment Laboratory	--	Course Code Change
8	FROM SOM	Intellectual Property Rights	--	Course Introduced
Academic Semester –II (Session 2025-27) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME25-M-MST108	Materials Modelling and Simulation	--	Course code changed

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2	MME25-M-MST109	Advances in Steel Making Technology	--	Course code changed
3	MME25-M-MST110	Advances in Corrosion Engineering	--	Course code changed
4	MME25-M-MST111 (1-4)	Program Elective- II	--	Course code changed
	MME25-M-MST111 (1)	Nanomaterials and Technology	--	Course code changed
	MME25-M-MST111 (2)	Artificial Intelligence in Steel Industries	--	Course code changed
	MME25-M-MST111 (3)	Introduction to Industry 4.0 and Industrial Internet of Things	--	Course code changed
	MME25-M-MST111 (4)	The Future of Manufacturing Business: Role of Additive Manufacturing	--	Course code changed
5	FROM SOS	Research Methodology	--	Course Introduced
6	MME25-M-MST112	Process Metallurgy Laboratory	--	Course code changed
7	MME25-M-MST113	Materials Modelling and Simulation Laboratory	--	Course code changed
8	FROM SOS	Scientific Paper Writing	--	Course Introduced

Academic Semester –III (Session 2025-27) NEP

S.No	Course code	Name of Course	Revision %	Remarks
1	MME25-M-MST201	Industrial Training/ Research Internship	--	Course Introduced
2	MME25-M-MST202	Dissertation I	--	Course Introduced

Academic Semester –IV (Session 2025-27) NEP

S.No	Course code	Name of Course	Revision %	Remarks
1	MME25-M-MST203	Dissertation II	--	Course Code changed

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Academic Semester –I (Session 2025-27) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME25-M-MMT101	Advanced Physical Metallurgy	--	Course Introduced
2	MME25-M-MMT102	Industrial Corrosion and control	--	Course Introduced
3	MME25-M-MMT103	Metal Forming Technology	--	Course Introduced
4	MME25-M-MMT104	Heat Treatment Technologies	--	Course Introduced
5	MME25-M-MMT105 (1)	Failure Analysis of Engineering Components	--	Course Introduced
6	MME25-M-MMT105 (2)	Non-Ferrous Extractive Metallurgy	--	Course Introduced
7	MME25-M-MMT105 (3)	Computational Metallurgy	--	Course Introduced
8	MME25-M-MMT105 (4)	Powder Metallurgy	--	Course Introduced
9	MME25-M-MMT105 (5)	Ceramics Materials	--	Course Introduced
10	MME25-M-MMT106	Physical Metallurgy Laboratory	--	Course Introduced
11	MME25-M-MST107	Metallography & Heat Treatment Laboratory	--	Course Introduced
12	FROM SOM	Intellectual Property Rights	--	Course Introduced

Academic Semester –II (Session 2025-27) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME25-M-MMT107	Metal Casting Technology	--	Course Introduced
2	FROM SOS	Research Methodology	--	Course Introduced
3	MME25-M-MMT108	Material Characterization	--	Course Introduced
4	MME25-M-MMT109	Advances in Iron & Steel Making	--	Course Introduced
5	MME25-M-MST111 (1)	Nanomaterials and Technology	--	Course Introduced
6	MME25-M-MMT110 (2)	Non Destructive Evaluation	--	Course Introduced
7	MME25-M-MMT110 (3)	Materials for Bio-implants	--	Course Introduced

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8	MME25-M-MMT110 (4)	Composite Materials	--	Course Introduced
9	MME25-M-MMT110 (5)	Artificial Intelligence in Material Industries	--	Course Introduced
10	MME25-M-MMT111	Metal Casting Laboratory	--	Course Introduced
11	MME25-M-MST106	Material Characterization Laboratory	--	Course Introduced
12	FROM SOS	Scientific Paper Writing	--	Course Introduced

Academic Semester –III (Session 2025-27) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME25-M-MMT201	Industrial Training/ Research Internship	--	Course Introduced
2	MME25-M-MMT202	Dissertation I	--	Course Introduced

Academic Semester –IV (Session 2025-27) NEP				
S.No	**Course code**	**Name of Course**	**Revision %**	**Remarks**
1	MME25-M-MMT203	Dissertation II	--	Course Introduced

Enclosures:

1. Screenshots of the meeting
2. Scheme and Syllabus of all programs of which approval is sought

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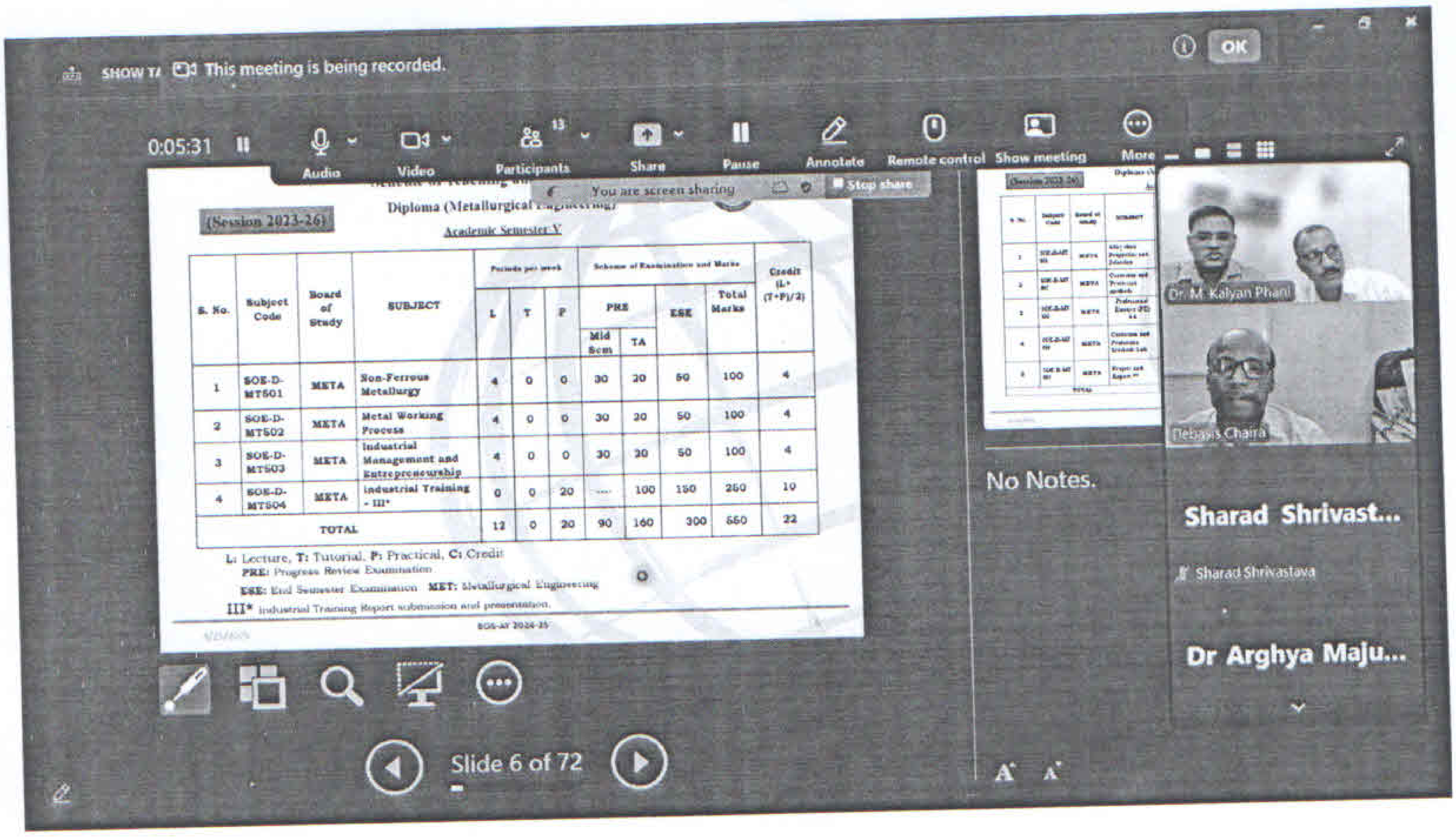

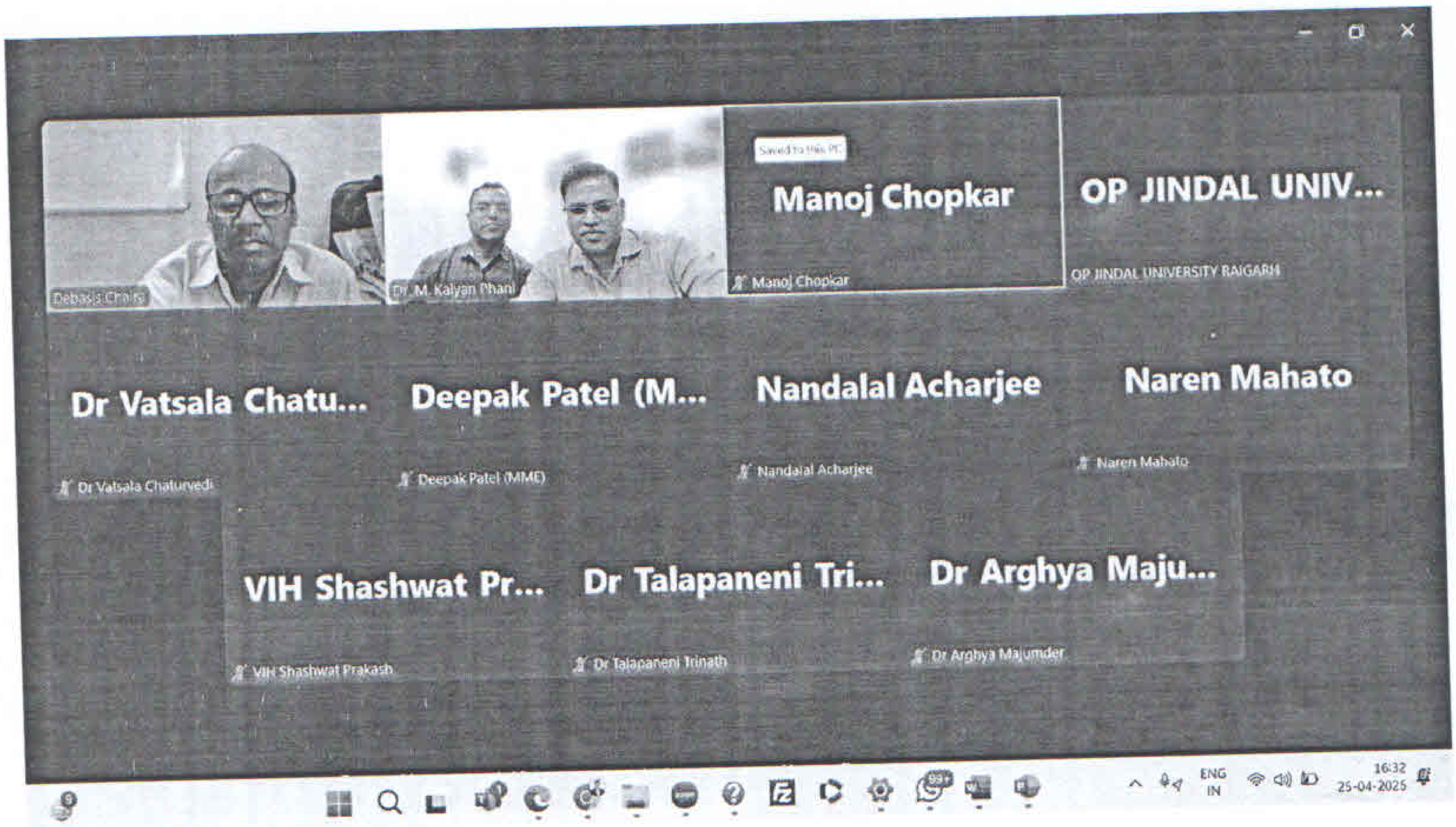

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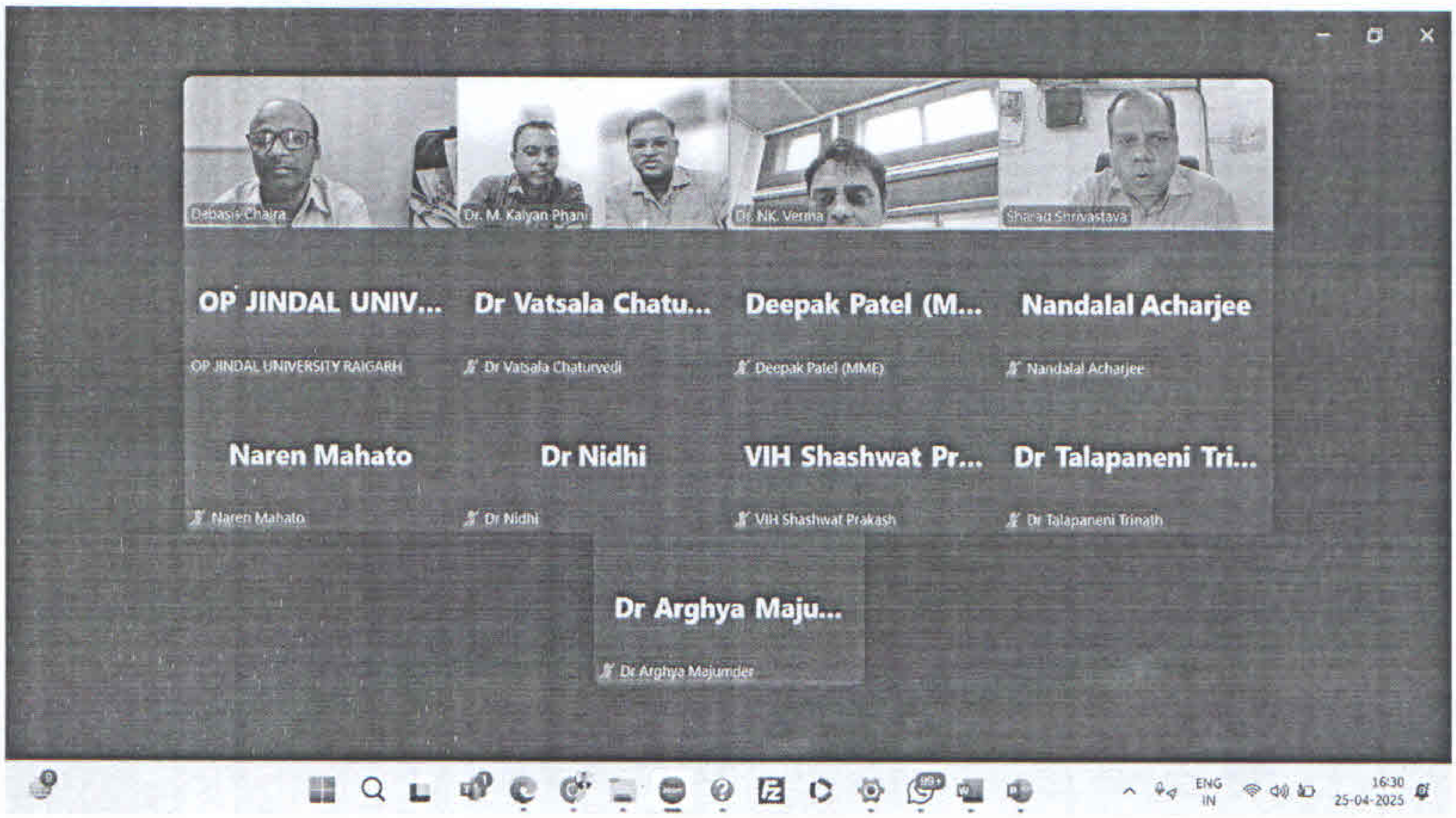
Debasis Chaira
Dr. M. Kalyan Phani
Dr. NK. Verma
Sharad Shrivastava
OP JINDAL UNIV...
OP JINDAL UNIVERSITY RAIGARH
Dr Vatsala Chatu...
Dr Vatsala Chaturvedi
Deepak Patel (M...
Deepak Patel (MME)
Nandalal Acharjee
Nandalal Acharjee
Naren Mahato
Naren Mahato
Dr Nidhi
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VIH Shashwat Pr...
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Dr Talapaneni Tri...
Dr Talapaneni Trinath
Dr Arghya Maju...
Dr Arghya Majumder
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Teaching Scheme and Syllabus
of
Diploma in Metallurgical Engineering

(PROGRAM CODE: 01UG050)
[5th Semester and 6th Semester]

DEPARTMENT OF METALLURGICAL ENGINEERING

SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2023-2026

PROGRAM OUTCOMES:

PO-1:	**Basic and Discipline Specific Knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and an engineering specialization to solve engineering problems.
PO-2:	**Problem analysis**: Identify and analyze well-defined problems using codified standard methods.
PO-3:	**Design/Development of Solutions**: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
PO-4:	**Modern Tools and Techniques for Scientific Experiments:** Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for a valid conclusion with a clear understanding of limitations.
PO-5:	**Society, Sustainability and Environment**: Apply appropriate technology in the context of society, sustainability, environment and ethical practices.
PO-6:	**Communication and Teamwork:** Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.
PO-7:	**Life-long Learning:** Ability to analyze individual needs and engage in updating in the context of technological changes.
PO-8:	**Society, Environment and Sustainability:** Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO-1:	Able to apply fundamental concepts of metals and materials to explore, develop, and operate in metallurgical and materials domain.
PSO-2:	**Problem analysis**: Identify and analyze well-defined problems using theoretical and practical methods.
PSO-3:	**Design/Development of Solutions**: Design solutions for well-defined technical problems to meet specified needs.
PSO-4:	**Modern Tools and Techniques for Scientific Experiments:** Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for a valid conclusion with a clear understanding of limitations.

Scheme of Teaching and Examination
Diploma (Metallurgical Engineering)

Academic Semester-V (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit (L+ (T+P)/2)
				L	T	P	PRE		ESE	Total Marks	
							Mid Sem	TA			
1	SOE-D-MT501	MET	Non-Ferrous Metallurgy	4	0	0	30	20	50	100	4
2	SOE-D-MT502	MET	Metal Working Process	4	0	0	30	20	50	100	4
3	SOE-D-MT503	MET	Industrial Management and Entrepreneurship	4	0	0	30	20	50	100	4
4	SOE-D-MT504	MET	Industrial Training – III*	0	0	20	----	100	150	250	10
TOTAL				**12**	**0**	**20**	**90**	**160**	**300**	**550**	**22**

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
PRE: Progress Review Examination. **ESE:** End Semester Examination
MET: Metallurgical Engineering.

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Scheme of Teaching and Examination
Diploma (Metallurgical Engineering)

Academic Semester-VI (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit (L+ (T+P)/2)
				L	T	P	PRE		ESE	Total Marks	
							Mid Sem	TA			
1	SOE-D-MT 601	MET	Alloy their Properties and Selection	4	0	0	30	20	50	100	4
2	SOE-D-MT 602	MET	Corrosion and Protection methods	4	0	0	30	20	50	100	4
3	SOE-D-MT 603 (1-3)	MET	Professional Elective **	3	0	0	30	20	50	100	3
4	SOE-D-MT 604	MET	Corrosion and Protection Methods Lab.	0	0	2	----	15	10	25	1
5	SOE-D-MT 605	MET	Project and Report **	0	0	20	----	100	150	250	10
TOTAL				**11**	**0**	**22**	**90**	**175**	**310**	**575**	**22**

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
PRE: Progress Review Examination. **ESE:** End Semester Examination
MET: Metallurgical Engineering.

Professional Electives:

S. No.	Subject Code	Board of Study	SUBJECT
1	SOE-D-MT 603 (1)	MET	Energy and Environmental Control
2	SOE-D-MT 603 (2)	MET	Quality Management
3	SOE-D-MT 603 (3)	MET	Non-Metallic Materials

Diploma Semester-V
(Detailed Syllabus)

Scheme of Teaching and Examination
Diploma (Metallurgical Engineering)

Academic Semester-V (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit (L+ (T+P)/2)
				L	T	P	PRE		ESE	Total Marks	
							Mid Sem	TA			
1	SOE-D-MT501	MET	Non-Ferrous Metallurgy	4	0	0	30	20	50	100	4
2	SOE-D-MT502	MET	Metal Working Process	4	0	0	30	20	50	100	4
3	SOE-D-MT503	MET	Industrial Management and Entrepreneurship	4	0	0	30	20	50	100	4
4	SOE-D-MT504	MET	Industrial Training – III*	0	0	20	----	100	150	250	10
TOTAL				**12**	**0**	**20**	**90**	**160**	**300**	**550**	**22**

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

ESE: End Semester Examination **PRE:** Progress Review Examination
MET: Metallurgical Engineering
III* Training report submission and presentation.

Programme:	**Diploma**	**Semester :**	**V**
Name of the Course:	**Non-Ferrous Metals Metallurgy**		
Course Code :	**SOE-D-MT 501**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:

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

Course Objectives:

Upon this course, each student should be able to:

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

Syllabus:

UNIT–I

Discovery of metals and their importance, common nonferrous metal production and consumption: global and Indian scenario. Sources of nonferrous metals uses of non-ferrous metals. Exploration methods.

UNIT–II

Principles of Metals Extraction: Thermodynamic principles, principles of electrochemistry; Electrometallurgy: electrolysis and electro-refining, Hydrometallurgy: leaching, solvent extraction, ion exchange, precipitation. Ellingham diagrams, Pyro-metallurgy: calcinations, roasting and smelting.

UNIT–III

Extraction of Metals from Oxide Sources: basic approaches and special features of specific extraction processes, alumina by Bayer process and aluminum by Hall Heroult Process, ALCOA, Process, TOTH Process.

UNIT–IV

Extraction of Metals from Sulphide Ores: Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc. concentration of copper ore and its roasting and smelting reduction and purification.

UNIT–V

Electro refining of copper, nickel, lead, tin and aluminum. Extraction of precious metals: Gold, silver and platinum. Secondary metals and utilization of metallurgical wastes, environmental issues.

Text Books:

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

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.
2. Material Science & Engineering, W. F. Smith & Javed. Hashemi, Ravi Prakash, Tata Mc. Grow Hill.
3. Phase Transformation in Metals and Alloys: David A. Porter, Kenneth E. Easterling and Mohamed Y. Sherif, CRC Press.

Course Outcome:

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

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Programme:	**Diploma**	**Semester :**	**V**
Name of the Course:	**Metal Working Process**		
Course Code :	**SOE-D-MT 502**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:
This course Metal Working Processes is principally aimed to introduce the students about force required to deform materials in desired shape with proper quality and minimum defect. This course comprises the concept of load requirements, 2D and 3D stress, response of materials to external loads, temperature requirements for material deformation, production of end product with minimal defects. This course explains various forming processes such as Rolling, forging, extrusion and possible defects and their remedy.

Course Objectives:
Upon this course, each student should be able to:

1. Understand the behavior of materials to external loads and select suitable materials for a particular application;
2. Provide a basic understanding of the underlying principles of
3. metal forming;
4. Provide a smooth link between the basic knowledge of science and engineering courses.

Syllabus:

UNIT–I
Fundamental concept of metal forming, flow stress, yield criteria; Von-mises theory, Tresca Criterion, classification of metal forming operations on the basis of cold, hot & warm working.

UNIT–II
Introduction of angle of bite, spread, deformation coefficient, relationship between roll diameter and friction angle. Classification of rolling mills on the basis of roller arrangement, classification of rolled products, blooms billets, slabs, plates, strips, sheets, wire rod etc., Rolling defects.

UNIT–III
Forging–Importance and characteristics of forging, open die and closed die forging, forged products, die materials, forging equipment, forging defects and their remedies.

UNIT–IV
Extrusion types of variables, defects and typical products. Drawing–types of drawing. Extrusion and drawing defects.

UNIT–V
Sheet metal forming- stretching, bending, shearing, trimming, canning, sizing etc.

Text Books:

1. Mechanical Metallurgy – Dieter.
2. Rolling mill practice – Polukhia.
3. Principles of metal working – Dr. Surendra Kumar.

Reference Books:

1. Theory of plastic working of metals – Masterovsky (MIR).
2. Rolling practice – Burtsev.
3. Principles of rolling – Chaturvedi.
4. Rolling Mill – ASM.
5. Industrial Metal Working – Rowe.
6. Forging Practice – Kamenschikov.

Course Outcome:
The course on mechanical working processes will help the student to understand:

1. The deformation behavior of materials to external loads;
2. Various metal forming processes and their importance for shaping selective material.

Programme:	**Diploma**	**Semester :**	**V**
Name of the Course:	**Industrial Management and Entrepreneurship**		
Course Code :	**SOE-D-MT 503**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:
This course will provide the basic understanding of practices related to industrial engineering and resources thereof and also encourages to develop the necessary competency and skills for a career in entrepreneurship. This course is designed to develop understanding of various functions of management and the introductory idea of entrepreneurship.

Course Objectives:
Upon this course, each student should be able to:

1. To develop understanding of various functions of management, role of workers and engineers;
2. To familiarize the participants with the concept and overview of
3. entrepreneurship;
4. To impart knowledge on the basics of entrepreneurial skills and competencies.

Syllabus:

UNIT–I
Principles of management, different functions of management, Structure of an industrial organization, functions of different departments, relationship between individual departments.

UNIT–II
Human relations and performance in organization, concept of ethics, concept of professionalism, need for professional ethics, factors determining motivation, methods for improving motivation, need for leadership, functions of a leader.

UNIT–III
Classification of accidents; according to nature of injuries i.e. fatal, temporary; according to event and according to place, classification of accidents; according to nature of injuries i.e. fatal, temporary; according to event and according to place, safety criteria, prevention of industrial accidents.

UNIT–IV
Concepts and overview of entrepreneurship, distinction between an entrepreneur and a manager role of entrepreneurship in economic development, models of Entrepreneurship, different types of entrepreneurships, Start-up policy framework.

UNIT–V
Definition & characteristics of an entrepreneur, qualities of an entrepreneur, Functions of an entrepreneur, definition of entrepreneurship, forces developing the entrepreneurship, process of entrepreneurship development, stages of entrepreneurship development, support agencies for MSME, support agencies for entrepreneurship guidance, training, registration.

Text Books:
1. Industrial Engineering and Management by O. P. Khanna; Dhanpat Rai and Sons, Delhi;
2. Industrial Management by VK Sharma, OP Harkut;
3. Industrial Organization and Management by Tara Chand; Nem Chand and Brothers; Roorkee;
4. Industrial Management by C.L. Mahajan; Saluja Parkashan, New Delhi;
5. Entrepreneurial Development – Principles, Policies & Programmes, Saravanavel P; The Journal of Entrepreneurship – Sage publications;
6. Fundamentals of Entrepreneurship, R. C. Agrawal,

Course Outcome:
After completion of the course the student will able to:

1. Explain work, method and time study in an industry;
2. Describe working conditions and environment of the work places;
3. Explain importance of safety related areas;
4. Define the terms like entrepreneur and entrepreneurship;
5. Explain qualities and functions of an entrepreneur;
6. Explain the concept of the term ‘entrepreneurship development’.

Programme:	**Diploma**	**Semester :**	**V**
Name of the Course:	**Industrial Training – III**		
Course Code :	**SOE-D-MT 504**	**Credits :**	**10**
Max Marks :	**250**	**No of Hours :**	**10 Hrs/Week**

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Course Description:
The course provides the knowledge about raw materials to product outcome detailed processes related to metallurgical industry. Industrial Training is an organized activity focused on required skill set, information to improve and enhance the performance or to help students to meet their career goals. This bridges the gap in academic curriculum and in the industry and also helps students to learn new technology, stay them updated with market demand, making them aware of new developments. This also meets with the wide range of experienced and professional mentors and trainers.

Course Objectives:
Upon this course, students will be able to:

1. Acquaint with problem-solving skills, and gain industry exposure during the training time.

Course Outcome:
On successful completion of this course, the student should be able to

1. Identify the nature of raw material for metallurgical production;
2. Identify the various beneficiation processes adopted for ferrous and non- ferrous industry;
3. Understand the various routes related to production;
4. Correlate the theoretical knowledge into practical aspects of the metallurgical productions. Gain opportunity for self-exposer in an industry.

Evaluation Pattern:
1. Progressive Assessment will be done by the internal examiner during the visits to industry;
2. Internal presentation of report at institute level.
3. End Semester External Exam would be conducted by external examiner.

Diploma Semester-VI
(Detailed Syllabus)

Scheme of Teaching and Examination
Diploma (Metallurgical Engineering)

Academic Semester-VI (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit (L+(T+P)/2)
				L	T	P	PRE		ESE	Total	
							Mid Sem	TA		Marks	
1	SOE-D-MT 601	MET	Alloy their Properties and Selection	4	0	0	30	20	50	100	4
2	SOE-D-MT 602	MET	Corrosion and Protection methods	4	0	0	30	20	50	100	4
3	SOE-D-MT 603 (1-3)	MET	Professional Elective **	3	0	0	30	20	50	100	3
4	SOE-D-MT 604	MET	Corrosion and Protection Methods Lab.	0	0	2	----	15	10	25	1
5	SOE-D-MT 605	MET	Project and Report **	0	0	20	----	100	150	250	10
TOTAL				**11**	**0**	**22**	**90**	**175**	**310**	**575**	**22**

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

ESE: End Semester Examination

PRE: Progress Review Examination.

MET: Metallurgical Engineering

** Project Report submission and presentation.

Professional Electives:

S. No.	Subject Code	Board of Study	SUBJECT
1	SOE-D-MT 603 (1)	MET	Energy and Environmental Control
2	SOE-D-MT 603 (2)	MET	Quality Management
3	SOE-D-MT 603 (3)	MET	Non-Metallic Materials

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Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Alloy their Properties and Selection**		
Course Code :	**SOE-D-MT 601**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

Course Description:
This course has been intended to improve the understanding of the students about the use of alloying and their effect in improving the properties of a material. Various alloying elements and their effects are discoursed. Effect of various alloying elements in both ferrous and non-ferrous alloys will be discussed thoroughly for better understanding with some examples. Various ferrous and non-ferrous alloys will be reviewed with respect to their properties and applications. Standards and Specifications of alloys will be also discussed.

Course Objectives:
Upon this course, each student should be able to:

1. Study about alloying and their effect on final properties;
2. Understand the need for alloying and utilize the knowledge in tailoring the alloys for a particular application;
3. Study the various ferrous based alloys, their production, properties and applications;
4. Explore the structure, properties and applications of various non-ferrous alloys;
5. Establish a concrete understanding of alloying and their effects in a particular material atomistically.

Syllabus:

UNIT-I
Alloying elements, use of alloying, Limitations of plain carbon steel, Effect of alloying elements on transformation temperature, effect of alloying elements on critical cooling rate, on hardenability and on tempering. Low alloy steels: Low alloy steels such as high tensile structural steel, case hardening steels, spring steels.

UNIT-II
Structure properties and applications of High Nickel steels, High Speed Steels, Die Steel, Hadfield steel and Maraging steel

UNIT-III
Introduction to Cast Irons: Structure and properties of white cast irons, grey cast iron, malleable cast iron, nodular cast iron and alloy cast irons. Introduction to Stainless steels.

UNIT-IV
Non Ferrous alloys: Structure and properties of Brasses, bronzes,

babbit. Structure and properties of titanium alloys, Aluminium alloys, Monels

UNIT-V
Metals at low temperatures: Effect of low temperature on properties, Steels for magnetic and electrical applications. Amorphous metals. Specifications of alloys: - ISI, AISI and EN standards (Basic concepts only).

Text Books:

1. Physical metallurgy for engineers- by D.S. Clark and Warne.
2. Structures and Properties of alloys- by Robert M. Brick and Phillips.
3. Introduction to Physical metallurgy- by Sidney H. Avner.

Reference Books:

1. The Materials Selector, N A Waterman and M F Ashby, Vols. I, II and III, Chapman and Hall, London, 1996.
2. Engineering Materials: Properties and Applications of Metals and Alloys, Chandra P Sharma, Prentice-Hall of India Pvt. Ltd; 1st edition, 2004.
3. Fathi Habashi, Alloys: Preparation, Properties, Applications, WILEYVCH Verlag GmbH, 2007.
4. Concepts in Physical Metallurgy, AL Kumar, IOP Science, 2017.
5. ASM Specialty Handbook: Cast Irons, Joseph R. Davis, ASM International,1996.

Course Outcome:
After completion of the course the student will able to:

1. Distinguish between various alloying effects;
2. Have an increased level of awareness towards alloys and their applications;
3. Help in the production of alloy steel, cast iron and nonferrous alloys as per their need;
4. Apply their basic understanding in development of alloys with better properties and understand the standards and specifications.

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Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Corrosion and Protection Methods**		
Course Code :	**SOE-D-MT 602**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:
The course will provide fundamentals knowledge and applications thorough practical training. Following pre-requisites, students acquire the fundamentals of chemistry, physics and metallurgy underpinning corrosion processes. This course will approach towards corrosion control, ranging from material selection, through cathodic protection, corrosion inhibition, protective coatings and also cover the related industrial practices to gain the knowledge of corrosion and its control parameters. This course could be the ideal career either in industry as a corrosion scientist or engineer or for cutting-edge academic research.

Course Objectives:
Upon this course, each student should be able to:

1. Understand the principles of electrochemistry, corrosion and metal protection.

Syllabus:

UNIT–I
Definition of corrosion, importance of corrosion studies, classifications of corrosion, expression for corrosion rate. Corrosion principles, electrochemical principles of corrosion, basic corrosion cell, classification of electro chemical corrosion cell.

UNIT–II
Different forms of corrosion, uniform attack, local attack, pitting, dezincification, inter-granular corrosion, hydrogen embitterment, erosion corrosion, stress corrosion cracking, corrosion fatigue.

UNIT–III
Environmental aspects of aqueous corrosion, corrosion in atmosphere, corrosion in water, corrosion in soil. Formation of oxide layer, rate laws of oxide, the structure of oxides, growth of thin oxide film, oxidizing atmosphere, oxidation protection.

UNIT–IV
Interpretation and measurement of corrosion, potential measurement, potential and current distribution measurement, rotating electrode method for corrosion current, polarization measurement.

UNIT–V
Corrosion protections against of environments, different ways of

protection, design improvement, modification of metal, use of coating, metallic and non- metallic coating, change of environment.

Text and Reference Books:

1. Corrosion Engineering – Fontana and Greene.
2. Introduction to Electrochemistry – S. Glasstone.
3. Chemical Metallurgy – J. J. Moore.
4. Corrosion causes and Prevention – Speller.

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

1. Design and selection and protection of materials under aggressive environment.

Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Energy and Environment Control (Professional Elective)**		
Course Code :	**SOE-D-MT 603 (1)**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:
This course provides an introduction to energy systems and renewable energy resources with a scientific examination of the energy field. There is an emphasis on alternative energy sources, their technology and application. This course will also provide the idea of environmental aspects of pollution control measures.

Course Objectives:
Upon this course, each student should be able to:

1. Gather concept about energy systems and their importance;
2. Understand the concept of energy conversation and recovery;
3. Understand the sources of environmental pollution and control measures.

Syllabus:

UNIT–I
Conventional Power Generation: Steam power station, Nuclear power plant – Gas turbine power plant- Hydro power station: Schematic arrangement, advantages and disadvantages, thermoelectric and thermionic generators, environmental aspects for selecting the sites and locations of power plants.

UNIT–II
Renewable Power Generation: Solar, wind, biogas and biomass, ocean thermal energy conversion (OTEC), tidal, fuel cell, magneto hydro dynamics (MHD): schematic arrangement, advantages and disadvantages.

UNIT–III
Energy consumption in metallurgical industries: electrometallurgical extraction processes, rolling mill, forging shop, blast furnace, arc furnace, L-D furnace, Induction furnace, cupola, heat treatment furnace, sponge iron plant, ferro- alloys plants, concept of energy conservation.

UNIT–IV
Environment and human health; air pollution: sources- effects- control measures; particulate emission, air quality standards and measurement of air pollution; environmental protection act- Air act.

UNIT–V
Water pollution: effects and control measures; rainwater harvesting and

water conservation; Noise pollution: effects and control measures; disposal of solid wastes, bio-medical wastes; thermal pollution – soil pollution -nuclear hazard.

Text and Reference Books:

1. A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, A Text book of Power System Engineering, Dhanpat Rai Publication.
2. Rai. G. D., Non-Conventional Energy Sources, Khanna Publishers, Delhi, 2006.
3. Rao S., Parulekar B.B., Energy Technology-Non conventional, Renewable and Conventional, Khanna Publishers, Delhi, 2005.
4. Glynn Henry J., Gary W. Heinke, Environmental Science and Engineering, Pearson Education, Inc, 2004.
5. J. M. Fowler, Energy and the Environment, McGraw-Hill, 2nd Edition, 1984.
6. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 2003

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

1. Understand the concept of various sources of energy and their importance;
2. Understand different energy considerations in metallurgical industries;
3. Comprehend the sources of environmental pollution and control measures.

Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Quality Management** (**Professional Elective**)		
Course Code :	**SOE-D-MT 603 (2)**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

Course Description:

The field of quality management keeps advancing in both depth and breadth with the scope of application in manufacturing and services. Quality issues are now the concern of all organizations, including public and service sectors. The purpose of this course is to put quality management into perspective, and to highlight its critical importance, as well as to present in-depth ideas on different methodologies, tools and techniques proposed for product and process improvement.

Course Objectives:
Upon this course, each student should be able to:

1. Provide a basic understanding on the quality issues concerned by both public and private sectors;
2. Create an awareness in the students about importance of quality control in a manufacturing company.

Syllabus:

UNIT–I
Introduction: Concept of Total Quality Management, objective of TQM, scope of TQM, components of TQM, evolution of TQM, definition of quality and its important.

UNIT–II
Components of Total Quality Management: Customer Supplier Relationship in TQM system, management, leaders in TQM System, managerial role in TQM.

UNIT–III
Practices for TQM: TQM and Human Resource Development, need and significance of TQM, process of TQM. quality systems: Need for ISO 9000 and other quality systems, ISO 9000:2000 Quality System – Elements, implementation of quality system, documentation, ISO14000–Concept, Requirement and Benefits.

UNIT–IV
Benchmarking: Reasons to benchmark, benchmarking process, Quality Function Development (QFD) – Cost of Quality, QFD Process, Six Sigma. Quality Circle: Purpose, Benefits, Problem in implementation of quality circles, Requirements of Elective circle.

UNIT–V
Statistical tools and techniques: Role of statistics in business, common statistical tools, flow diagram, check sheets, correlation or scatter diagram.

Text and Reference Books:

1. Feigenbaum A.V. "Total Quality Management, McGraw-Hill, 1991.
2. Total Quality Management, Principles & Practice – S. K. Mandal, Vikas Publishing House, Pvt. Ltd.
3. Oakland J.S. "Total Quality Management Butterworth – Heinemann Ltd., Oxford,1989.
4. Narayana V. and Sreenivasan, N.S. Quality Management – Concepts and Tasks, New Age International, 1996.
5. Zeiri, "Total Quality Management for Engineers Wood Head Publishers, 1991.

Course Outcomes:
The course on Quality Management will help the student to understand the various terminologies and its significance, quality control management and its consequence in any Manufacturing unit.

Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Non-Metallic Materials** (**Professional Elective**)		
Course Code :	**SOE-D-MT 603 (3)**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:
Non-metallic materials are based on the engineering polymers, ceramics and composites materials and focus on the theoretical basic knowledge of polymers, ceramics and composites and their applications to engineering systems. It is an extension and deepening of the prerequisite engineering concepts in Metallurgy and Materials Engineering experts. This course provides a systematic study of polymers, ceramics and composites fundamentals, principles, methods and applications. This course helps for material selection and engineering design principles in the domain of non-metallic materials.

Course Objectives:
Upon this course, each student should be able to:

1. Select non-metallic materials in view of their composition, properties and applications.

Syllabus:

UNIT–I
Polymeric Materials: Polymers definition, types, characteristics, properties, mechanism of polymerization and uses of thermoplastics, thermosetting plastics and rubbers, characteristics and uses of ABS, acrylics. nylons and vinyls, epoxides, melamine and bakelite, neoprene, butadiene, silicons – properties and applications,

UNIT–II
Ceramic Materials: types, properties and applications of ceramics and glasses, Glass-ceramic materials, concepts of refractory materials and their properties and applications, refractory selection parameters, high temperature refractories, raw materials used for abrasives.

UNIT–III
Composite of Materials: Types, properties and advantages of composites, role of plasticizers, Fiber and matrix phases, role of matrix and reinforced materials, concept of particulate reinforced composites, fiber reinforced composites, polymer matrix composites, ceramic matrix composites and metal matrix composites.

UNIT–IV
Processes of composite manufacturing emphasized with Hand layout process, autoclave process, filament winding process, Stir casting, injection process, spray deposition and strengthening mechanism.

UNIT–V

Scope of powder metallurgy in industry, powder metallurgy process, applications and limitations, basics of compaction techniques, sintering processes of powder products, secondary operations in powder products, sintering furnaces and applications.

Text Books and Reference Books:

1. Mishra, Introductory Polymer Chemistry, V.R. Gowariker, Polymer Science,
2. Textbook of Polymer Science, F. N. Billmeyer, Wiley Inter science, 1971.
3. Fundamentals and Polymer Science and Engineering, Kumar and S. K. Gupta, Tata McGraw-Hill, 1978
4. Engineering Plastics, Engineering Materials Handbook, Epel, J.N.: ASM International 1988.
5. Introduction to ceramics, F.H. Norton
6. Fuels, Furnaces and Refractories, O. P. Gupta, Khanna Publications.
7. Powder Metallurgy, K. Sinha, Dhanpat Rai and Sons.

Course Outcomes:

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

1. Understand the techniques and their characteristics/limitations of synthesis of polymers;
2. Understand and apply the various processing and manufacturing techniques of composite materials;
3. Understand and apply various processes of ceramic products;
4. Understand the fundamental knowledge of refractory materials;
5. Understand the fundamental knowledge of powder materials products.

Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Corrosion and Protection Methods Lab.**		
Course Code :	**SOE-D-MT 604**	**Credits :**	**1**
Max Marks :	**50**	**No of Hours :**	**1 Hr./Week**

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Course Description:
The course will provide fundamentals knowledge and applications thorough practical training. This laboratory course will approach towards corrosion control and also cover the related industrial practices.

Course Objectives:
Upon this course, each student should be able to:
1. Understand the practical exposure of corrosion through advanced Techniques;
2. Understand the corrosive behavior of materials in the respective Environments;
3. Learn the handling of equipment used for determination of rate of corrosion.

List of Experiments:

1. Study of electrochemical behavior of steel in different environment by polarization method.
2. Effect of inhibitors on corrosion behavior of metals.
3. Study of galvanic corrosion by different combination of metals.
4. Study of corrosion behavior of aluminum by immersion method.
5. Study the corrosion of welded steel.
6. Corrosion rate measurement by electro-chemical method.

References:

1. Corrosion Engineering by G. Fontana.
2. Introduction to electrometallurgy and corrosion by Saran & Narayan.

Course Outcome:
The student should aware of the effect of corrosion and its environment and must have mastery in handling the corrosion equipment.

Programme:	**Diploma**	**Semester :**	**VI**
Name of the Course:	**Project and Report**		
Course Code :	**SOE-D-MT 605**	**Credits :**	**10**
Max Marks :	**250**	**No of Hours :**	**10 Hrs./Week**

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Course Description:
The project work is included in the syllabus to encourage the students to undertake and treacle an independent problem in their core domain. This course helps them to ignite their individual thinking and application to a problem. This this course, students will select a topic to any subject of the syllabi and will design and carry out tests and trials and submit the findings in a report following departmental format. The report must contain with literature review and findings of experiments. This course meets with the wide range of experienced and professional mentors and trainers and will develop problem-solving skills, knowledge and also gain self-exposure in their domain areas.

Course Objectives:
To help the student to acquaint with problem-solving skills, knowledge and develop their professional antiquates and also self confidence in the selective topics or areas.

Course Content:
Selection of topic for Project work and relevant experimentation, literature surveys and interpretation of result data. Group discussion and presentation of the final project report is a mandatory part of the content.

Course Outcome:
On successful completion of this course, the student will be able to:

1. Gain the knowledge of their selective topic;
2. Identify the various technical process related experiments;
3. Understand the various routes related to mobilize their technical thoughts;
4. Gain the knowledge how to write the literature survey;
5. Gain opportunity for self-exposer and confidence.

Teaching Scheme and Syllabus
of
Diploma in Metallurgical Engineering

(PROGRAM CODE: 01UG050)

[3rd Semester and 4th Semester]

DEPARTMENT OF METALLURGICAL ENGINEERING

SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2024-2027

PROGRAM OUTCOMES:

PO-1:	**Basic and Discipline Specific Knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and an engineering specialization to solve engineering problems.
PO-2:	**Problem analysis**: Identify and analyze well-defined problems using codified standard methods.
PO-3:	**Design/Development of Solutions**: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
PO-4:	**Modern Tools and Techniques for Scientific Experiments:** Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for a valid conclusion with a clear understanding of limitations.
PO-5:	**Society, Sustainability and Environment**: Apply appropriate technology in the context of society, sustainability, environment and ethical practices.
PO-6:	**Communication and Teamwork:** Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.
PO-7:	**Life-long Learning:** Ability to analyze individual needs and engage in updating in the context of technological changes.
PO-8:	**Society, Environment and Sustainability:** Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO-1:	Able to apply fundamental concepts of metals and materials to explore, develop, and operate in metallurgical and materials domain.
PSO-2:	**Problem analysis**: Identify and analyze well-defined problems using theoretical and practical methods.
PSO-3:	**Design/Development of Solutions**: Design solutions for well-defined technical problems to meet specified needs.
PSO-4:	**Modern Tools and Techniques for Scientific Experiments:** Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for a valid conclusion with a clear understanding of limitations.

Scheme of Teaching and Examination
Diploma in Metallurgical Engineering

Academic Semester-III (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				
				L	T	P	PRE		ESE	Total Marks	Credit (L+(T+P)/2)
							Mid Sem	TA			
1	SOE-D-MT301	MET	Metallurgical Thermodynamics	3	0	0	15	15	70	100	3
2	SOE-D-MT302	MET	Heat Treatment of Materials	3	0	0	15	15	70	100	3
3	SOE-D-MT303	MET	Metal Joining Process	3	0	0	15	15	70	100	3
4	SOE-D-MT304	MET	Testing of Materials	4	0	0	15	15	70	100	4
5	SOE-D-MT305	MET	Heat Treatment of Materials Lab.	0	0	2	---	15	10	25	1
6	SOE-D-MT306	MET	Metal Joining Process Lab.	0	0	2	---	15	10	25	1
7	SOE-D-MT307	MET	Testing of Materials Lab	0	0	2	---	15	10	25	1
8	SOE-D-MT308	MET	Industrial Training – I*	0	0	20	----	100	150	250	10
TOTAL				13	0	26	60	205	460	725	26

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
PRE: Progress Review Examination. **ESE:** End Semester Examination
MET: Metallurgical Engineering.

Course Bifurcation (Related to Industrial Training):

S. No.	Subject Code	Board of Study	SUBJECT		Periods per week			Credit (L+(T+P)/2)
					L	T	P	
8.	SOE-D-MT308	MET	**Industrial Training-I***	Coke Making Plant	0	0	4	2
				Sinter Making Plant	0	0	4	2
				DRI Plant	0	0	4	2
				Blast Furnace	0	0	4	2
				Pig Casting	0	0	4	2
TOTAL					0	0	20	10

I* - Industrial Training Report submission and presentation

Scheme of Teaching and Examination
Diploma (Metallurgical Engineering)

Academic Semester-IV (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				
				L	T	P	PRE		ESE	Total Marks	Credit (L+ (T+P)/2)
							Mid Sem	TA			
1	SOE-D-MT401	MET	Iron and Steel Making	4	0	0	15	15	70	100	4
2	SOE-D-MT402	MET	Foundry Technology	4	0	0	15	15	70	100	4
3	SOE-D-MT403	MET	Powder Metallurgy	4	0	0	15	15	70	100	4
4	SOE-D-MT404	MET	Foundry Technology Lab.	0	0	4	---	15	10	25	2
5	SOE-D-MT405	MET	5 S Management Lab.	0	0	2	---	15	10	25	1
6	SOE-D-MT406	MET	Industrial Training – II*	0	0	20	----	105	150	250	10
TOTAL				**12**	**0**	**26**	**45**	**180**	**380**	**600**	**25**

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
ESE: End Semester Examination **MET:** Metallurgical Engineering
PRE: Progress Review Examination.

Course Bifurcation (Related to Industrial Expose):

S. No.	Subject Code	Board of Study	SUBJECT		Periods per week			Credit (L+(T+P)/2)
					L	T	P	
6.	SOE-D-MT406	MET	Industrial Training-II*	SMS-I	0	0	4	2
				SMS-II	0	0	4	2
				RUBM Plant	0	0	4	2
				Rolling Mill	0	0	4	2
				Extrusion Plant	0	0	4	2
TOTAL					**0**	**0**	**16**	**10**

II* Industrial Training report submission and presentation.

Diploma Semester-III
(Detailed Syllabus)

Scheme of Teaching and Examination
Diploma in Metallurgical Engineering

Academic Semester-III (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				
				L	T	P	PRE		ESE	Total Marks	Credit (L+(T+P)/2)
							Mid Sem	TA			
1	SOE-D-MT301	MET	Metallurgical Thermodynamics	3	0	0	15	15	70	100	3
2	SOE-D-MT302	MET	Heat Treatment of Materials	3	0	0	15	15	70	100	3
3	SOE-D-MT303	MET	Metal Joining Process	3	0	0	15	15	70	100	3
4	SOE-D-MT304	MET	Testing of Materials	4	0	0	15	15	70	100	4
5	SOE-D-MT305	MET	Heat Treatment of Materials Lab.	0	0	2	---	15	10	25	1
6	SOE-D-MT306	MET	Metal Joining Process Lab.	0	0	2	---	15	10	25	1
7	SOE-D-MT307	MET	Testing of Materials Lab	0	0	2	---	15	10	25	1
8	SOE-D-MT308	MET	Industrial Training – I*	0	0	20	----	100	150	250	10
TOTAL				**13**	**0**	**26**	**60**	**205**	**460**	**725**	**26**

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
ESE: End Semester Examination **MET:** Metallurgical Engineering
PRE: Progress Review Examination.

Course Bifurcation (Related to Industrial Training):

S. No.	Subject Code	Board of Study	SUBJECT		Periods per week			Credit (L+(T+P)/2)
					L	T	P	
8.	SOE-D-MT308	MET	**Industrial Training-I***	Coke Making Plant	0	0	4	2
				Sinter Making Plant	0	0	4	2
				DRI Plant	0	0	4	2
				Blast Furnace	0	0	4	2
				Pig Casting	0	0	4	2
TOTAL					**0**	**0**	**20**	**10**

I* - Industrial Training Report submission and presentation

Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Metallurgical Thermodynamics**		
Course Code :	**SOE-D-MT301**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:
This course deals with the understanding of different laws of thermodynamics and will provide deep understanding of the basic principles of thermodynamics and kinetics which is must for understanding of any metallurgical processes involving chemical reactions and physical changes at high temperature.

Course Objectives:

1. To understand various thermo-dynamical concepts;
2. To understand the concept of thermodynamics and kinetics;
3. To understand the various chemical reactions occurring in metallurgical processes;
4. To understand the various physical changes in materials at high temperatures.

Syllabus:

UNIT–I
Definition of thermodynamics, applications of thermodynamics in metallurgy, basic terms used in thermodynamics-system & surrounding, concept of system (isolated, closed, open), homogeneous and heterogeneous systems, state of system, equation of state, properties of a system (extensive, intensive), laws of thermodynamics – 1stlaw, 2nd Law, 3rd law, Zeroth Law.

UNIT–II
First Law of thermodynamics: Internal energy, enthalpy, constant volume and constant pressure process; Isothermal and adiabatic process; heat capacity, importance of Cp and Cv, enthalpy change at constant pressure, enthalpy change with temperature, enthalpy change due to chemical reaction - heat of reaction, heat of formation, heat of combustion, latent heat, heat of solution; simple numerical problems on enthalpy change, heat of reaction, heat of formation.

UNIT–III
Second Law of thermodynamics: entropy, entropy changes for reversible and irreversible processes, Free energy, combined statement of the first and second law of thermodynamics, Max-Wells equation, Gibbs Helmholtz equation, numerical.

UNIT–IV
Thermodynamics of solutions: binary solutions; ideal solutions-

Raoul's law, activity, activity coefficient, Henry's law, partial and integral molar quantities, regular solutions, real solutions, Sievert's law. Gibbs Durham equation and its application, Numerical.

UNIT–V

Kinetics of chemical process, order of reaction: zero order reaction, first order and second order reaction, Determination of order of reaction, Metallurgical Processes such as de-oxidation, desulphurization, decarburization, dephosphorization, Degassing of steel Melts.

References:

1. Introduction to the thermodynamics of Materials by David R. Gaskell.
2. Textbook of Materials and Metallurgical Thermodynamics by Ahindra Ghosh.
3. Problems in Metallurgical Thermodynamics and Kinetics by G. S. Upadhyaya and R.S.Dube.

Course Outcome:

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

1. Explain concepts and laws of thermodynamics;
2. Derive different thermodynamic relations and solve problems;
3. Comprehend the concept and applications of energy, entropy and energy;
4. Interpret Ellingham Diagram for oxides.

Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Heat Treatment of Materials**		
Course Code :	**SOE-D-MT302**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

Course Description:
This course 'Phase Transformations & Heat Treatment of Materials' is principally aimed to introduce the students about basic concept of phases, phase diagrams and phase transformation of materials during heat treatment. The students also will get idea to use the Iron-Cementite diagram, TTT/CCT for different purposes.

Course Objectives:
1. Phase transformation and Heat treatment has become integral parts of metal processing technique to impart the specific properties to the materials;
2. To provide a basic understanding of principles that determines the evolution of structures in metals and alloys during heat treatment and phase transformation which enhances the performance of materials during entire service condition.

Syllabus:

UNIT–I
Principles of heat treatment: purpose of heat treatment, annealing, normalizing, hardening and tempering of steels, hardening defects, temper embrittlement, subzero treatment, martempering and austempering. hardenability and its measurement, effect of alloying on hardenability.

UNIT–II
Classification of alloy steels, advantages and disadvantages of alloy steels, heat treatment of ferrous alloys, heat treatment of non-ferrous alloys.

UNIT–III
Heat treatment of cast irons, structure-property correlation of different cast irons, application of alloy cast irons; age hardening, application of age hardening, study of age hardened alloys.

UNIT–IV
Case hardening and surface treatments: carburizing, nitriding, cyaniding, carbonitriding, nitrocarburising and burnishing, flame, induction and laser hardening of alloys.

UNIT–V
Inspection and quality control: causes and remedies for defects (like low hardness and strength, soft spots, oxidation and decarburization,

overheating and burning, quench cracks, distortion and warping) in heat-treated parts.

References:

1. Heat Treatment, Principles and Techniques by Rajan and Sharma.
2. Heat Treatment of Metals by Vijendar Singh.
3. Handbook of Heat Treatment of Steels by K.H. Prabhudev.

Course Outcomes:

After completion of the course student should able to:

1. Understand the different methods of heat treatment process for steel;
2. Appreciate the concept of hardenability;
3. Identify the types of alloy steels and tool steels and their properties and application.

Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Metal Joining Process**		
Course Code :	**SOE-D-MT303**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:

This course will give fundament knowledge about various joining and their processes like gas, Arc, and advanced joining techniques. Further the course will give awareness about joining of similar and dissimilar alloys.

Course Objectives:

1. To provide the knowledge on basics of joining processes;
2. To gain the knowledge on the Gas and Arc welding and Resistance and Pressure;
3. To know the welding processes;
4. To gain the knowledge on the special welding processes and soldering and brazing techniques;

Syllabus:

UNIT–I

Introduction to metal joining, welding, physics of welding, classification of welding processes, metallurgy of welded joints, principles, application and equipment's used in gas and electric arc welding.

UNIT–II

Oxyacetylene welding, arc welding, arc characteristics, shielded metal arc welding, Gas–Tungsten arc welding, plasma arc welding, Gas–Metal arc Welding.

UNIT–III

Flux-Core arc welding, submerged arc welding, electro slag welding, high energy beam welding: electron beam welding, laser beam welding.

UNIT–IV

Solid state welding and its applications: resistance welding, spot, seam, projection, flash butt welding, Ultrasonic, explosion and friction welding 'soldering and brazing: welding of aluminum and its alloys, welding of cast iron, welding of stainless steels and high alloyed steels.

UNIT–V

Defects in welded joints, inspection and testing of welded joints.

References:

1. Welding Technology by R.S. Parmar.
2. Welding Technology by N.K. Srinivasan.
3. Welding metallurgy by Sindo Kou.
4. Welding and Welding Technology by R. L. Little.

Course Outcome:

Students will know the various metal joining operations and able to adopt this for various metals to understand proper fabricated structure.

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Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Testing of Materials**		
Course Code :	**SOE-D-MT304**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:
This course 'Testing of Material' is principally aimed to introduce the students about mechanical properties, deformation behavior and testing of materials. This course comprises the concept of tensile test, hardness test, fracture test, fatigue and creep test.

Course Objectives:

1. Aware of the engineering problem involved issues related to material selection and to understanding the behavior of materials, particularly mechanical properties correlation helped to select suitable materials for a particular application;
2. To provide a basic understanding of the underlying principles that determines the evolution of structures in metals and alloys during their processing and its relation with their properties & performance in service;
3. The students will get basic concept of different destructive testing's.

Syllabus:

UNIT–I
Basics of plastic deformation, mechanical properties of materials, stress and strain, elastic and plastic strain, engineering. stress-strain, true stress – strain, Relation between true stress and engineering stress and strains, universal testing machine, slip and twinning, yield point phenomena.

UNIT–II
Hardness Test: Brinell hardness test, Vickers hardness, Rockwell hardness, micro hardness tests, impact test, concept of fracture, types of fracture, Griffth's theory of brittle fracture, torsion failure.

UNIT–III
Concept of fatigue and creep failure, S-N curve for fatigue failure, fatigue testing, factors affecting fatigue properties, mechanisms of creep deformation, creep curve, stress- rupture test.

UNIT–IV
Introduction to non-destructive testing, dye penetrant test, ultrasonic test, magnetic test, radiography test and eddy current test.

UNIT–V
Basic concept of creep, various types of creep, creep mechanism, elongation time graph and its significance, creep rate, various types of

creep test and related application.

References:

1. Mechanical Metallurgy by GE Dieter.
2. Introduction to Dislocations by D Hull and DJ Bacon.
3. Mechanical Behavior of Materials by T H Courtney
4. Fundamentals of Material science and engineering by William Callister.

Course Outcome:

After successful completion of the course students should be able to:

1. Know about elastic and plastic deformation of metallic materials;
2. Understand effect of deformation behavior of ductile & brittle material;
3. Able to understand various strengthening methods of metals & alloys;
4. Able to understand various concepts of creep, fatigue behaviors in metals.

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Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Heat Treatment of Materials Lab.**		
Course Code :	**SOE-D-MT305**	**Credits :**	**1**
Max Marks :	**25**	**No of Hours :**	**1 Hrs/Week**

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Course Objectives:

1. Determine the changes in properties of steel on annealing and normalizing;
2. Infer the changes in properties of steel on hardening and tempering;
3. Determine the hardenability of hardened steel.

List of experiments:

1. Study the change in microstructures by annealing of steel.
2. Study the change in microstructures by normalizing of steel.
3. Study the change in microstructures by quenching of steel.
4. Study the change in microstructures by tempering of steel.
5. Study of hardenability of plain carbon steel by Jominy end quench est.
6. Study of surface hardening techniques- pack carburizing,
7. Study the microstructure of heat treated tool steel and stainless steel.
8. Study the effect of cold working on microstructure of steel.
9. Study of nucleation and growth in Eutectoid steel.
10. Effect of cooling parameter on microstructure of rail steel.

References:

1. Handbook of Heat Treatment of Steel, K.H.Prabhudev.
2. Heat Treatment of Metals, Prof. Vijendra Singh.

Outcomes:
After completing this laboratory, students will be able to practically understand the heat treatment process and also understand the structure property correlations co-relation for various materials.

Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Metal Joining Process Lab.**		
Course Code :	**SOE-D-MT306**	**Credits :**	**1**
Max Marks :	**25**	**No of Hours :**	**1 Hrs/Week**

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Course Objectives:

1. To get the hands on practice of various welding process;
2. To gain hands on experience on inspection and testing of weld elements.

List of experiments:

1. Resistance Welding
2. Gas Welding
3. Arc welding
4. MIG welding
5. Soldering and Brazing
6. To Study various welding defects and its Remedies.
7. To study various Joints and their positions
8. To study the microstrucre of the weld joint
9. To study the weld zone, heat affected zone and the base metal.
10. Inspection /testing of welds

References:

1. Welding Technology by R.S. Parmar.
2. Welding Technology by N.K. Srinivasan.
3. Welding metallurgy by Sindo Kou.
4. Welding and Welding Technology by R. L. Little.

Course Outcome:

The students will get the practical exposure of various welding processes during the fabrication of component in structure industry.

Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Testing of Materials Lab.**		
Course Code :	**SOE-D-MT307**	**Credits :**	**1**
Max Marks :	**25**	**No of Hours :**	**1 Hrs/Week**

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Course Objectives:

1. To understand the basic importance of materials testing, its applications, several codes for practical demonstrations along with principles and hands on applications;
2. Able to operate as effective engineers or scientists in materials industries, academia, or related fields.

List of experiments:

1. To perform tensile test of steel.
2. To perform tensile test of aluminium alloys
3. To perform tensile test of brass/bronze
4. To perform Brinell hardness test.
5. To perform Rockwell hardness test.
6. To perform Vickers hardness test.
7. To perform Izod impact test.
8. To perform Charpy impact test.
9. To perform fractography of tensile test specimen.
10. Study of fatigue tests.

References:

1. Mechanical Testing and Evaluation, ASM Hand Book, Vol.8
2. Testing of Materials, A.V. K. Suryanarayan.

Course Outcome:

The course 'Testing of Materials' will help the students to understand the mechanical properties and various mechanical testing processes such. They come to know the basic concepts responsible for mechanical properties of materials. In addition, they also understand the ways to overcome the problem exists in general practices. This course provides a smooth link between the basic knowledge of science and engineering.

Programme:	**Diploma**	**Semester :**	**III**
Name of the Course:	**Industrial Training – I***		
Course Code :	**SOE-D-MT308**	**Credits :**	**10**
Max Marks :	**250**	**No of Hours :**	**10 Hrs/Week**

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Course Description:

The course provides fundamentals knowledge about raw materials required for iron making and its beneficiation processes. Also, it gives knowledge about construction and design of blast furnace and alternative routes of iron making process.

Course Bifurcation (Related to Industrial Expose):

S. No.	Subject Code	Board of Study	SUBJECT		Periods per week			Credit (L+(T+P)/2)
					L	T	P	
8.	SOE-D-MT308	MET	**Industrial Training-I***	Coke Making Plant	0	0	4	2
				Sinter Making Plant	0	0	4	2
				DRI Plant	0	0	4	2
				Blast Furnace	0	0	4	2
				Pig Casting	0	0	4	2
TOTAL					**0**	**0**	**20**	**10**

Course Outcome:

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

1. Identify the nature of raw material for blast furnace production;
2. Identify the various beneficiation processes adopted for iron making;
3. Understand the iron making process through various routes;
4. Correlate the practical aspects of iron making process.

Diploma Semester-IV
(Detailed Syllabus)

Scheme of Teaching and Examination
Diploma in Metallurgical Engineering

Academic Semester-IV (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				
				L	T	P	PRE		ESE	Total Marks	Credit (L+ (T+P)/2)
							Mid Sem	TA			
1	SOE-D-MT401	MET	Iron and Steel Making	4	0	0	15	15	70	100	4
2	SOE-D-MT402	MET	Foundry Technology	4	0	0	15	15	70	100	4
3	SOE-D-MT403	MET	Powder Metallurgy	4	0	0	15	15	70	100	4
4	SOE-D-MT404	MET	Foundry Technology Lab.	0	0	4	---	15	10	25	2
5	SOE-D-MT405	MET	5 S Management Lab.	0	0	2	---	15	10	25	1
6	SOE-D-MT406	MET	Industrial Training – II*	0	0	20	----	105	150	250	10
TOTAL				12	0	26	45	180	380	600	25

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
ESE: End Semester Examination **MET:** Metallurgical Engineering
PRE: Progress Review Examination.

Academic Semester-IV (Proposed)

Course Bifurcation (Related to Industrial Expose): Industrial Training – II*

S. No.	Subject Code	Board of Study	SUBJECT		Periods per week			Credit (L+(T+P)/2)
					L	T	P	
6.	SOE-D-MT406	MET	Industrial Training-II*	SMS-I	0	0	4	2
				SMS-II	0	0	4	2
				RUBM Plant	0	0	4	2
				Rolling Mill	0	0	4	2
				Extrusion Plant	0	0	4	2
TOTAL					0	0	16	10

* Industrial Training-II report submission and presentation.

Programme:	**Diploma**	**Semester :**	**IV**
Name of the Course:	**Iron and Steel Making**		
Course Code :	**SOE-D-MT401**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:

The course provides fundamentals knowledge about history of iron making, raw materials required for iron making and its beneficiation processes. Also, it gives knowledge about construction and design of blast furnace and various reactions takes place inside the blast furnace. Apart from these, this course will give information about alternative routes of iron making and other advanced techniques in the field of iron making.

Course Objectives:

1. Students will become familiar with iron making and steel making;
2. To become conversant with the role of thermodynamics and kinetics in iron and steel making
3. To get the idea of producing iron and steel through different route.

Syllabus:

UNIT –I

History of iron making, iron making in India. raw materials and its preparation- coke: manufacturing process, functions of coke, quality requirements, Iron ore beneficiation and agglomeration processes- Sintering: principle, process variables, and mechanism of sintering, palletization: principle, theory of bonding, mechanism of ball formation, disc and drum pelletizer, induration of pellets, limestone and dolomite.

UNIT –II

Construction and design of blast furnace, different zones of BF, BF refractories and cooling system, operational procedures in blast furnace, raw material charging system, various reactions which takes place at different parts of the BF, products of BF and its utilization. Irregularities in blast furnace and its remedies; modern development of blast furnace operation; blast furnace charge calculations.

UNIT –III

Alternative routes of iron making- sponge iron production – rotary kilns and fastmet processes, finmet, HyL, Midrex processes; Smelting Reduction – Corex, Hismelt, Finex, Fastmelt, and ITmK3 processes.

UNIT –IV

History of steel making process, acid and basic Bessemer processes – their limitations; basic principle of open hearth process and its limitations. design aspects of LD vessel, raw materials for steel making in LD, reactions in LD converter, and modern trends in BOF process, constructional features of electric arc furnace (EAF), raw materials and making of steel in EAF; developments in EAF steel making process; steelmaking in induction furnace, Conarc process.

UNIT –V

Objectives of secondary steel making, degassing processes, deoxidation process, tundish metallurgy, mould used for continuous casting, electromagnetic stirring, thin slab casting and strip casting. casting defects and its remedies. numerical problems on material and heat balance.

References:

1. An Introduction to Modern Iron Making by R H Tupkary and V R Tupkary.
2. Iron Making and Steel Making-Theory and Practice by Ahindra Ghosh and Amit Chatterjee.
3. Principles of Blast Furnace iron making by A K Biswas.
4. Introduction to Modern Steel Making by R.H. Tupkary.
5. Steel making by A.K. Chakravarty.

Course Outcome:
On successful completion of this course, the student will be able to -

1. Know the historical description of iron and steel making;
2. Identify the nature of raw material for iron and steel making;
3. Understand various steel making routes;
4. Appreciate the importance of secondary steel making techniques adopted and gain knowledge about continuous casting of liquid steel.

Programme:	**Diploma**	**Semester :**	**IV**
Name of the Course:	**Foundry Technology**		
Course Code :	**SOE-D-MT402**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:

This course is designed to explore the various foundry practices and the theory behind solidification processes. Various foundry methods, theories and parameters will be discussed in detail. The existing casting technologies and the new insights in metal casting will be discoursed. Casting of various metals and alloys are also explored.

Course Objectives:

1. To learn the basic principles of solidification of metals and foundry technology;
2. To utilize the knowledge for industrial application;
3. Apply basic scientific principles for technical problem solving in foundry to increase technical Skills.

Syllabus:

UNIT–I

Pattern making: Materials for patterns, types of patterns, pattern colors and importance, fundamentals of pattern design, functions and pattern allowances. mould material: moulding sand, constituents of molding sand, properties and selection of materials and additives used, Molding Sand Tests: Moisture test, strength test, and permeability test.

UNIT–II

Core and core making: core, types of cores, core sand, core making material, binders and machines used in core making, core making process, core baking by different methods, finishing of cores. gating and riser system: different elements of gating system – riser, runner, pouring cup, down spur, in-gates etc., types of gates, functions and types of risers, chills, types and functions, Caine's method & Chvorinov's rule.

UNIT–III

Melting practices: crucible furnaces, electric furnaces, induction furnaces, melting of aluminum and its alloys, melting of magnesium and its alloys, steel melting practice, melting practice of cast iron, casting processes: details of different casting processes sand casting, plaster mold casting, permanent mold casting, die casting, centrifugal casting, shell mold casting, investment casting, CO_2 process of casting.

UNIT–IV

Solidification of Castings: Nucleation, growth, rate of solidification, solidification of pure metals, solidification of alloys, directional solidification, methods of obtaining directional solidification, fettling steps.

UNIT–V

Castings Defects: Causes and remedies of following defects: blow holes, gas holes, pin holes, scabs, hot tears, cold cracks, shrinkage cavity.

References:

1. Foundry Technology by O.P. Khanna.
2. Foundry Technology by K.P. Sinha, D.B. Goel.
3. Principles of Metal Casting by Heine, Loper and Rosenthal.

Course Outcomes:

At the end of the course, student would be able to -

1. Select the appropriate design of the molds, patterns etc.;
2. Design a new pattern or mold for required applications, if needed;
3. Choose the appropriate furnace for the production of new materials;
4. Distinguish the casting microstructures for different materials;
5. Minimize and remove the defects during casting process.

Programme:	**Diploma**	**Semester :**	**IV**
Name of the Course:	**Powder Metallurgy**		
Course Code :	**SOE-D-MT403**	**Credits :**	**4**
Max Marks :	**100**	**No of Hours :**	**4 Hrs/Week**

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Course Description:
This course has been intended to improve the students career in metallurgical engineering where knowledge to provide them with an insight into the emerging technology of powder metallurgy as an alternative route to conventional metal processing.

Course Objectives:

1. To assess of emergence and importance of powder metallurgy, scope and limitations;
2. To gain familiarity with fundamental concepts associated with metals powders;
3. Explain the physical and physico-chemical phenomena underlying the processes;
4. To understand the knowledge of powder production techniques and characteristics;
5. Implement the fundamental understanding for further industrial applications.

Syllabus:

UNIT–I
Introduction- Principle, advantages and limitations, applications, classification of powder manufacturing methods, production of metal powder, various powder manufacturing processes, related machining.

UNIT–II
Characteristics and testing of metal powder, methods of analysis, particle characteristics- particle shape, specific surface, apparent density, tap density, flow rate, green density, green Strength, pressing properties.

UNIT–III
Techniques of compaction die compaction-equipment, methods, design considerations, properties of green compacts, high density processing, cold
isostatic pressing, powder rolling and powder forging, advance processes. Sintering.

UNIT–IV
Theory of sintering, sintering mechanisms, sintering variables, sintering furnaces and atmospheres, pressure less sintering, liquid Phase

Sintering, modern sintering techniques: spark plasma sintering, microwave sintering.

UNIT–V

Production of bearings, friction materials, carbide tools, P/M of magnetic materials related tools, dispersion strengthened alloys by P/M, importance of powder alloys, applications of commercial P/M Alloys, P/M applications of porous and bio- materials and related concept.

References:

1. Powder metallurgy technology by G. S. Upadhyaya.
2. Powder metallurgy–science, Technology and applications by P.C. Angelo and R. Subramanian.
3. Powder Metallurgy by A.K. Sinha.
4. Powder Metallurgy of Iron & Steel by Randall M German.

Course Outcomes:

1. At the end of the course, student would be able to -
2. Describe the various routes for powder production and related fundamentals;
3. Characterize the various powders related to industrial applications;
4. Implement different particulate materials for different engineering applications.

Programme:	**Diploma**	**Semester :**	**IV**
Name of the Course:	**Foundry Technology Lab.**		
Course Code :	**SOE-D-MT404**	**Credits :**	**2**
Max Marks :	**25**	**No of Hours :**	**2 Hrs/Week**

Course Objectives:
To learn the concept of different casting techniques and know the requirement of different equipment and accessories related to foundry.

List of Experiments:
1. To determine the moisture content in the molding sand
2. To determine grain fineness number of silica sand.
3. Preparation of sand mould.
4. To determine the hardness of the silica sand.
5. To determine green compressive and shear strength of the molding sand.
6. To determine the shatter index of molding sand.
7. Sand casting of Al alloys.
8. Permanent mould casting of Aluminium.
9. To compare the properties of Aluminium cast in two different molds.
10. Study the casting defects and their remedial measures.

References:

1. Foundry Technology by O.P. Khanna.
2. Foundry Technology by K.P. Sinha, D.B. Goel.

Course Outcomes:

At the end of the course, student would be able to-

1. Prepare molds for different applications;
2. Determine the properties of foundry sand;
3. To cast different metals and alloys;
4. To understand the reason for casting defects and how to eliminate it.

Programme:	**Diploma**	**Semester :**	**IV**
Name of the Course:	**5 S Management Lab.**		
Course Code :	**SOE-D-MT405**	**Credits :**	**1**
Max Marks :	**25**	**No of Hours :**	**1 Hrs/Week**

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Course Description:
This course deals with the understanding 5S as it is a proven project execution methodology being employed across nearly every type of workplace in the industry as well as institutions. This course will provide the basic knowledge of the 5S.

Course Objectives:
1. To reduces the waste
2. To increase the safety issue
3. To increase the productivity of individuals

Syllabus:

THE 5S' STEP-BY-STEP

1. Concept of 5S All About: An overview of the 5S's, benefits and operational impact of implementing the 5S's.
2. Sort: Clearing the work area, organize the work area for efficiency and effectiveness, stepwise approach to clear the work area.
3. Set in Order: Designated Locations Designate "a place for everything" and ensure "everything is in its place", considerations for establishing locations for storing items including: storage rationale, storage options, location- specific tips, storage don'ts, using signs and labels and documenting the plan.
4. Shine: Cleanliness and workplace appearance, three aspects of Shine: getting the workplace clean, maintaining its appearance, and using preventive measures to keep it clean.
5. Standardize: Everyone Doing Things the Same Way, design systems that helps ensure that everyone does things the same way with full involvement, standardized training, and a "copy exactly" mindset.
6. Sustain: Ingrain it in the culture, implement techniques to prevent backsliding to sustain and ingrain workplace organization

References:

1. https://qualitytrainingportal.com/courses/5s-training/
2. https://alison.com/course/the-5s-system-lean-methodology-on-workplace- optimization
3. https://www.udemy.com/course/5-s-workplace-management-technique/

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Programme:	**Diploma**	**Semester :**	**IV**
Name of the Course:	**Industrial Training – II***		
Course Code :	**SOE-D-MT406**	**Credits :**	**10**
Max Marks :	**250**	**No of Hours :**	**1 Hrs/Week**

Course Description:

The course provides fundamentals knowledge about raw materials required for Steel making and its process. Also, it gives knowledge about various products obtained from casting process and its deformation processes.

Course Bifurcation (Related to Industrial Expose):

S. No.	Subject Code	Board of Study	SUBJECT		Periods per week			Credit (L+(T+P)/2)
					L	T	P	
6.	SOE-D-MT406	MET	Industrial Training-II*	SMS-I	0	0	4	2
				SMS-II	0	0	4	2
				RUBM Plant	0	0	4	2
				Rolling Mill	0	0	4	2
				Extrusion Plant	0	0	4	2
TOTAL					**0**	**0**	**16**	**10**

Course Outcome:

On successful completion of this course, the student will be able to -

1. Identify the nature of raw material for steel making production;
2. Understand the steel making process through various routes;
3. Understand various mechanical working process.

Teaching Scheme and Syllabus
of
Diploma in Metallurgical Engineering

(PROGRAM CODE: 01UG050)

[1st Semester and 2nd Semester]

DEPARTMENT OF METALLURGICAL ENGINEERING

SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2025-2028

PROGRAM OUTCOMES:

PO-1:	**Basic and Discipline Specific Knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and an engineering specialization to solve engineering problems.
PO-2:	**Problem analysis**: Identify and analyze well-defined problems using codified standard methods.
PO-3:	**Design/Development of Solutions**: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.
PO-4:	**Modern Tools and Techniques for Scientific Experiments:** Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for a valid conclusion with a clear understanding of limitations.
PO-5:	**Society, Sustainability and Environment**: Apply appropriate technology in the context of society, sustainability, environment and ethical practices.
PO-6:	**Communication and Teamwork:** Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.
PO-7:	**Life-long Learning:** Ability to analyze individual needs and engage in updating in the context of technological changes.
PO-8:	**Society, Environment and Sustainability:** Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO-1:	Able to apply fundamental concepts of metals and materials to explore, develop, and operate in metallurgical and materials domain.
PSO-2:	**Problem analysis**: Identify and analyze well-defined problems using theoretical and practical methods.
PSO-3:	**Design/Development of Solutions**: Design solutions for well-defined technical problems to meet specified needs.
PSO-4:	**Modern Tools and Techniques for Scientific Experiments:** Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for a valid conclusion with a clear understanding of limitations.

Scheme of Teaching and Examination
Diploma (Common to All Branches)

Academic Semester-I (Already passed in previous BOS)

S. No.	Course Code	Board of Study	Name of the Courses	Periods Per Week			Scheme of Exam and Marks				Credit
				L	T	P	PRE		End Sem	Total Marks	(L+ (T+P)/2)
							Mid Sem	TA			
1	MAT25-D-101	MAT	Mathematics-I	3	0	0	15	15	70	100	3
2	HUM25-D-101	HUM	Communication English-I	2	0	0	7.5	7.5	35	50	2
3	PHY25-D-101	PHY	Engineering Physics	3	0	0	15	15	70	100	3
4	CHE25-D-101	CHE	Engineering Chemistry & Environmental Studies	3	0	0	15	15	70	100	3
5	ME25-D-101	ME	Computer Aided Drawing	2	0	4	15	15	70	100	4
6	PHY25-D-102	PHY	Engineering Physics Lab	0	0	2	-	15	35	50	1
7	CHE25-D-102	CHE	Engineering Chemistry Lab	0	0	2	-	15	35	50	1
8	ME25-D-102	ME	Workshop Practice	0	0	4	-	15	35	50	2
9	CSE25-D-101	CSE	Computer Fundamentals Lab	0	0	2	-	15	35	50	1
TOTAL				15	0	10	67.5	127.5	455	650	20

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
PRE: Progress Review Examination.
ESE: End Semester Examination
ME: Mechanical Engineering
CSE: Computer Science and Engineering
PHY: Physics
CHE: Chemistry
MAT: Mathematics.
HUM: Humanities

Scheme of Teaching and Examination
Diploma in Metallurgical Engineering

Academic Semester-II (Proposed)

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				
				L	T	P	PRE		ESE	Total Marks	Credit (L+ (T+P)/2)
							Mid Sem	TA			
1	SOE-25-D-201	META	Introduction to Physical Metallurgy	3	0	0	15	15	70	100	3
2	SOE-25-D-202	META	Fuels, Furnaces and Refractory	3	0	0	15	15	70	100	3
3	SOE-25-D-203	META	Mineral Dressing	3	0	0	15	15	70	100	3
4	SOE-25-D-204	META	Physical Metallurgy Lab.	0	0	4	---	15	35	50	2
5	SOE-25-D-205	META	Fuels, Furnaces and Refractory Lab.	0	0	2	---	15	35	50	1
6	SOE-25-D-206	META	Mineral Dressing Lab.	0	0	4	---	15	35	50	2
7	MAT-25-D-201	MAT	Mathematics-II	3	0	0	15	15	70	100	3
8	HUM-25-D-201	HUM	Communication English-II	2	0	0	7.5	7.5	35	50	2
9	HUM-25-D-202	HUM	Yoga and Meditation	0	0	2	-	15	35	50	1
TOTAL				**14**	**0**	**12**	**67.5**	**127.5**	**455**	**550**	**20**

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
PRE: Progress Review Examination.
ESE: End Semester Examination
META: Metallurgical Engineering
MAT: Mathematics.
HUM: Humanities

Diploma Semester-II
(Detailed Syllabus)

Scheme of Teaching and Examination
Diploma in Metallurgical Engineering

Academic Semester-II

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				
				L	T	P	PRE		ESE	Total Marks	Credit (L+ (T+P)/2)
							Mid Sem	TA			
1	SOE-25-D-201	META	Introduction to Physical Metallurgy	3	0	0	15	15	70	100	3
2	SOE-25-D-202	META	Fuels, Furnaces and Refractory	3	0	0	15	15	70	100	3
3	SOE-25-D-203	META	Mineral Dressing	3	0	0	15	15	70	100	3
4	SOE-25-D-204	META	Physical Metallurgy Lab.	0	0	4	---	15	35	50	2
5	SOE-25-D-205	META	Fuels, Furnaces and Refractory Lab.	0	0	2	---	15	35	50	1
6	SOE-25-D-206	META	Mineral Dressing Lab.	0	0	4	---	15	35	50	2
7	MAT-25-D-201	MAT	Mathematics-II	3	0	0	15	15	70	100	3
8	HUM-25-D-201	HUM	Communication English-II	2	0	0	7.5	7.5	35	50	2
9	HUM-25-D-202	HUM	Yoga and Meditation	0	0	2	-	15	35	50	1
TOTAL				**14**	**0**	**12**	**67.5**	**127.5**	**455**	**550**	**20**

L: Lecture, **T:** Tutorial, **P:** Practical, **C:** Credit
PRE: Progress Review Examination.
ESE: End Semester Examination
META: Metallurgical Engineering
MAT: Mathematics.
HUM: Humanities

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Introduction to Physical Metallurgy**		
Course Code :	**SOE-25-D-201**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:
This course, 'Introduction to Physical Metallurgy' is principally aimed to introduce the students to know how relationships between physical metallurgy, materials science and solid state physics. This course comprises the concept of structure – property correlation, crystal structure, grain size, solid solution, Iron carbon diagram; significance of TTT and CCT diagrams will be discussed.

Course Objectives:
The course will provide the students an insight into importance of crystal structure, solid solution including Iron carbon diagram and metallography.

Syllabus:

UNIT-I
Chemical bonding, space lattice, unit cells, lattice parameter, crystal structure of metals, coordination number, crystal systems, miller indices of planes and directions, Packing factor and density calculation of structures.

UNIT-II
Solid solution and alloys, Hume Rotheryrules, imperfections in crystals, intermediate phases, nucleation and growth of solid.

UNIT-II
System, component, phase, equilibrium, equilibrium diagrams, Phase rule and its applications, degree of freedom, cooling curves, lever rule.

UNIT-IV
Fe-Fe3C phase diagrams, critical temperatures and invariant reactions, study of important binary systems of Fe-Fe3C, isothermal and continuous transformation diagram. diffusion and its laws.

UNIT-V
Metallurgical microscope, application and limitation of metallurgical microscope, types of objectives and eyepieces, metallography.

References:

1. An Introduction to Physical Metallurgy by S.H. Avner.
2. Physical Metallurgy by Vijendra Singh.
3. Material Science& Engineering-A First Course by V Ragavan.
4. Physical Metallurgy Principles, by Robert E. Reed-Hill.

Course Outcomes:

The course of ‘Introduction to Physical Metallurgy’ will help the student to

1. Understand the crystal structure, behavior of materials, the kinetics of phase transformation, the properties of materials and their applications.
2. Make them to understand about structure properties correlation of materials.
3. Provide the concept of relationships between physical metallurgy, materials science and solid state physics.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Fuels, Furnaces and Refractory**		
Course Code :	**SOE-25-D-202**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description

The 'Fuels, Furnaces, Refractories' course is to prepare students for careers in metallurgy engineering where knowledge of 'Fuels, Furnaces, Refractories' can be applied to the advancement of technology. For different metallurgical processes heat treatment is an essential operation for which fuels and furnaces are used. To allow all these thermal processes in a furnace including use of refractory is a prominent issue to contain heat and protect the furnace structure. Study of fuels and refractories is thus a very significant topic in this course.

Course Objectives:

1. To understand a knowledge about solid, liquid and gaseous fuels;
2. To acquire ideas about the manufacturing process and uses of the fuels;
3. To acquire fundamental ideas about the refractories and metallurgical furnaces;
4. To understand constructional and working principles of different types of furnaces and refractories.

Syllabus:

UNIT-I

Definition the fuel, types of fuels, importance of solid, liquid and gaseous fuels, theory of coal, properties of coal, characteristics and significance of its constituents, proximate and ultimate analysis of coal, criteria for selection of metallurgical coal, principle of carbonization and its types, testing of coke, calorific value and its determination through bomb calorimeter, Related numerical.

UNIT-II

Origin and source of liquid fuels, properties and testing techniques for liquid fuels, advantages and disadvantages of liquid fuels; Gaseous fuels-composition, manufacture, properties, application of water gas, carburetted water gas, producer gas, coke oven gas, blast furnace gas and natural gas, combustion and combustion related numerical.

UNIT-III

Different types of metallurgical furnaces and its characteristics: muffle furnace, electric arc furnace, Induction furnace, microwave furnace, reverberatory furnace, furnace accessories and measuring devices, heat losses in furnaces and heat balance natural, forced, induced and balanced draft, chimney height, waste heat recovery.

UNIT-IV

Definition of refractory, classification and characteristics of metallurgical refractory, general production methods of different refractories, testing and application of common and special refractories, selection of refractories for coke oven, blast furnace, convertor, soaking furnaces, castable refractories.

UNIT-V
Modes of failures of refractories in service and its prevention. Modern refractory practices.

References:

1. Fuels, Furnaces and Refractories by O. P. Gupta.
2. Fuels, Furnaces and Refractories by J.D. Gilchrist.
3. Fuels Furnaces, Refractories & pyrometry by A.V. K. Surya Narayana.

Course Outcomes:

After completion of the course, students will be able to

1. Understand the characteristics of different ores and minerals;
2. Familiar with the different ore dressing processes utilized in industrial practices;
3. Use the techniques, skills, and modern engineering tools necessary for industrial practices;
4. Work effectively as an individual and as a member of a multidisciplinary team.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Mineral Dressing**		
Course Code :	**SOE-25-D-203**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:
'Mineral Dressing' is a key engineering discipline, which combines knowledge of chemistry, mathematics with physical principles and real world economic considerations. This course involves the science and technology of adding value to raw mined products through the extraction of valuable minerals and their subsequent conversion into products. The application of process principles of minerals processing operations includes ore preparation, pre-blending, size reduction, separation and concentration, sorting, flotation.

Course Objectives:

1. To familiarize the students with fundamentals of minerals;
2. To understand the distribution of minerals deposits in different forms;
3. To understand the basics of mineral beneficiation;
4. To understand the physical and chemical properties of different ores and minerals;

Syllabus:

UNIT-I
Different types of minerals and their basic characteristics, metallic and non- metallic minerals, scope and objectives of ore dressing, sampling of ores,theory of liberation of minerals, theories of comminution – Kick's, Rittinger's and Bond's theories, concept of Work Index.

UNIT-II
Crushers- types, principles and operational processes. Grinders–principle, types and operations, open circuit and closed circuit of grinding, grinding mills – theory of operation, related parameters and numerical.

UNIT-III
Concept of sizing, laboratory sizing and reporting the data in various numerical and graphical forms factors affecting performance of screens, types of screen, grizzlies, trommels, sedimentation, and elutriation, vibrating and shaking screens, concept of terminal velocity, free and hindered settling ratio, principle of classification, types classifiers.

UNIT-IV
Jigging– Theory of jigging, jigging processes, jigging cycle, types of jigging machines, Concept of Tabling - Theory of flowing film, Wilfley table, Gravity separation-magnetic and electrostatic separation- principles, and operations processes.

UNIT-V
Principle of heavy media separations, principle of flotation, factors affecting flotation, practical utility of frother, collector, modifier, activators; types of flotation cells, application of flotation process.

References:

1. Principles of Mineral Dressing: A. M. Gaudin, Tata McGraw Hill Edition.
2. Principles of Mineral Dressing: A. M. Gaudin, Tata McGraw Hill Edition.
3. S. K. Jain, Ore Processing, Oxford- IBH Publishing Company, 2005.

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

1. Understand the characteristics of different ores and minerals;
2. Familiar with the different ore dressing processes utilized in industrial practices;
3. Use the techniques, skills, and modern engineering tools necessary for industrial practices;
4. Work effectively as an individual and as a member of a multidisciplinary team.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Physical Metallurgy Lab.**		
Course Code :	**SOE-25-D-204**	**Credits :**	**2**
Max Marks :	**50**	**No of Hours :**	**4 Hrs/Week**

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Course Objectives:

1. To operate metallurgical microscope;
2. To prepare test samples for macro and micro studies;
3. Identify the micro and macro constituents in the given sample of metals and alloys.

List of experiments:

1. Study and perform the hot mounting process.
2. Study and perform the cold mounting process.
3. Study and preparation of crystal models.
4. Study of metallurgical microscope and its components.
5. Preparation of specimens for microscopic examination.
6. Study of etching process and etching reagents.
7. Study of microstructure of different steels, cast irons.
8. Study of microstructure of copper, brass and bronze.
9. Study the ASTM method for grain size Measurements.
10. Study the Effect of cold working on microstructure.

Reference Source:

1. The Principles of Metallographic Laboratory Practice by George L. Khel.
2. Hand Book of Metallography and Microstructure, ASM Handbook, Vol. 9.
3. Introduction to Physical Metallurgy, Sidney H. Avner.
4. Material Science by S P Gupta.

Course Outcomes:

1. Conduct and analyze internal characteristics of metals and alloys.
2. Able to know the concept of grain size and related mechanical properties correlation;
3. Perform the problems through experiments and reach a solution related to a specified metal or alloy;
4. Provide continuing professional development and self-learning.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Fuels, Furnaces and Refractory Lab.**		
Course Code :	**SOE-25-D-205**	**Credits :**	**1**
Max Marks :	**50**	**No of Hours :**	**2 Hrs/Week**

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Course Objectives:

1. To understand a knowledge over practical phenomenon of solid, liquid and gaseous fuels;
2. Well-rounded individuals who both understand the principles and also undertake the practice the properties and related uses of the above fuels;
3. To acquire practical fundamental ideas about refractories and metallurgical furnaces;
4. Able to operate as effective engineers or scientists in metallurgical and materials industries or related fields.

List of Experiments:

1. To study of Flash and Fire point of liquid fuel by Pensky-Martin Apparatus.
2. To study of Flash and Fire point of viscous oil by Able's Apparatus.
3. To study of the Kinematic and dynamic viscosity characters of viscous liquid by Redwood Viscometer.
4. To study Bomb Calorimeter.
5. To study of Blast Furnace, Cupola and Induction furnace.
6. Proximate Analysis of coal.
7. Proximate analysis of coke.
8. To study of Refractories.
9. Determination of Spalling Resistance of Refractories.
10. Determination of apparent porosity of a refractory sample.

Reference Source:

1. Refractories and Furnaces, Francis Thompson Havard (Mc-Graw Hill)
2. Industrial Furnaces - Vol. I & II, W. Trinks and M. H. Mawhiney, Wiley
3. Refractories, F. H. Norton, CBLs Publication.

Course Outcomes:

Conduct and analyze a fuel;

1. Ability to select a fuel for their specific applications;
2. Perform of the experiments to reach the sustainable solution related to specified solid or liquid fuels;
3. Provide continuing professional development and self-learning;
4. Overall understanding about the different types of furnaces and refractories.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Mineral Dressing Lab.**		
Course Code :	**SOE-25-D-206**	**Credits :**	**2**
Max Marks :	**50**	**No of Hours :**	**4 Hrs/Week**

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Course Objectives:

1. To adapt and progress in the field of mineral practices;
2. To understand various beneficiation processes of different ores.
3. To understand the principles and processes of the mineral dressing;
4. Able to operate as effective engineers in metallurgical and materials industries or related fields.

List of Experiments:

1. Study of various minerals
2. Determination of reduction ratio in Jaw crusher
3. Crushing the ore using Roll crusher
4. Study of Rod mill.
5. Study of Jigging process.
6. Study of Akin's Classifier
7. Grinding the ore using Ball mill.
8. Grinding of ore using Pot mill.
9. Laboratory Sizing and Sieve analysis.
10. Concentration ore by Froth Flotation Cell.

References:

1. Introduction to mineral processing, Kelly E.G., Spottiswood, D., J.,
2. Mineral Processing Technology, Wills, B.A.

Course Outcomes:

1. Conduct and analyze minerals’ size reduction;
2. Select and redesign a problem;
3. Perform the experiments and reach the sustainable solution related to as specified mineral or ore;
4. Provide continuing professional development and self-learning.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Mathematics-II**		
Course Code :	**MAT-25-D-201**	**Credits :**	**3**
Max Marks :	**100**	**No of Hours :**	**3 Hrs/Week**

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Course Description:

Principles and application in Engineering are firmly ground on abstract mathematical structures. Students passing from secondary level need familiarization with such structure with a view to develop their knowledge, skill and perceptions about the applied science.

Course Objectives:

1. To introduce the concepts of determinants and matrices and apply them to solve systems of linear equations.
2. To develop an understanding of complex numbers, their properties, and their geometric representation.
3. To equip students with fundamental techniques of integral calculus and its practical applications.
4. To familiarize students with the formation and solution methods of first-order and linear differential equations.
5. To provide a foundational understanding of probability theory and its application in analysing random events and outcomes.

Syllabus:

UNIT-I: Determinant and Matrices

Determinant, minor and cofactor, properties of determinant, Cramer's rule, Matrices, addition, subtraction and multiplication of matrices, properties of matrix multiplication, types of matrices, finding inverse of a matrix, Elementary operations on rows or columns, solving simultaneous linear equation.

UNIT-II: Complex Number

Need for complex numbers, Definition, Argand diagram, Modulus and argument, Algebra of complex numbers, square root of a complex number, Exponential and circular functions of complex numbers, polar representation of complex numbers De Moivre's theorem.

UNIT-III: Integral Calculus

Definition, integration of some basic functions, Integration by parts, partial fraction and substitution, definite integration, Application of integration to finding area between two curves.

UNIT-IV: Differential Equation

Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given. Solution of differential equations by method of separation of variables, homogeneous differential equations of first order and first degree. Solutions of linear differential equation, exact diff. equation.

UNIT-V: Probability
Random experiments: outcomes, sample spaces (set representation). Events: Occurrence of events, ‘not’, ‘and’ & ‘or’ events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability, Probability of an event, probability of ‘not’, ‘and’, & ‘or’ events. Multiplications theorem on probability. Conditional probability, independent events, total probability, Baye’s theorem.

Text Books:

1. H. K. Dass, Applied Mathematics for polytechnic, CBS Publishers.
2. G. Prasad, Differential Calculus, Rashi Kansal.

Reference Books:

1. S. L. Loney, The Elements of Coordinate Geometry, Arihant Publication.
2. Hall & Knight, Higher Algebra, Arihant Publication.
3. Mathematics Part- I & Part- II- Textbook for Class XII, NCERT Publication.

Course Outcomes:
After learning the course, the students will be able to:

1. Apply determinants and matrix operations to solve systems of linear equations using methods such as Cramer’s rule and matrix inversion.
2. Represent and manipulate complex numbers in algebraic and polar forms, and apply De Moivre’s Theorem to solve related problems.
3. Evaluate integrals using standard techniques such as substitution, partial fractions, and integration by parts, and apply integration to find areas between curves.
4. Formulate and solve first-order and linear differential equations using appropriate analytical methods.
5. Apply probability concepts, including conditional probability and Bayes’ Theorem, to solve problems involving random experiments and events.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Communication English-II**		
Course Code :	**HUM-25-D-201**	**Credits :**	**2**
Max Marks :	**50**	**No of Hours :**	**2 Hrs/Week**

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Course Description:
This course is designed to help students develop formal communication skills required in professional settings. It covers workplace etiquette, effective listening, non-verbal communication, and public speaking. Students will learn to give presentations, write emails and resumes, and prepare for interviews through practical activities and real-life scenarios. The course aims to build confidence and competence in formal communication.

Course Objectives:
The main objectives of the course are:
1. To introduce students to formal communication practices used in professional environments.
2. To develop effective listening habits and awareness of barriers in communication.
3. To teach the role and use of non-verbal cues in enhancing communication.
4. To build public speaking and presentation skills for academic and professional use.
5. To prepare students for job interviews through resume writing, cover letters, and mock interviews.

Syllabus:

UNIT-I: Formal Communication
Workplace etiquette: office conversations, phone conversations, writing emails, delivering formal speeches.

UNIT-II: Listening skill
Types of listening, principles of effective listening, barriers of listening.

UNIT-III: Nonverbal Communication
Role, importance and types of non-verbal communication, effective communication through non-verbal's cues.

UNIT-IV: Presentation and Public Speaking Skills
Presentation skills: Planning, preparation, and delivery, public speaking: Techniques and practice, delivering just-a-minute sessions.

UNIT-V: Interview Skills
Cover letter, resume writing, group discussion and mock interviews.

Text Book:

1. Viswamohan, English for Technical Communication, McGraw Hill Education.

Reference Books:

1. S. Verma, Technical Communication for Engineers, Vikas Publishing House.
2. S. Kumar and Pushplata, Communication Skills, Oxford University Press.

Course Outcomes:

After learning the course, the students will be able to:

1. Demonstrate proper workplace communication through conversations, emails, and formal speech.
2. Apply effective listening strategies in classroom and professional interactions.
3. Use non-verbal cues confidently to support verbal communication.
4. Prepare and deliver structured presentations and public speeches.
5. Create job-ready resumes, cover letters, and perform well in group discussions and interviews.

Programme:	**Diploma**	**Semester :**	**II**
Name of the Course:	**Yoga and Meditation**		
Course Code :	**HUM-25-D-202**	**Credits :**	**1**
Max Marks :	**50**	**No of Hours :**	**1 Hr/Week**

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Course Description:

This course explores the history, philosophy, and foundational practices of yoga. Students will learn physical postures (asanas), breathing techniques (pranayama), and meditation. The course emphasizes ethical principles and their relevance to modern life. It aims to promote physical health, mental clarity, and emotional balance through yoga.

Course Objectives:

The main objectives of the course are:

1. To introduce students to the meaning, aims, and objectives of yoga and yoga practices.
2. To teach correct techniques and sequences of various asanas, including standing, sitting, and advanced postures.
3. To develop an understanding of the physical and mental benefits of yoga practices, including their precautions and limitations.
4. To train students in foundational yogic techniques such as pranayama, meditation, bandha, mudra, and Surya Namaskar.
5. To promote the addition of yoga into daily life for enhanced physical fitness, emotional balance, and mental clarity.

Syllabus:

UNIT-I: Practice of Yoga

Meaning of yoga, aim and objectives of yoga and yogic practice. Asana (sitting, standing, prone and supine), benefits, sequence, preclusion. Pranayama, meditation, bandha, mudra, surya namaskar.

UNIT-II: List of Asanas

1. Standing Asanas: Tadasana, Triyak tadasana, Katti chakrasana, Trikonasana (any variation), Vriksh asana, Natraj asana, Dolasana.
2. Surya Namaskar.
3. Advance Asanas: Naukasana, Tiryaka Bhujangasana, Shalabhasana**.**

UNIT-III:

Sitting Asanas: Titli asana, Chakki chalasana, Nauka sanchalasana, Paschimottasana, Janu sirsasana, Meru wakrasana (spinal twist), Ardha matsyendrasana (half spinal twist).

Text Books:

1. B. K. S. Iyengar, Light on Yoga: The Bible of Modern Yoga, Schocken Publishers, USA.
2. L. Kaminoff, Yoga Anatomy, Human Kinetics, USA.
3. M. Kirk, The Hatha Yoga Illustrated, Human Kinetics, USA.

4. A. P. Mukerji. The Doctorine and Practice of Yoga. General Books, LLC, New Delhi.
5. W. W. Norton, Yoga for Osteoporosis: The Complete Guide, Norton & Company, USA

Reference Books:

1. N. Sarin, Yoga Dawara Rogoon Ka Upchhar, Khel Sahitya Kendra.
2. S. S. Rama, Breathing, Rishikesh Sadhana Mandir Trust.
3. S. Ram, Yoga & Married Life, Rishikesh Sadhana Mandir Trust.
4. K. Krishna and Bhat, The Power of Yoga, Su Yoga Publications, Mangalore.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the fundamental concepts, aims, and objectives of yoga.
2. Demonstrate correct performance of various asanas, including standing, sitting, and advanced postures.
3. Identify the physical, mental, and therapeutic benefits of specific yoga practices.
4. Effectively practice basic pranayama, meditation, bandha, and mudra techniques.
5. Apply yoga principles and routines in daily life to enhance overall well-being and stress management.

Teaching Scheme and Syllabus
of
B. Tech in Metallurgical and Materials Engineering

(PROGRAM CODE: 01UG050)

DEPARTMENT OF METALLURGICAL ENGINEERING

SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2022-26

B. Tech (Metallurgical and Materials Engineering) (REVISED MAY 25)

PROGRAMME OUTCOME (PO)

Currently OP Jindal University is offering undergraduate programmes (3/4 Years), postgraduate and doctoral programmes in the field of engineering, management, and science. OPJU aims to bring high quality education to its students based on a world class industry- based curriculum, the latest teaching methodology, research, innovation, and entrepreneurship developed by committed faculty members. The outcome of each of the programme in detail are summarized below:

PROGRAM OUTCOMES FOR ENGINEERING GRADUATE

1. **Engineering Knowledge and Problem Analysis** -- Apply the knowledge of engineering domain with adequate amalgamation of science, mathematics, and management to Identify, formulate, and critically analyze complex engineering problems.
2. **Modern tools and techniques for investigating complex problems** – Apply appropriate tools and techniques to analyze, predict and simulate the data for valid conclusion with clear understanding of limitations.
3. **Design and development of innovative systems**: Design and develop system components or processes to provide solutions of complex engineering problems that meet the specified conditions of societal, health, safety, and environmental needs.
4. **Communication and Teamwork -** Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.
5. **Project management and finance**: Develop and apply knowledge of engineering, management, and finance principles to handle a project in a multidisciplinary environment.
6. **Life-long learning**: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.
7. **Ethics and citizenship**: Apply ethical principles and commit to professional ethics, norms, and responsibilities of the engineering practice; and act with informed awareness to participate in civic life activities.
8. **Society, Sustainability and Environment** -- Understand the impact of various solutions in the context of societal, economical, health, safety legal and environmental impact for sustainable development.

PROGRAM SPECIFIC OUTCOME (PSO):

PSO	Engineering Graduates will be able to:
PSO1	Inculcate strong fundamental knowledge and skills in Metallurgical and Materials Engineering domains and able to align the acquired knowledge with other domains.
PSO2	Ability to test and analyze the related methodologies of various metallurgical and materials processes and able to develop an aligned methodology towards the projects or collaborative skills.
PSO3	Ensure the holistic growth through the awareness of effective communications, ethical responsibilities or physical/mental fitness enriched with updated soft skills.
PSO4	Build a solid foundation in the domain of metallurgical and materials Engineering for developing analytical, technical, professional & management skills.

SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering) Academic Semester VII

S. No.	Subject Code	Board of Study	Type of Course	Subjects	Periods per week			Scheme of Examination and Marks				Credit
								PRE**				
					L	T	P	Mid Sem	TA	ESE*	Total Marks	L+(T+P)/2
1.	SOE-B-MME701	MME	CC	Alloys their Properties and Selection	4	0	0	30	20	50	100	**4**
2.	SOE-B-MME702 (1-4)	MME	CC	**Professional Elective-II**	4	0	0	30	20	50	100	**4**
3	SOE-B-MME703	MME	Internship	Internship*	0	0	20	0	125	125	250	**10**
4.	HUM-B-SOE701	HUM	SEC	**Professional Development-I**	0	0	2	0	15	10	25	**1**
5.	SOE-B-MME704	SEC	SEC	Skill Development Course from MOOCs#	0	0	4	0	30	20	50	2
TOTAL					**8**	**0**	**26**	**60**	**210**	**255**	**525**	**21**

L: Lecture, **T:** Tutorial, **P**: Practical, **C**: Credit
*Internship will be of 10-12-week duration (June to August)
****PRE:** Progress Review Examination
***ESE:** End Semester Examination.

Professional Elective-II

S. No.	Subject Code	Board of Study	Subjects
1	SOE-B-MME702 (1)	MME	Design and Selection of Materials
2	SOE-B-MME702 (2)	MME	Introduction to Nano-Science and Nano-Technology
3	SOE-B-MME702 (3)	MME	Ceramic and Powder Metallurgy
4	SOE-B-MME702 (4)	MME	Light Weight Materials

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MOOC's Course

S. No.	Subject Code	Board of Study	Subjects
1	SOE-B-MME704 (1)	MME	Materials data science and Informatics
2	SOE-B-MME704 (2)	MME	Introduction to Solar cells
3	SOE-B-MME704 (3)	MME	Introduction to High-Throughput Materials Development
4	SOE-B-MME704 (4)	MME	Transmission electron Microscopy for Material Science
5	SOE-B-MME704 (5)	MME	Shape and property control of metals I & II
6	SOE-B-MME704 (6)	MME	A circular economy of metal: Towards a Sustainable societal metabolism

Note: Students may opt one subject from any MOOC platform (NPTEL/SWAYAM/SWAYAM+/Coursera)

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SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering)
Academic Semester VIII

S. No.	Subject Code	Board of Study	Subjects	Periods per week			Scheme of Examination and Marks				Credit
				L	T	P	PRE**		ESE*	Total Marks	L+(T+P)/2
							Mid Sem	TA			
1	SOE-B-MME801	MME	Corrosion Engineering	4	0	0	30	20	50	100	4
2	SOE-B-MME-802	MME	Entrepreneurship Development	3	0	0	30	20	50	100	3
3	SOE-B-MME803 (1-4)	MME	**Professional Elective-III**	3	0	0	30	20	50	100	3
4	SOE-B-MME804	MME	Corrosion Engineering Lab	0	0	4	0	30	20	50	2
5	SOE-B-MME805	MME	Major Project	0	0	16	0	50	50	100	10
TOTAL				**10**	**0**	**20**	**90**	**140**	**220**	**450**	**22**

L: Lecture, **T:** Tutorial, **P**: Practical, **C**: Credit
****PRE:** Progress Review Examination
***ESE:** End Semester Examination.

Professional Elective-III

S. No.	Subject Code	Board of Study	Subjects
1	SOE-B-MME803 (1)	MME	Introduction to Stainless Steel
2	SOE-B-MME803 (2)	MME	Advance Materials Processing
3	SOE-B-MME803 (2)	MME	Nuclear Materials
4	SOE-B-MME804 (4)	MME	Energy Storage Materials

B. Tech Semester-VII
(Detailed Syllabus)

SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering)
Academic Semester VII

S. No.	Subject Code	Board of Study	Type of Course	Subjects	Periods per week			Scheme of Examination and Marks				Credit
					L	T	P	PRE** Mid Sem	PRE** TA	ESE*	Total Marks	L+(T+P)/2
1.	SOE-B-MME701	MME	CC	Alloys their Properties and Selection	4	0	0	30	20	50	100	**4**
2.	SOE-B-MME702 (1-4)	MME	CC	**Professional Elective-II**	4	0	0	30	20	50	100	**4**
3	SOE-B-MME703	MME	Internship	Internship*	0	0	20	0	125	125	250	**10**
4.	HUM-B-SOE701	HUM	SEC	**Professional Development-I**	0	0	2	0	15	10	25	**1**
5.	SOE-B-MME704	SEC	SEC	Skill Development Course from MOOCs#	0	0	4	0	30	20	50	2
TOTAL					**8**	**0**	**26**	**60**	**210**	**255**	**525**	**21**

L: Lecture, **T:** Tutorial, **P**: Practical, **C**: Credit
*Internship will be of 10-12-week duration (June to August)
****PRE:** Progress Review Examination
***ESE:** End Semester Examination.

Professional Elective-II

S. No.	Subject Code	Board of Study	Subjects
1	SOE-B-MME702 (1)	MME	Design and Selection of Materials
2	SOE-B-MME702 (2)	MME	Introduction to Nano-Science and Nano-Technology
3	SOE-B-MME702 (3)	MME	Ceramic and Powder Metallurgy
4	SOE-B-MME702 (4)	MME	Light Weight Materials

MOOC's Course

S. No.	Subject Code	Board of Study	Subjects
1	SOE-B-MME704 (1)	MME	Materials data science and Informatics
2	SOE-B-MME704 (2)	MME	Introduction to Solar cells
3	SOE-B-MME704 (3)	MME	Introduction to High-Throughput Materials Development
4	SOE-B-MME704 (4)	MME	Transmission electron Microscopy for Material Science
5	SOE-B-MME704 (5)	MME	Shape and property control of metals I & II
6	SOE-B-MME704 (6)	MME	A circular economy of metal: Towards a Sustainable societal metabolism

Students may opt one subject from any MOOC platform (NPTEL/SWAYAM/SWAYAM+/Coursera)

Program: B.Tech **Semester: VII**
Name of the Course: Alloys their Properties and Selection
Code: SOE-B-MME701 **Credit: 4**
Max. Marks: 100 **No of Hours: 4 hours/week**

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Course Description:
This course has been intended to improve the understanding of the students about the use of alloying and their effect in improving the properties of a material. Various alloying elements and their effects are discoursed. Effect of various alloying elements in both ferrous and non-ferrous alloys will be discussed thoroughly for better understanding.

Course Objectives:
1. Study about alloying and its effect on final properties;
2. Understand the need for alloying and utilize the knowledge in tailoring the alloys for a particular application;
3. Study the various ferrous based alloys, their production, properties and applications;
4. Explore the structure, properties and applications of various non-ferrous alloys;
5. To establish a concrete understanding of alloying and their effects in a particular material atomistically.

Syllabus:

UNIT-I
Specifications of alloys: - ISI, AISI and EN standards (Basic concepts only), Alloying elements, use of alloying, limitations of plain carbon steel, effect of alloying elements on transformation temperature, effect of alloying elements on critical cooling rate, on hardenability and on tempering, low alloy steels such as high tensile structural steel, case hardening steels, ball bearing steels, spring steels, Introduction to alloy design.

UNIT-II
Structure properties and applications of high nickel steels, High Speed Steels, Die Steel, Hadfield steel and maraging steel.

UNIT-III
Introduction to cast irons, structure and properties of white cast irons, gray cast iron, malleable cast iron, nodular cast iron and alloy cast irons, and Stainless steels.

UNIT-IV
Introduction to Non-ferrous alloys, structure and properties of brasses, bronzes, babbits, structure and properties of titanium alloys, aluminum

alloys, monels.

UNIT-V
Effect of low temperature on alloy properties, on notched bar test, magnetic steels and alloys, alloys for electrical applications, zirconium alloys in nuclear technology, high entropy alloys.

Text Books:

1. Physical metallurgy for engineers- by D.S. Clark and Warne.
2. Structures and Properties of alloys- by Robert M. Brick and Phillips.
3. Introduction to Physical metallurgy- by Sidney H. Avner.

Reference Books:

1. The Materials Selector, N A Waterman and M F Ashby, Vols. I, II and III, Chapman and Hall, London, 1996.
2. Engineering Materials: Properties and Applications of Metals and Alloys, Chandra P Sharma, Prentice-Hall of India Pvt. Ltd; 1st edition, 2004.
3. Fathi Habashi, Alloys: Preparation, Properties, Applications, WILEY-VCH Verlag GmbH, 2007.
4. Concepts in Physical Metallurgy, AL Kumar, IOP Science, 2017.
5. ASM Specialty Handbook: Cast Irons, Joseph R. Davis, ASM International, 1996.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Attain an ability to distinguish between various alloying effects;
CO-02	Have an increased level of awareness towards alloys and their applications;
CO-03	Have knowledge on production of alloy steel, cast iron and nonferrous alloys as per their need;
CO-04	Apply their basic understanding in development of alloys with better properties.
CO-05	Understand the properties of various alloys.

CO-PO & PSO Correlation

Course Name: Alloys their Properties and Selection												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	2					1			2			1
CO-02				1	1	1			1			1
CO-03		1	1		1	1			1			1
CO-04	1				1				1			2
CO-05	1		1	1	1				1			2

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VII**
Name of the Course: Design and selections of Materials (PE-II)
Code: SOE-B-MME702 (1) **Credit: 4**
Max. Marks: 100 **No of Hours: 4 hours/week**

Course Description:
This course focuses on the scientific and engineering principles involved in the design and systematic selection of materials for various applications. It emphasizes how the intrinsic properties of metals, ceramics, polymers, and composites influence design decisions in real-world engineering systems. The course is specially tailored for Metallurgical and Materials Engineering students, providing them with tools to apply material selection principles within the broader context of processing-structure-properties-performance relationships. It integrates concepts of mechanical behavior, degradation mechanisms, cost considerations, and sustainability to enable students to make optimal material choices for modern applications.

Course Objectives:
1. Impart a clear understanding of how to approach engineering design with an informed material selection strategy, using both qualitative and quantitative methods.
2. It aims to provide students with the ability to analyze materials based on their performance under various conditions, select them based on design requirements, and justify their choices using tools like Ashby charts and computer-aided systems.
3. Emphasis is placed on developing a holistic perspective, incorporating lifecycle thinking, economic constraints, and the environmental impact of materials.

Syllabus:

UNIT-I: Introduction to Materials and Design
Importance of materials in engineering design, Classification: metals, ceramics, polymers, composites, and hybrid materials, Structure-property-performance relationship, Functional requirements of a component, Design constraints and objectives, Concept of performance indices Ashby's material selection charts: construction and interpretation, Materials selection strategy: screening and ranking, Translation of design requirements into material attributes

UNIT-II: Mechanical and Functional Properties of Materials
Stress-strain behavior and elastic/plastic deformation, Toughness, hardness, and ductility considerations in design, Fatigue strength and fatigue life estimation, Creep deformation and time-temperature dependence, Wear mechanisms: abrasive, adhesive, erosive, Corrosion: types, mechanisms, material susceptibility, Functional properties: thermal conductivity, specific

heat, thermal expansion, Electrical and magnetic properties of materials, Optical and acoustic behavior in functional design.

UNIT-III: Material Selection Methodologies
Stepwise material selection process: translation, screening, ranking, and optimization, Role of materials databases and data reliability, Cost-performance trade-off analysis, Environmental performance indices, Multi-criteria decision-making approaches (e.g., weighted sum model), Introduction to CES EduPack or equivalent software, Application of software in real-world case studies, Design-limiting properties and their estimation, Exercises using Ashby plots for different engineering scenarios.

UNIT-IV: Materials for Advanced and Strategic Applications
Criteria for materials in aerospace and automotive industries, Selection of biomaterials for implants and devices, High-performance alloys for nuclear and high-temperature service, Conductive and dielectric materials for electronic applications, Refractory and ceramic materials for extreme environments, Composite materials: design, processing, and performance trade-offs, Emerging materials: shape memory alloys, nanomaterials, metamaterials, High-entropy alloys and their design principles, Case studies on failures due to improper material selection.

UNIT-V: Sustainable Design and Lifecycle Considerations
Principles of sustainable materials engineering, Lifecycle analysis (LCA) of materials: cradle-to-grave and cradle-to-cradle, Energy and carbon footprint of materials, Eco-selection criteria and Ashby's method for sustainable materials, Circular economy and material recovery strategies, Design for disassembly and recyclability, Safety, reliability, and regulatory aspects in material selection, Environmental compliance and material restrictions (e.g., RoHS, REACH), Future trends in green materials and digital tools for sustainable design

Text/Reference Books:
1. "Materials Selection in Mechanical Design" – Michael F. Ashby
2. "Materials: Engineering, Science, Processing and Design" – Michael F. Ashby, Hugh Shercliff, David Cebon, Publisher: Butterworth-Heinemann
3. "Selection and Use of Engineering Materials" – J.A. Charles, F.A.A. Crane, and D.C. Furness, Publisher: Butterworth-Heinemann
4. "Engineering Materials 1 & 2" – Michael F. Ashby and David R.H. Jones, Publisher: Elsevier.
5. "Introduction to Materials Science for Engineers" – James F. Shackelford
6. "Callister's Materials Science and Engineering" – William D. Callister Jr., David G. Rethwisch, Publisher: Wiley.
7. "Engineering Design: A Materials and Processing Approach" – George E. Dieter, Publisher: McGraw-Hills.

Course Outcomes:

CO	**Metallurgical and Materials Engineering Graduates will be able to:**
CO-01	Understand the fundamentals of material behavior and the structure-property-performance relationship in design
CO-02	Evaluate a wide range of mechanical, functional, and degradation properties relevant to engineering components.
CO-03	Apply structured material selection methodologies and digital tools for optimized decision-making.
CO-04	Identify and recommend materials for advanced applications, considering technological and environmental constraints.
CO-05	Incorporate sustainability, lifecycle thinking, and eco-design principles in material selection and engineering design

CO-PO & PSO Correlation

Course Name: Design and selections of Materials (PE-II)												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO-01	**1**		**2**	**1**		**1**			**1**		**1**	
CO-02	**1**	**2**			**1**					**2**	**1**	
CO-03			**2**	**1**							**1**	**1**
CO-04	**1**											
CO-05		**1**	**2**		**1**				**1**			**1**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VII**
Name of the Course: Introduction to Nano-Science and Nano-Technology (PE-II)
Code: SOE-B-MME702 (2) **Credit: 4**
Max. Marks: 100 **No of Hours: 4 hours/week**

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Course Description:

This course will provide an introduction to scientific principles and applications related to nano technology. This is a system based approach of nano scale with unique functions and characteristics. This course also endows with the nano technology tools and how to use this tools/equipment for nano scale fabrication and characterization.

Course Objectives:

1. To provide a basic knowledge of nanotechnology and overview of nano-materials in terms of the synthesis, characterization, properties;
2. Critically analyse nano technology systems and distinguish their features;
3. Describe operational principles of devices based on nano-scale patterning or nano- structural materials;
4. Know how the potential impact of nano-science in applications;
5. Adopt current challenges of nano-technology.

Syllabus:

UNIT-I

Introduction to nano-science and nano-technology, basic idea about atoms, molecules and structure definition and background of development, length scale, band structure and density at nano-science.

UNIT-II

Technique for synthesis and preparation of nano-materials, bottom up and top approach of nano -technology, electron beam lithography, mechanical milling, sol-gel method, chemical vapor deposition.

UNIT-III

Measurement and characterization of nano-materials, caning probe microscopy, STM and AFM, Electron microscopy, resolution vs magnification, SEM, Field Ion, high resolution TEM.

UNIT-IV

Introduction to Carbon Molecules, Carbon Clusters, Carbon Nano-tube, type of carbon nano- tube, type of carbon nano-tube, formation of carbon nanotube and properties and application of carbon nano-tube.

UNIT-V

Cutting age areas of application of Nanotechnology, state of art of the nano technology, current areas of research, scope and opportunity of the technology, some special topics on application of nano-materials.

Text Books:

1. Introduction to Nanoscale Science and Technology by Massimiliano Di Ventra.
2. Nano technology, Stephane Evoy and James R Helflin, Jr. Kluwer, Academic Publisher, New York.
3. Nano-structured Materials, Carl C Koch, Noyes Publication, 2002.

Reference Books:

1. Introduction to Nanotechnology. Charles P Pool. Frank J Owen, John Weily and Son Publication, New Jersey.
2. Nanotechnology: Basic Science and Emerging Technology, Mick Wilson, Overseas Press, Indian Edition, New Delhi.
3. Introduction to Nano-science and Nanotechnology, K K Chattopadhyay and A.N Banerjee, PHI, Privet Limited, New Delhi.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand the need to increase nanotechnology awareness;
CO-02	Explain the fundamental principles for the different synthesis techniques,
CO-03	Understand the nanomaterials and physical and chemical properties at the nanoscale;
CO-04	Explain general concepts and physical phenomena of relevance within the field of nano-science;
CO-05	Know the processing and characterization tools/equipment to synthesize nano-particles;

CO-PO & PSO Correlation

Course Name: Introduction to Nano-Science and Nano-Technology (PE-II)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	1		1						1			
CO-02	2	1				1			1			1
CO-03	1		1						1			1
CO-04				1	1	1			1		1	1
CO-05	1	2	1			1			2	1		1

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VII**
Name of the Course: Ceramics and Powder Metallurgy (PE-II)
Code: SOE-B-MME702 (3) **Credit: 4**
Max. Marks: 100 **No of Hours: 4 hours/week**

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Course Description:
This course has been intended to improve the students for careers in metallurgy engineering where knowledge to provide them with an insight into the emerging technology of powder metallurgy as an alternative route to conventional metal processing. This course describes the fundamental aspects of advanced ceramic powder preparation, densification and microstructure evolution during sintering procedure. The course provides thorough knowledge of powder production and processing as well as to choose the right technical method to suit application. The major goal is to establish the powder fabrication route as a technologically and economically viable means of materials production.

Course Objectives:
1. Students to gain familiarity with fundamental concepts associated with powdered metals or nonmetals powders;
2. Explain the physical and physico-chemical phenomena underlying the processes of shaping of massive bodies from metal or ceramics powders via dry, wet, or plastic methods;
3. To assess of emergence and importance of powder metallurgy, scope and limitations;
4. To increase the knowledge of powder production techniques and characteristics;
5. To encourage the knowledge of knowledge of compaction and sintering techniques and related applications.

Syllabus:

UNIT-I
Ceramic raw materials, processing and beneficiation, synthesis of ceramic powders by mechanical methods, Sol-gel processing, casting processes, role of processing additives, processing of glass for formation of glass ceramics.

UNIT-II
comparison of powder metallurgy with other manufacturing techniques, its scope and limitations, and applications of powder metallurgy, basic steps for powder metallurgy, metal powder production methods: atomization, reduction from oxide, electrolysis, crushing, milling, condensation of metal vapour,

hydride and carbonyl processes, mechanical milling, new developments.

UNIT-III

Particle size, shape and size distribution of powders, concept of shape factor and aspect ratio, angle of repose, characteristics of powder mass such as apparent density, tap density, flow rate, friction index, surface area, porosity measurements, properties of green compacts and sintered compacts.

UNIT-IV

Powder mixing processes, related parameters, types of compaction presses, behavior of powder during compaction, isostatic pressing, roll compaction, powder extrusion, and forging, slip casting, cold pressing and hot isostatic pressing, modern methods of powder consolidation, compaction tooling and role of lubricants.

UNIT-V

Definition of sintering, solid, stages of sintering, sintering furnaces, driving forces for sintering, mechanism of sintering, sintering atmospheres, sintering zones, effect of variables, powder metallurgy applications especially porous metals, cermets, cemented carbides, electrical and magnetic materials; dispersion strengthened materials etc.

Text Books:

1. Powder Metallurgy: Science, Technology, and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, Universities Press.
2. Powder Metallurgy Science – RM German, MPIF, NJ, USA.
3. Introduction to Powder Metallurgy, A. K. Sinha, Dhanpatrai Publication.
4. Material Science and Metallurgy, Kodgire U. D, 37th edition, Everest Publishing House.
5. Sintering of Ceramics, Mohamed N. Rahaman, CRC Press.

Reference Books:

1. Powder Metallurgy, ASM Handbook, Vol-VII.
2. Handbook of Powder Metallurgy, H. H. Hausner.
3. Powder Metallurgy, W. D. Jones.
4. Sintering Theory and Practice, German, R. M., Metal Powder Industries Federation.
5. Principles of Powder Metallurgy, T. Shukerman.
6. Introduction to ceramics, W.D. Kingery, Wiley & Sons (second edition).

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand the fundamental principles and properties of ceramics such as structure, physical and chemical properties;
CO-02	Have fundamental knowledge on principles of the powder metallurgy part production;
CO-03	Have knowledge of particular powders preparation, their properties, compaction techniques;
CO-04	Conceptualize the blend between theory and practical knowledge especially understanding the key parameters of powder metal processing;
CO-05	Understand sintering mechanisms, process variables, and industrial applications to design advanced materials for engineering systems.

CO-PO & PSO Correlation

Course Name: Ceramics and Powder Metallurgy (PE-II)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	2					1			2			
CO-02		1	1			1			1	2		1
CO-03		2	1			1			1	1		1
CO-04						2			1			1
CO-05				2	1							2

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VII**
Name of the Course: Light Weight Materials (PE-II)
Code: SOE-B-MME702 (4) **Credit: 4**
Max. Marks: 100 **No of Hours: 4 hours/week**

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Course Description:
This course has been intended to improve the understanding of the students about the various light alloys their microstructure, properties and applications. Various alloy classifications and identification has been discoursed.

Course Objectives:
1. To understand the physical metallurgy of light metal alloys;
2. To explore the various properties and applications of light metal alloys;
3. Study the detailed classifications of the light metal alloys.

Syllabus:

UNIT-I
Aluminium alloys, Classification, Properties and physical metallurgy of Al-Cu alloys, Al-Mg alloys, Al-Zn alloys, Al-Mn alloys and Al-Si alloys aluminium alloys: Ternary phase diagrams, Al-Cu-Mg alloys, Al-Si-Mg alloys and Al-Zn-Mg alloys.

UNIT-II
Magnesium alloys, precipitation hardening in magnesium base alloys, Mg-Al-Zn alloys, corrosion resistance of Mg-alloys.

UNIT-III
Commercially pure titanium and its properties, applications, strengthening mechanisms of Titanium alloys. Types of Titanium alloys

UNIT-IV
Beryllium alloys classification, properties and applications, Polymers for structural applications, Metallic foams.

UNIT-V
Types, structure, properties and applications of Composite Materials, Metal Matrix Composites, Polymer matrix composites, Ceramic Matrix composites, Ceramic foams, Polymer foams.

Text Books:
1. Light alloys: Metallurgy of the light metals E. Arnold, I. J. Polmear, Metal Park, Ohio American society for metals, London, 1982.
2. Structures and Properties of alloys, Robert M. Brick and Phillips.
3. Introduction to Physical metallurgy, Sidney H. Avner.

Reference Books:

1. Metallurgical abstracts on light metals and alloys Keikinzoku Shōgakukai, Light Metal Educational Foundation., 1999.
2. Engineering Materials: Properties and Applications of Metals and Alloys, Chandra P Sharma, Prentice-Hall of India Pvt. Ltd; 1st edition, 2004.
3. Concepts in Physical Metallurgy, AL Kumar, IOP Science, 2017.
4. Alloys: Preparation, Properties, Applications, Fathi Habashi, WILEY-VCH Verlag GmbH, 2007.
5. ASM Metals Handbook Vol-1 & 2.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Attain sound knowledge on microstructures, properties, and applications of several nonferrous alloys such as Al, Be, Mg, Ti alloys;
CO-02	Design light alloys for specific metallurgical applications.
CO-03	Understand the properties, applications, and strengthening mechanisms of commercially pure titanium and its alloys.
CO-04	Understand the classification, properties, and applications of beryllium alloys, polymers for structural applications, and metallic foams.
CO-05	Understand the types, structure, properties, and applications of various composite materials.

CO-PO & PSO Correlation

Course Name: Light Weight Materials (PE-II)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	2		1			1			1			1
CO-02	1	1	1			1			1	1		1
CO-03	1	1		1	1				1		1	
CO-04	1	1	1						1			1
CO-05	1		2		1					1		1

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VII**
Name of the Course: Internship
Code: SOE-B-MME703 **Credit: 10**
Max. Marks: 250 **No of Hours: 20 hours/week**

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Course Description:
Every student of 7th semester has to undergo three-month Internship Program after the completion of their 6th semester in a reputed Industry/Organization/Research Institute. Department facilitates this rigorous internship under the Mentorship both from Institute and industry/Organizations/Research Institute. In this course, students first visit the place as assigned and after completing the program, students will submit their Report to the Departmental Mentor individually and evaluation of final report based on both of the mentors' comments.
This course provides fundamentals knowledge about practical experience in an organization and also an excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. Through this program, students get opportunities to learn new skills, practice communication and teamwork skills, learn strategies like time management, multi-tasking etc. in an industrial setup and likewise to meet new people and learn networking skills. Finally makes a valuable addition to their resume for job/higher education/ entrepreneurship.

Course Objectives:

1. To acquire on-job skills, knowledge, attitudes, and perceptions along with the experience needed to constitute a professional identity;
2. To encourage the supervised professional experiences;
3. To provide an insight into the working of the real organizations;
4. To understand the practice of individual department and their interconnectivity;
5. To develop perspective idea of a business organization/ industry/ research institute;
6. To help the students to explore career opportunities in their areas of interest;
7. To grow deeper understanding in specific functional areas.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Gain knowledge of a specific company/industry about various job functions;
CO-02	Acquire specific skills, confidence, competency towards carrier front;
CO-03	Work independently with sensitivity for the organization;
CO-04	Practice communication and teamwork skills;
CO-05	Understand effective management of personal behavior, ethics and attitudes.

CO-PO & PSO Correlation

Course Name: Internship												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	1	2							1	2		2
CO-02	1	1				2				2		2
CO-03		1					1	1		1		1
CO-04				2			1	1				2
CO-05							2	2				2

Note: 1.: Low 2.: Moderate 3.: High

B. Tech Semester-VIII
(Detailed Syllabus)

SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering)
Academic Semester VIII

S. No.	Subject Code	Board of Study	Subjects	Periods per week			Scheme of Examination and Marks				Credit
				L	T	P	PRE**		ESE*	Total Marks	L+(T+P)/2
							Mid Sem	TA			
1	SOE-B-MME801	MME	Corrosion Engineering	4	0	0	30	20	50	100	4
2	SOE-B-MME-802	MME	Entrepreneurship Development	3	0	0	30	20	50	100	3
3	SOE-B-MME803 (1-4)	MME	**Professional Elective-III**	3	0	0	30	20	50	100	3
4	SOE-B-MME804	MME	Corrosion Engineering Lab	0	0	4	0	30	20	50	2
5	SOE-B-MME805	MME	Major Project	0	0	16	0	50	50	100	10
TOTAL				**10**	**0**	**20**	**90**	**140**	**220**	**450**	**22**

L: Lecture, **T:** Tutorial, **P**: Practical, **C**: Credit
****PRE:** Progress Review Examination
***ESE:** End Semester Examination.

Professional Elective-III

S. No.	Subject Code	Board of Study	Subjects
1	SOE-B-MME803 (1)	MME	Introduction to Stainless Steel
2	SOE-B-MME803 (2)	MME	Advance Materials Processing
3	SOE-B-MME803 (2)	MME	Nuclear Materials
4	SOE-B-MME804 (4)	MME	Energy Storage Materials

Program: B.Tech | **Semester: VIII**
Name of the Course: Corrosion Engineering | **Code: SOE-B-MME801**
Credit:4 | **No of Hours: 4 hours/week**
Max. Marks: 100

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Course Description:

The course provides fundamentals knowledge and able to apply this knowledge in corrosion domains. Prerequisite to study this subject requires the fundamental knowledge across chemistry, physics, and metallurgy fundamentals. This subject includes underpinning corrosion processes and respective approaches to control through advanced techniques ranging from material selection through cathodic protection to corrosion inhibition and the protective coatings. Moreover, the sophisticated advance tools used are also to be covered.

Course Objectives:

1. To learn advanced topics of corrosion and advanced corrosion with emphasis on basic concepts.
2. To understand the significance of corrosion principles.
3. Learn about the various types of form of corrosion.
4. Select the appropriate corrosion protection approach for engineering applications.

Syllabus:

UNIT-I

Introduction: Definition of corrosion Cost of Corrosion, corrosion damage, environments, classification of corrosion. Corrosion Principles: Electrochemical reactions, thermodynamics of corrosion, cell potential, EMF and galvanic series, representation of cell/cell diagram, electrode kinetics.

UNIT-II

Forms of Corrosion: Uniform attack, galvanic or two-metal corrosion, crevice corrosion, pitting corrosion, inter-granular corrosion – sensitization and weld decay, Selective leaching, erosion-corrosion; Stress corrosion cracking (SCC), and hydrogen damage.

UNIT-III

Exchange current Density, Pilling Bed Worth ratio, polarization – activation, concentration and combined, Pourbaix diagram, Evans diagram, Passivation, mixed potential theory, passivity, methods of testing in corrosion like Potentiodynamic polarization, linear polarization, electrochemical impedance, Spectroscopy, weight loss.

UNIT-IV

Selection of corrosion-resistant materials – alloying, stainless steel, and brass, aluminium, magnesium, and its alloys. Titanium and its alloys.

UNIT-V

Corrosion Prevention (Materials, alteration of environments, design, protection techniques, coatings), case studies of corrosion in industry e.g. steel, chemical, fertilizer, food, etc.

Text Books:

1. Fontana M.G, Corrosion Engineering, Tata McGraw Hill, 3rd Edition, 2005
2. Sudarshan T.S, Surface Modification Technologies-An Engineers guide, Marcel Dekker, Newyork, 1989.
3. Electroplating and other surface treatments, A Practical Guide, CD Varghese, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.

Reference Books:

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

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Learn the applications of cathodic and anodic protection to engineering systems.
CO-02	Have fundamental knowledge on of electrochemical reaction of alloys and cathodic and anodic relations.
CO-03	Analyze the Tafel curve in acid, gases and mixture of both.
CO-04	Construct a system for protection of materials through various coating.
CO-05	Select and apply corrosion-resistant materials, including stainless steel, aluminum, magnesium, titanium, and their alloys, for various applications.

CO-PO & PSO Correlation

Course Name: Corrosion Engineering												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	**2**	**1**				**1**			**1**	**1**		**1**
CO-02	**2**	**1**	**1**			**1**		**1**	**1**	**1**		**1**
CO-03	**1**	**2**	**1**			**1**			**1**	**2**		**2**
CO-04			**1**		**1**				**1**	**1**		**1**
CO-05	**1**	**2**	**1**					**1**	**1**			

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Entrepreneurship Development
Credit:3
Max. Marks: 100

Semester: VIII
Code: SOE-B-MME802
No of Hours: 3 hours/week

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Course Description:

This course is designed for 4th Year B. Tech student so that they can appreciate appreciate and understand the importance of Entrepreneurship and its effect on Country's economy. The course motivates the students to go for entrepreneurship and they will be equipped with the knowledge of Entrepreneurship. Students will be able to understand the different types of legal entities and how to generate funds and market their products and services

Course Objectives:

1. To Develop Entrepreneurial Qualities and Skills.
2. To Provide Comprehensive Business Knowledge and Competencies.
3. To Foster Innovation and Creativity.
4. To Promote Self-Employment and Economic Growth.
5. To Enhance Managerial and Leadership Skills.

Syllabus:

UNIT-I

Economic Contributions of Entrepreneurs, Definition, Motivation and Types of Entrepreneurship Vision, Mission and Values, Entrepreneurial Qualities, Myths and Realities around Entrepreneurship. Causes of Failure of Startups, Why Startups Fail?

UNIT-II

Forms of Legal Entities Factors Driving Competitive Advantages Marketing for Startups Marketing Research, Business Model, Canvas Value, Proposition Canvas, Illustration of Business Model Canvas

UNIT-III

Features of Winning Business Models Business Model Identifying Opportunities Based on Trend Circle of Competence and Effectuation, Lean, Startup

UNIT-IV

Design and Innovation Introduction to Financial Statements Depreciation and Amortization and Treatment of Capital Gain or Loss from Sale of Fixed Asset Cost, Volume, Profit: Break-Even Point Analysis

UNIT-V

Founding Team and Early Recruits Business Plan, Pitching the Business Plan: Funding New Venture –Some Dos and Don’ts, Market Strategies, Capital Budgeting Decisions, Startup Valuation, Human Resource Management, Growth Strategies

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Appreciate and understand the importance of Entrepreneurship and its effect on Country’s economy
CO-02	Understand the forms of legal entities, competitive advantages, marketing strategies for startups, and business modeling tools like the Business Model Canvas and Value Proposition Canvas.
CO-03	Understand the different types of legal entities and ow to generate funds and market their products and services
CO-04	Understand financial statement analysis, depreciation, amortization, and cost-volume-profit analysis, enabling them to make informed business decisions.
CO-05	Understand the key aspects of launching and growing a startup, including building a founding team, creating a business plan, pitching for funding, market strategies, and growth management.

CO-PO & PSO Correlation

Course Name: Entrepreneurship Development												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	1					1			2			1
CO-02	1	2			1	1			2	1		2
CO-03			1		1	1			1	1		1
CO-04	1	1	2			1			1	2		1
CO-05	1		2		1				1			1

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech | **Semester: VIII**
Name of the Course: Introduction to Stainless Steel (PE-III) | **Code: SOE-B-MME803 (1)**
Credit:3 | **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Descriptions:

This course is an industry linked course. Department used to conduct this course in association with Jindal Stainless Steel (JSL), Hissar, Haryana. This course is relevant to the steel industry practices and lectures being delivered by the eminent Industrial Professionals of JSL, Hissar, Haryana. Students used to gain the knowledge through direct interactions with the steel professionals and also develop their skills in work ethics, communication and management aspects.

Course Objectives:

1. Identify the mechanical and physical properties of the different types and grades of stainless steel.
2. Specific application of different types and grades of stainless steel.
3. Troubleshoot industrial problems related to stainless steel.
4. Manufacturing processes of stainless steel components.
5. Design aspects of stainless steel products.

Syllabus:

This Course is solely designed by the JSL, Hissar, Haryana and delivered accordingly.

UNIT-I

Stainless Steel (SS) making process: complete overview, advancements in technology, if any. Family tree of SS, major grades, functions of alloying elements and their impact on mechanical properties of SS, cost implications of alloy addition and using substitutes, phase transformations in Stainless Steel, secondary phase transformations, mechanism of phase transformation and its effect on properties of SS.

UNIT-II

Stainless Steel fabrication: Hot rolling, cold rolling, shearing, cold roll forming (CRF), process mechanism, tools and equipment, issues faced during fabrication of stainless steel and their solutions, corrosion in stainless steel, galvanic corrosion, mechanism and prevention, pitting corrosion: mechanism and prevention, PREN, crack propagation mechanisms, inter-granular and trans-granular.

UNIT-III

Welding of Stainless Steel: Sensitization/Weld decay: causes, mechanisms, remedies, high temperature sensitization, 475 embrittlement, α' phase transformation, distortion: causes, mechanisms, remedies, effect of alloying elements on weldability of SS, Schaeffler De Long diagram interpretations: Cr, Ni and C equivalent.

UNIT-IV

Testing of Stainless Steel: PMI technique, other NDT methods, handling and storage of stainless steel, recommended procedures for storage.

UNIT-V

Applications of stainless steel in various segments: current applications of SS grades, conversion of components into SS and reasons for the same.

Text Books:

1. Ghosh, Secondary Steelmaking – Principle & Applications, CRC Press – 2001.
2. Ahindra Ghosh and Amit Chatterjee, Ironmaking and Steelmaking Theory and Practice, Prentice-Hall of India Private Limited, 2008.
3. An Introduction to Modern Steel Making, R H Tupkary, Khanna Publication, India.

Reference Books:

1. Ghosh, Principles of Secondary Processing and Casting of liquid steel, Oxford & IBH Publication.
2. Fundamentals of steel making, E.T. Tukdogan.
3. Steel making, Kurdin.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Distinguish between various stainless steels.
CO-02	Have an increased level of awareness towards stainless steel and their applications.
CO-03	Have fundamental understanding of the phase transformations in ferrous alloys.
CO-04	Apply their basic understanding in development of alloys with better properties.
CO-05	Understand the applications of stainless steel in various industries, current uses of different SS grades, and the reasons for converting components to stainless steel.

CO-PO & PSO Correlation

Course Name: Introduction to Stainless Steel (PE-III)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01		2	1			2			2			1
CO-02	1	3	2			2			2	2		1
CO-03	1	3	2			2			2	2		1
CO-04	1	3	2			2			2	2		1
CO-05	1	1		1					1	1		

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VIII**
Name of the Course: Advanced Materials Processing (PE-III) **Code: SOE-B-MME803 (2)**
Credit:3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Descriptions:
Advanced Materials Processing focuses on the science and engineering behind modern techniques used in shaping, forming, and fabricating advanced materials such as composites, ceramics, polymers, and high-performance alloys. The course aims to provide students with a comprehensive understanding of processing-structure-property relationships, enabling the design and manufacture of materials for high-end applications across industries such as aerospace, biomedical, automotive, and electronics.

Course Objectives:

1. To impart in-depth knowledge of the processing and behavior of advanced materials.
2. To study structure-property-processing relationships in composites, aerospace alloys, and nanomaterials.
3. To familiarize students with modern fabrication methods and surface modification technologies.
4. To understand the applications of smart materials and nanostructured materials in engineering.
5. To develop analytical skills to assess material selection for high-performance applications.

Syllabus:

UNIT-I
Composite Materials: Types of metal matrices and reinforcements and their properties, bonding mechanisms, structure-property relationships, preforms, design of composites. Physical and mechanical properties. Characterization of microstructures and macrostructures. Fabrication techniques – metal infiltration, pressure and vacuum casting methods. Case studies.

UNIT-II
Aerospace Alloys: High strength Aluminium and Magnesium alloys, Nickel and Cobalt-based Superalloys, Titanium alloys, their structures, structure-property relationships, heat treatment. Directional solidification and single crystal turbine blades. Case studies.

UNIT-III
Smart Materials and Nanomaterials: Shape memory materials – concept of shape memory, crystal structure, phase transformation mechanism, characteristics, properties, classification, applications. Nanomaterials – properties, classification, characterization techniques, materials behavior,

fabrication methods, and applications.

UNIT-IV

Advanced Ceramics and Glasses: Structure and types of advanced ceramics; oxide and non-oxide ceramics; ceramic matrix composites. Processing techniques – slip casting, tape casting, spark plasma sintering, hot pressing. Bio-ceramics and transparent ceramics. Glass ceramics – structure, processing, and applications. Mechanical and thermal behavior.

UNIT-V

Surface Engineering and Advanced Coating Technologies: Thermal spraying, plasma spray, laser cladding, physical vapor deposition (PVD), chemical vapor deposition (CVD), ion implantation, surface alloying. Tribological performance improvement, corrosion resistance, biomedical coatings. Case studies on surface-engineered components in aerospace and biomedical applications.

Text Books:

1. Clyne T. W. and Withers P. J. – 'An Introduction to Metal Matrix Composites' – Cambridge University Press – 2003
2. Duerig T. W, Melton K. N., Stöckel D. and Wayman C. M. – 'Engineering Aspects of Shape Memory Alloys' – Butterworth Heinemann – 1990

Reference Books:

1. 'Handbook of Nanostructured Materials and Nanotechnology' – Academic Press – 2000
2. Wang Z. I., Liu Y. and Zhang Z. – 'Handbook of Nanophase and Nanostructured Materials: Vol 1. Synthesis' – Kluwer Academic/Plenum Publishers – 2002
3. Sinha A. K. – 'Physical Metallurgy Handbook' – McGraw Hill – 2002

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Identify and classify different advanced materials and their applications.
CO-02	Analyze the processing methods and microstructural characteristics of composite and aerospace materials.
CO-03	Understand the behavior and functional mechanisms of smart and nanomaterials.
CO-04	Apply suitable fabrication techniques for advanced materials based on property requirements.
CO-05	Evaluate the performance of processed materials through case studies and structure-property analysis.

CO-PO & PSO Correlation

Course Name: Advanced Materials Processing (PE-III)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	1	2	1	2					1	1		1
CO-02	1	2	1									1
CO-03	1		1		2				1		1	
CO-04	2	1		1					2	1	1	
CO-05	1		1	1					1		1	

Note: 1.: Low 2.: Moderate 3.: High

OPJU

NAAC GRADE A Accredited University

Program: B.Tech | **Semester: VIII**
Name of the Course: Nuclear Materials (PE-III) | **Code: SOE-B-MME803 (3)**
Credit:3 | **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Descriptions:

This course provides a comprehensive overview of materials used in nuclear reactors, including fuels, cladding, moderators, control materials, and structural components. It focuses on material behavior under extreme environments such as high temperature, radiation exposure, and corrosive conditions, with attention to degradation mechanisms and material selection strategies in fission and fusion systems.

Course Objectives:

1. To understand the role and requirements of materials used in nuclear applications.
2. To study the effects of irradiation and high-temperature environments on material properties.
3. To explore the design and performance of nuclear fuels, claddings, and structural materials.
4. To introduce corrosion, creep, swelling, and embrittlement issues in nuclear reactors.
5. To provide insights into material challenges for advanced reactor concepts and fusion systems.

Syllabus:

UNIT-I

Introduction to Nuclear Materials: Classification of nuclear materials – fuels, cladding, moderators, coolants, reflectors, control and shielding materials. Basic nuclear interactions relevant to materials – neutron cross-section, energy spectrum, neutron economy. Overview of reactor types and material compatibility.

UNIT-II

Nuclear Fuel Materials: Uranium and plutonium-based oxide fuels, carbide and nitride fuels, thorium-based fuels, dispersion fuels, metallic fuels. Fuel fabrication techniques – pelletizing, sintering, coating. Thermal conductivity, swelling, fission gas release, burn-up effects. Spent fuel behavior and reprocessing.

UNIT-III

Radiation Effects on Materials: Point defects, dislocation loops, voids, and gas bubbles. Irradiation creep, swelling, embrittlement, and phase instability. Radiation-induced segregation and transmutation. Mechanical property degradation under irradiation. Testing and characterization of irradiated materials.

UNIT-IV

Cladding and Structural Materials: Zirconium alloys, stainless steels, advanced austenitic and ferritic-martensitic steels. High-temperature behavior, oxidation, corrosion in primary coolants. Stress corrosion cracking, hydrogen embrittlement. Weldability and joining issues in nuclear systems. Case studies from LWR and fast reactor materials.

UNIT-V

Materials for Advanced and Fusion Reactors: Refractory metals, SiC/SiC composites, ODS alloys, tungsten-based materials. Material challenges in fusion environments – neutron wall load, tritium retention, plasma-material interactions. Radiation-tolerant material design. High-entropy alloys and novel concepts for next-generation reactors.

Reference Books:

1. Frost, “Nuclear Fuel Elements: Design Fabrication and Performance”, pergamon publications, 1982.
2. Gupta C K “Materials in Nuclear Applications” vol.1, CRC publications, 1989.
3. Kaufman A R, John Wiley, “Nuclear Reactor Fuel Elements, Metallurgy and Fabrication”, 1962
4. Olander D R., “Fundamental Aspects of Nuclear Reactor Fuel Elements” NTIS publication, 1976
5. Benedict M and Pigter T.A. “Nuclear Chemical Engineering” Mcgraw Hill 1981
6. Combined power plants by J.H.Horlocks by Pergamon press,1992
7. L.C. Merrite, “Basic principles of Nuclear science and Reactors” Wiley Eastern 1977.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Classify and describe the functions of various nuclear materials in reactor systems.
CO-02	Analyze the effects of radiation damage and thermal exposure on material behavior.
CO-03	Evaluate the performance and failure mechanisms of nuclear fuels and claddings.
CO-04	Apply knowledge of degradation phenomena in assessing materials for reactor safety and longevity.
CO-05	Understand material needs and innovations for next-generation and fusion reactors.

CO-PO & PSO Correlation

Course Name: Nuclear Materials (PE-III)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	1	1	1						1	2		
CO-02			2	1					1		1	
CO-03	1	1		1						1		
CO-04	1	1		2					1	1		
CO-05	1		1						1		1	

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VIII**
Name of the Course: Energy Storage Materials (PE-III) **Code: SOE-B-MME803 (4)**
Credit:3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Descriptions:
This course provides an in-depth understanding of various materials used for energy storage applications. It covers the principles, classifications, and performance characteristics of energy storage materials, including batteries, super capacitors, hydrogen storage, and thermal energy storage systems. The course emphasizes the relationship between material properties and their energy storage capabilities.

Course Objectives:

1. To understand the fundamental principles of energy storage systems.
2. To study various materials used in different energy storage technologies.
3. To analyze the performance characteristics of energy storage materials.
4. To explore recent advancements and applications of energy storage materials.
5. To evaluate the suitability of materials for specific energy storage applications.

Syllabus:

UNIT-I
Introduction to Energy Storage Systems, Classification of energy storage systems: mechanical, thermal, electrical, chemical, Importance and applications of energy storage in modern technology, Criteria for material selection in energy storage applications.

UNIT-II
Electrochemical Energy Storage Materials, Battery technologies: lead-acid, nickel-cadmium, lithium-ion, sodium-sulfur, Electrode materials: anode and cathode materials, electrolytes, Performance parameters: energy density, power density, cycle life, efficiency.

UNIT-III
Super capacitors and Hybrid Systems, Principles of super capacitors: electric double-layer capacitors, pseudo capacitors, Materials for super capacitors: carbon-based materials, metal oxides, conducting polymers, Hybrid energy storage systems: combining batteries and super capacitors.

UNIT-IV
Hydrogen and Thermal Energy Storage Materials Hydrogen storage methods:

metal hydrides, chemical hydrides, physisorption, Materials for hydrogen storage: alloys, nanostructured materials, Thermal energy storage: sensible heat storage, latent heat storage, phase change materials.

UNIT-V
Advanced Energy Storage Materials and Applications, Emerging materials: solid-state electrolytes, redox flow battery materials, Nanomaterials in energy storage: synthesis, properties, applications, Case studies on energy storage systems in renewable energy integration.

Text Books:

1. Energy Storage: Fundamentals, Materials and Applications by Robert A. Huggins
2. Materials for Energy Storage by Niroj Kumar Sahu, Arpan Nayak, and Grace
3. Energy Storage and Conversion Materials by Stephen Skinner
4. Energy Storage Materials Characterization: Determining Properties and Performance
5. Energy Storage: A Nontechnical Guide by Richard Baxter

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Explain the working principles and classifications of various energy storage systems.
CO-02	Analyze the structure–property relationships of materials used in batteries, supercapacitors, and other storage systems.
CO-03	Evaluate the performance characteristics of energy storage materials in terms of energy density, power density, and cycle life.
CO-04	Compare different material systems for hydrogen and thermal energy storage applications.
CO-05	Propose suitable materials and design strategies for emerging and hybrid energy storage technologies.

CO-PO & PSO Correlation

Course Name: Energy Storage Materials (PE-III)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO-01	1	1	1						1	1	2	
CO-02				2	1					1	2	
CO-03	1		1						1		1	1
CO-04	1	1		1						1		
CO-05		1	1	1					1		1	

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Corrosion Engineering Lab
Credit:2
Max. Marks: 50

Semester: VIII
Code: SOE-B-MME804
No of Hours: 4 hours/week

Course Description:

The laboratory course provides practical knowledge thorough training in corrosion and its surface modification techniques. Students will get an expose in surface techniques ranging from material selection till surface coating for protection of corrosion and wear issues.

Course Objectives:

1. To learn the concept regarding the degradation of materials.
2. To understand the behavior of corrosive environment on the respective materials.
3. To learn the handling of equipment used for surface modification techniques.
4. Acquiring knowledge of various coating processes used in industries.
5. Providing hands-on experience in pin on disc wear testing.

List of Experiments:

1. Corrosion rate measurement by weight loss study.
2. Corrosion rate measurement by electrochemical study.
3. Corrosion in sulfide environment.
4. Electroplating of Cu and Ni.
5. Oxidation loss at high temperature.
6. To find out the wear rate of different materials using a wear testing machine.
7. Electrochemical impedance, cyclic potentiodynamic polarization, and polarization resistance test of metallic coating in seawater.
8. Corrosion and wear analysis of electroplating of steel.
9. Evaluation of corrosion characteristics by potentiostatic /galvanostatic techniques –investigation of the effectiveness of inhibitors.
10. Determination of wear, wear rate and wear characteristics pin on disc wear testing.

List of Equipment:

1. Pin on Disc Wear Testing Machine
2. Potentiostat/Galvanostat.
3. Respective chemicals and metals.
4. PH measuring instrument.

5. Digital weight balance.
6. High-temperature furnaces.
7. Optical Microscopes.

Course Outcomes:

COs	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Have the knowledge of different corrosion and surface engineering laboratory related equipment.
CO–02	Hands on experience on various surface medication techniques related to corrosion and wear methods.
CO–03	Understand the electrochemical properties of the coated materials.

CO-PO & PSO Correlation

Course Name: Corrosion Engineering Lab												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**	**2**	**1**	**1**				**1**	**1**	**1**		**1**
CO–02	**2**	**2**	**1**	**1**				**1**	**1**	**1**		**1**
CO–03	**1**	**2**	**1**	**2**				**1**	**1**	**1**		**1**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Major Project
Credit:10
Max. Marks: 100

Semester: VIII
Code: SOE-B-MME805
No of Hours: 16 hours/week

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Course Description:

Major Project has its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of UG curriculum and related to project/research practicality of their own field of specialization/interest. This course provides the students a space to work of their technical choice field

Course Objectives:

1. To set out the chosen project/research methods, including their theoretical basis, and the literature supporting;
2. To perform experiments and correlate the results to reach a discussion;
3. Aim to increase the analytical methods and establishment of the case studies or project area of interest/industrial problem based project/research topics.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Understand to summarize the research methods including literature survey process;
CO–02	Know the interpretation approach and problem solving skills;
CO–03	Understand the key challenges to be faced in the research/ immediate industrial problems/case studies;
CO–04	Able to perform a detailed draft the project/research methods.
CO–05	Enhance their ability to analyze data and critically investigate technical or societal issues, leading to well-informed conclusions and solutions.

CO-PO & PSO Correlation

Course Name: Introduction to Stainless Steel (PE-III)												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	1	2	1			1			2	2		2
CO–02				2	2	1		1	2	2		2
CO–03	1	2	1			1			1	2		2
CO–04		1	1	1	1					1		2
CO–05	1	1		1	1				1	1		1

Note: 1.: Low 2.: Moderate 3.: High

Teaching Scheme and Syllabus
of
B.Tech in Metallurgical and Materials Engineering

(PROGRAM CODE: 01UG050)

DEPARTMENT OF METALLURGICAL ENGINEERING
SCHOOL OF ENGINEERING
O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2023-27

B. Tech (Metallurgical and Materials Engineering) (REVISED MAY 25)

PROGRAMME OUTCOME (PO)

Currently OP Jindal University is offering undergraduate programmes (3/4 Years), postgraduate and doctoral programmes in the field of engineering, management, and science. OPJU aims to bring high quality education to its students based on a world class industry- based curriculum, the latest teaching methodology, research, innovation, and entrepreneurship developed by committed faculty members. The outcome of each of the programme in detail are summarized below:

PROGRAM OUTCOMES FOR ENGINEERING GRADUATE

1. **Engineering Knowledge and Problem Analysis** -- Apply the knowledge of engineering domain with adequate amalgamation of science, mathematics, and management to Identify, formulate, and critically analyze complex engineering problems.
2. **Modern tools and techniques for investigating complex problems** – Apply appropriate tools and techniques to analyze, predict and simulate the data for valid conclusion with clear understanding of limitations.
3. **Design and development of innovative systems**: Design and develop system components or processes to provide solutions of complex engineering problems that meet the specified conditions of societal, health, safety, and environmental needs.
4. **Communication and Teamwork -** Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.
5. **Project management and finance**: Develop and apply knowledge of engineering, management, and finance principles to handle a project in a multidisciplinary environment.
6. **Life-long learning**: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.
7. **Ethics and citizenship**: Apply ethical principles and commit to professional ethics, norms, and responsibilities of the engineering practice; and act with informed awareness to participate in civic life activities.
8. **Society, Sustainability and Environment** -- Understand the impact of various solutions in the context of societal, economical, health, safety legal and environmental impact for sustainable development.

PROGRAM SPECIFIC OUTCOME (PSO):

PSO	Engineering Graduates will be able to:
PSO1	Inculcate strong fundamental knowledge and skills in Metallurgical and Materials Engineering domains and able to align the acquired knowledge with other domains.
PSO2	Ability to test and analyze the related methodologies of various metallurgical and materials processes and able to develop an aligned methodology towards the projects or collaborative skills.
PSO3	Ensure the holistic growth through the awareness of effective communications, ethical responsibilities or physical/mental fitness enriched with updated soft skills.
PSO4	Build a solid foundation in the domain of metallurgical and materials Engineering for developing analytical, technical, professional & management skills.

SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering)
Academic Semester V

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	SOE-B-MME501	Melting and Casting Technology	4	0	0	30	20	50	100	4
2	SOE-B-MME502	Steel Making	3	2	0	30	20	50	100	4
3	SOE-B-MME503	Principles of Extractive Metallurgy	4	0	0	30	20	50	100	4
4	SOE-B-MME504	Phase Transformation	4	0	0	30	20	50	100	4
5	SOE-B-MME505	Melting and Casting Technology Lab	0	0	4	0	30	20	50	2
6	SOE-B-MME506	Process Metallurgy Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME507	Industrial Training and Seminar	0	0	2	0	25	25	50	1
Total			**15**	**2**	**10**	**120**	**165**	**265**	**550**	**21**

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SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering)
Academic Semester VI

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	SOE-B-MME601	Metal Forming Processes	4	0	0	30	20	50	100	4
2	SOE-B-MME602	Materials Characterization	4	0	0	30	20	50	100	4
3	SOE-B-MME603	Transport Phenomena in Metallurgical Processes	4	0	0	30	20	50	100	4
4	SOE-B-MME604	Metal Joining Processes	4	0	0	30	20	50	100	4
5	SOE-B-MME605 (1-4)	Professional Elective-I	3	0	0	30	20	50	100	3
6	SOE-B-MME606	Materials Characterization Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME607	Welding Metallurgy Lab	0	0	4	0	30	20	50	2
8	SOE-B-MME608	Transport Phenomena in Metallurgical Processes Lab	0	0	4	0	30	20	50	2
9	SOE-B-MME609	Professional Development	0	0	2	0	25	25	50	1
10	SOE-B-MME610	NPTEL (Transferred Course)	0	0	0	0	0	0	0	0
Total			**19**	**0**	**14**	**150**	**215**	**335**	**700**	**26**

Program Elective I

S. N	Subject Code	Name of the Courses
1	SOE-B-MME605 (1)	Advanced Materials and Processes
2	SOE-B-MME605 (2)	Solar Engineering Materials
3	SOE-B-MME605 (3)	Surface Engineering
4	SOE-B-MME605 (4)	Fracture Mechanics and Failure Analysis

B. Tech Semester-V
(Detailed Syllabus)

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SCHEME OF TEACHING AND EXAMINATION

B. Tech (Metallurgical and Materials Engineering)
Academic Semester V

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	SOE-B-MME501	Melting and Casting Technology	4	0	0	30	20	50	100	4
2	SOE-B-MME502	Steel Making	3	2	0	30	20	50	100	4
3	SOE-B-MME503	Principles of Extractive Metallurgy	4	0	0	30	20	50	100	4
4	SOE-B-MME504	Phase Transformation	4	0	0	30	20	50	100	4
5	SOE-B-MME505	Melting and Casting Technology Lab	0	0	4	0	30	20	50	2
6	SOE-B-MME506	Process Metallurgy Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME507	Industrial Training and Seminar	0	0	2	0	25	25	50	1
Total			**15**	**2**	**10**	**120**	**165**	**265**	**550**	**21**

OPJU

Program: B.Tech **Semester: V**
Name of the Course: Melting and Casting Technology **Code: SOE-B-MME501**
Credit: 4 **No of Hours:4 hours/week**
Max. Marks: 100

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Course Description:
This course is designed to explore the various foundry practices and the theory behind solidification processes. Various foundry methods, theories and parameters will be discussed in detail. The existing casting technologies and the new insights in metal casting will be discoursed. Casting of various metals and alloys will also will explored.

Course Objectives:
1. A basic understanding of foundry practice and metal casting.
2. Basics of solidification of pure metals and alloys.
3. Knowledge about the melting practices for casting of ferrous and non-ferrous alloys.
4. An overview of the pattern and moulds designing, casting design, casting defects, inspection and testing of castings.
5. Need for modernisation and application of computers in foundry industries.

Syllabus:

UNIT-I
Introduction to casting process and the steps involved; components produced by casting process, advantages and limitations of casting process. Solidification of metals: Nucleation and growth. Solidification of alloys: dendritic growth and segregation; shrinkage in alloys. Progressive and directional solidification; Rate of solidification; Chvorinov's rule.

UNIT-II
Pattern Making: types of patterns, types of moulding sands, general characteristic of sands, testing of moulding sands, cores- function, types, core sands, core binders, core supports. Pattern allowances: shrinkage allowance, machining allowance, draft allowance, shake allowance, distortion allowance, numerical based on pattern allowance.

UNIT-III
Mould Making: green sand mould, dry sand mould, skin dried mould, shell moulding, CO_2 moulding, permanent moulds, investment moulding. Gating systems: types of gates and risers, gating ratio, sprue design, riser design and location, casting design. Casting Processes: sand casting, investment casting, die casting, centrifugal casting, permanent mould casting, squeeze casting, stir casting, continuous casting.

UNIT-IV

Melting equipment for foundries, melting practices of cast irons, steels, aluminium, magnesium. Defects in castings, their causes and remedies. Fettling and cleaning of castings, inspection and testing of castings, heat treatment of castings.

UNIT-V

Need for modernisation, application of computers in foundries: Procast, Autocast, Flow+, pollution control in foundries, energy saving in foundries.

Text Books:

1. Foundry Technology- D B Goel and K P Sinha.
2. Foundry Technology – P R Beeley.
3. Foundry Engineering – O P Khanna.

Reference Books:

1. Principles of metal casting, R.W. Heine, C.R. Loper and P.C. Rosenthal.
2. Solidification of castings – Institute of Metals, London – R.W. Ruddle.
3. Metal casting. – R.A. Flin.

Course Outcomes:

CO	**Metallurgical and Materials Engineering Graduates will be able to:**
CO–01	Distinguish between various methods of foundry practice.
CO–02	Compare various types of patterns based on their uses.
CO–03	Develop skills to conceptualize to design the process and solve the practical problems encountered while metal processing.
CO–04	Recognize the casting defects, their causes, and remedies.
CO–05	Know the inspection techniques to detect casting defects.

<u>CO-PO & PSO Correlation</u>

Course Name: Melting and Casting Technology												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**	**1**							**3**	**3**		**2**
CO–02	**2**		**3**			**3**	**2**	**3**	**1**	**2**		
CO–03	**3**	**1**	**2**	**2**	**3**	**3**		**2**	**3**	**3**		**2**
CO–04	**3**	**1**	**2**	**3**	**3**		**2**	**2**	**3**	**3**		**3**
CO–05	**3**	**2**	**3**	**3**	**3**			**2**	**2**	**3**		**3**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Steel Making
Credit: 4
Max. Marks: 100

Semester: V
Code: SOE-B-MME502
No of Hours:5 hours/week

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Course Description:
This course is broadly categorized into two domains, one is primary steel making, which includes topics related to Bessemer process, open hearth process, BOF process, EAF process etc.; and the other part contains topics related to secondary steel making, which includes ladle metallurgy, deoxidation, desulphurization, degassing techniques, clean steel and tundish metallurgy. Apart from these, the course also covered the glimpses pertain to current scenario of steel industry in India.

Course Objectives:
To impart knowledge on importance of the steel making process and to apply them for the advancement of the production feasibilities in steel Industries to compete with the modern day manufacturing routes.

Syllabus:

UNIT-I
History of steelmaking, acid Bessemer process and its limitations, basic Bessemer process and its limitations, open hearth process and its limitation, introduction to basic oxygen furnace, LD design, related refractory, oxygen lance, gas cleaning system, Raw materials for BOF, reactions in LD converter, behaviour of oxygen jet, bottom blowing process and its disadvantages, combined blowing process, modern trends in BOF technology; novel steel making technologies- EOF, CONARC.

UNIT-II
Steel making in electric arc furnace- raw materials for EAF process, design and construction futures of EAF process, electrical considerations for AC/DC furnaces, graphite electrodes, gas collection and cleaning system, fluxes and additives, Furnace operations, refining process, developments in EAF steel making process, Induction furnace steelmaking process, use of sponge iron as a charge, use of hot metal and Fe_3C as charge material.

UNIT-III
Ladle Metallurgy- Objectives of secondary steel making, inert gas stirring in ladles, design of synthetic slag and its practice, desulphurization, kinetics of desulphurization, injection metallurgy, deoxidation of liquid steel, ladle furnace, deoxidation kinetics, degassing techniques; decarburization techniques- AOD, VOD; clean steel- source of inclusions, slag carry over and its consequences, effect of inclusions on properties of steel, types of inclusions, properties of inclusions, control of inclusions, inclusion engineering, VAR, ESR processes.

UNIT-IV

Ingot casting technologies- ESR, VAR processes, Tundish Metallurgy**-** role of tundish in the continuous casting process, design and operation of tundish, flow control devices, role of tundish flux, refractories, mould and its operation, electromagnetic stirring; mechanism of solidification, quality control in continuous casting, recent trends in continuous casting, continuous casting defects and its remedies.

UNIT-V

Finishing operations- Reheating of billets/blooms/slabs, hot rolling, cold rolling, galvanizing, problems faced by domestic iron and steel industry, case study on defects occurred during processing of final products, numerical related to steel making.

Reference Books:

1. An introduction to Modern steel making by R.H. Tupkary.
2. Ironmaking and Steelmaking theory and practice by Ahindra Ghosh and Amit Chatterjee.
3. Tundish technology for clean steel production by Yogeshwar Sahai and Toshihiko Emi.
4. A First Course in Iron and Steelmaking by Dipak Mujumdar.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Have fundamental knowledge on basic principles of steel making.
CO–02	Understand the working process of open hearth, Bessemer, LD and Q-BOP steel making processes.
CO–03	Describe the secondary refining techniques of steel making.
CO–04	Understand the principle of continuous casting of steel.
CO–05	Correlate problems faced by domestic iron and steel industry.

CO-PO & PSO Correlation

Course Name: Steel Making												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**					**1**		**1**	**2**	**1**		
CO–02	**3**	**1**	**1**			**1**			**3**			**1**
CO–03	**2**	**1**						**1**	**1**			**1**
CO–04	**2**	**1**							**2**			**2**
CO–05	**2**		**1**						**2**			**1**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: V**
Name of the Course: Principles of Extractive Metallurgy **Code: SOE-B-MME503**
Credit: 4 **No of Hours:4 hours/week**
Max. Marks: 100

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Course Description:
This course introduces the various extraction processes which include pyro metallurgy, hydrometallurgy and electrometallurgy and various extraction methods of various metals (ferrous and non-ferrous) from its ores. This course also gives an overview about significance of thermodynamics and kinetics in the extraction process. This course deals with the physicochemical framework of ferrous and non-ferrous metals adhere to its related fundamental principles and applications.

Course Objectives:
1. Overview of various processes involved in extraction of various ferrous and non-ferrous metals from their ores.
2. To develop understanding to know the associated principles of different processes of extraction.
3. To be able to identify economical extraction and refining process selection.
4. To provide information about the role of reaction kinetics in various extractive processes.

Syllabus:

UNIT-I
Discovery of metals and their importance, common ferrous & nonferrous metal production and consumption: global and Indian scenario. Introduction: role of unit processes in metal extraction and exploration methods. General methods of ore beneficiation like comminution, classification and concentration, electrostatic and magnetic separations.

UNIT-II
Principles of metals extraction and thermodynamic principles. Pyro-metallurgy: calcinations, roasting: mechanism of roasting, thermodynamics of roasting; predominance area diagram and Ellingham diagram and its significance, smelting and converting. Hydrometallurgy: leaching, various types of leaching such as pressure leaching and bacterial leaching, in-situ, heap, and percolation leaching. Solvent extraction, ion exchange and precipitation method. Electrometallurgy: introduction, Faradays laws of electrolysis, basic arrangement in electrolysis, electrowinning, electrorefining and its application and electroplating. Numericals related with electrometallurgy. Reaction Kinetics: introduction, types of reactions, rate of

reaction, order of reaction: zero, first and second order. Determination oforder and rate constant of a reaction and its numerical.

UNIT-III

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

UNIT-IV

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

UNIT-V

Refining of zinc by distillation in refluxing units, refining of lead bullion by Parks process. electro refining of copper, nickel, lead, tin and aluminium, extraction of precious metals: gold, silver, platinum, uranium and titanium. Secondary metals and utilization of metallurgical wastes, importance of rare earth and related process, environmental issues.

Text Books:

1. Extraction of Non-ferrous Metals-H. S Ray, R. Shridhar and K. P Abraham, East-west Press (pvt.) Ltd.
2. Principles of Extractive Metallurgy-H. S ray and A. Gosh, New Age International Publishers; Third edition.
3. Principles of Extractive Metallurgy - T. Rosenquist, Tapir Academic Press, 2nd Edition.
4. Extractive Metallurgy Processes and Applications - S.K. Dutta, PHI Learning Publisher.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Know about various ferrous and non-ferrous metals and their processing.
CO–02	Understand the techniques related to extraction of metals.
CO–03	Have fundamental knowledge on applications of ferrous and non-ferrous metals.
CO–04	Understand extraction of Cu, Zn and Pb from its ores
CO–05	Understand Refining of zinc, copper, nickel, lead etc. and utilization of metallurgical wastes

CO-PO & PSO Correlation

Course Name: Principles of Extractive Metallurgy												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO–01	3							1	2			
CO–02	1	2	1						1	2		1
CO–03	1		1	1	1				1	1		1
CO–04	1		1						2			1
CO–05	1			1					1			1

Note: 1 : Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Phase Transformation
Credit: 4
Max. Marks: 100

Semester: V
Code: SOE-B-MME504
No of Hours:4 hours/week

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Course Description:
This courses Phase Transformations of Materials is principally aimed to introduce the students about basic concept of phase, phase diagram and phase transformation of material. This course comprises the contents as Gibb's phase rule, determination and uses of phase diagram, lever rule, phase transformation in steel, solid state phase transformation to improve the mechanical properties. The students also will get idea to use the concept of phase transformation to meet the desired properties of materials for different purposes.

Course Objectives:
1. Phase transformation has become integral parts of metal processing technique to impart the specific properties to the materials.
2. To provide a basic understanding of principles that determines the evolution of structures in metals and alloys during phase transformation which enhances the performance of materials during entire service condition.

Syllabus:

UNIT-I
Definition of a phase, thermodynamic criterion for phase stability, Gibb's phase rule, unary and binary phase diagram, determination of phase diagram, uses of phase diagram. Phase diagram and concepts of solidus, liquidus, solvus curves, tie line, lever rule, conversion of temperature-composition diagram to free energy-composition diagram.

UNIT-II
Gibb`s free energy for single and binary solutions, ideal and regular solutions, chemical potential of a solution. Ordered and intermediate phases, Solidification, isomorphous phase diagram and solidification of alloys, Scheil equation, constitutional and thermal super-cooling, dendritic solidification principles.

UNIT-III
Diffusion, atomic mechanism of diffusion, interstitial & substitutional (self and vacancy) diffusion Fick`s law of diffusions, determination of diffusion coefficient, effect of temperature on diffusion coefficient, Kirkendal effect, Darken's equation, application of diffusion in some metallurgical processes like carburizing & nitriding of steels.

UNIT-IV

Solid-Solid Phase Transformations: Thermodynamics of transformation, overall transformation kinetics, massive transformation, pearlite to austenite, austenite to pearlite, austenite to bainite, austenite to martensite transformation.

UNIT-V

Interphase interfaces in solids, coherent, semi-coherent & in-coherent interfaces, role of interfacial energy on fully coherent, partially coherent and in-coherent precipitates, interface and diffusion-controlled growth.

Text Books:

1. Phase transformation in metal and alloys- David A. Porter, E. Easterling & Y. Sherif.
2. Solid State Phase Transformations- V R Raghavan Heat Treatment: Principles and Techniques by T.V Rajan, C.P Sharma & Ashok Sharma.
3. Physical Metallurgy, Vijendra Singh, SPD, Pvt Ltd.
4. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mc Grow Hill Publishing Co.

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.
2. Material Science & Engineering, W.F. Smith & Javed Hashemi, Ravi Prakash, Tata Mc Grow Hill
3. Material Science & Engineering, W. D. Calister Jr. Willy India Pvt. Ltd.

Course Outcomes:

CO	**Metallurgical and Materials Engineering Graduates will be able to:**
CO–01	Understand the different types of phases present in the materials.
CO–02	Have fundamental knowledge on phase diagrams.
CO–03	Understand the kinetics of phase transformation.
CO–04	Have idea about the surface treatments of the materials.
CO–05	Understand the interphase interfaces in solids.

CO-PO & PSO Correlation

Course Name: Phase Transformation												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**					**1**			**1**			**1**
CO–02	**2**	**1**			**1**				**1**	**1**		
CO–03	**2**				**1**	**1**			**2**			**1**
CO–04	**1**		**1**			**1**		**1**	**1**			**1**
CO–05	**1**		**1**		**1**				**1**			**1**

Note: 1.: Low 2.: Moderate 3.: High

OPJU

Program: B.Tech
Name of the Course: Melting and Casting Technology Lab
Credit: 2
Max. Marks: 50

Semester: V
Code: SOE-B-MME505
No of Hours:4 hours/week

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Course Objectives:
To learn the concept of different casting techniques, moulding sand, their properties and know the requirement of different foundry equipment and accessories.

List of Experiments:
1. To find the grain fineness number of the silica sand.
2. To test the permeability of the silica sand.
3. To test the moisture content in the silica sand.
4. To find the hardness of the silica sand mold.
5. To find the dry compressive strength and dry shear strength of the silica sand mold.
6. To design the silica sand mold for the casting process.
7. To melt the aluminum/ copper or medium carbon steel in an induction furnace and cast it in a silica sand mold.
8. To melt the aluminum/ copper or medium carbon steel in an induction furnace and cast it in a permanent mold.
9. To compare the mechanical properties of the aluminum/ copper or medium carbon steel cast in silica sand mold and permanent mold.
10. To observe the casting defects, and identify their causes occurred in aluminum/ copper or medium carbon steel.

List of Equipment:
1. Casting sand
2. Wooden pattern
3. Induction furnace
4. Aluminum and medium carbon steel
5. Permeability tester
6. Rapid moisture meter
7. Sieve shaker.

Recommended Books:
Principles of Foundry Technology- P L Jain, Tata McGraw-Hill, New Delhi.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Have knowledge of moulding sand.
CO–02	Hands on Experience on different foundry equipment, their use and different type casting processes.
CO–03	Learn the concept of different casting techniques

CO-PO & PSO Correlation

Course Name: Melting and Casting Technology Lab												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**	**1**	**1**			**1**			**1**			**1**
CO–02	**2**	**1**	**1**						**1**	**2**		
CO–03	**2**	**1**	**1**			**1**				**2**		**1**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Process Metallurgy Lab
Credit:2
Max. Marks: 50

Semester: V
Code: SOE-B-MME506
No of Hours:4 hours/week

Course Objectives:
To provide practical knowledge about the various processes occur in iron and steel making and testing done for raw material.

List of Experiments:
1. Determination the effect of shape of iron ore and its agglomerates on the angle of repose.
2. Determination of Shatter and Tumbler strength.
3. Effect of moisture content on drop strength of green iron ore pellets.
4. Determination of Cold Crushing strength.
5. Effect of Time on Reduction and Swelling Behaviour of Iron Oxide Pellet reduced in a bed of carbon.
6. Determination of the hardness and strength of the coke using micum index test.
7. Determination of the Reactivity of carbon.
8. Determination of the % pipe volume, % pipe length and % yield of cast wax ingot.
9. Air Jet and water Interaction: A cold model study.
10. Determination of Inclusions.

Equipment Required:
1. Disc Pelletizer
2. Tumbler drum
3. Cold compression strength machine
4. Hot air oven
5. Muffle furnace
6. Mecum Drum
7. Digital Vernier callipers
8. Weighing machine

Recommended Books:
1. An Introduction to Modern Iron Making – R.H. Tupkary

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Understand testing processes related to iron making raw materials
CO–02	Analyze the BF charge calculations.
CO–03	Analyze inclusions in steel

CO-PO & PSO Correlation

Course Name: Process Metallurgy Lab												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**	**1**	**1**			**1**		**1**	**1**	**2**		
CO–02	**2**		**1**			**2**			**3**			**1**
CO–03	**2**		**1**			**2**			**1**			**1**

Note: 1.: Low 2.: Moderate 3.: High

cold rolling, rolling load, angles in rolling, power loss, torque and power, roll camber and its importance, defects in rolled products, residual stresses in rolled products.

UNIT-IV

Extrusion: Introduction, classification of extrusion, extrusion equipment, extrusion dies, metal flow and deformation, lubrication, defects in extruded products, hydrostatic extrusion, extrusion of seamless tubes, hooker extrusion process.

UNIT-V

Drawing: Introduction, rod drawing, wire drawing, tube drawing, drawing force and power, maximum allowable reduction, defects in drawn products, residual stresses in drawn products, sheet metal forming, deep drawing, explosive forming, electro- hydraulic forming, electro- magnetic forming, equal channel angular pressing (ECAP) process, defects in ECAP process.

Text Books:

1. Mechanical Properties and Working of Metals and Alloys by Amit Bhaduri.
2. Manufacturing Processes-III- Dr A C Niranjan
3. Mechanical Metallurgy- Dieter
4. Rolling Mill Practice – Polukhia
5. Principles of Metal Working – Dr Surendra Kumar

Reference Books:

1. Theory of Plastic Working of Metals, Masterovsky (Mir Pub)
2. Rolling Practice – Burtsev
3. Principles of Rolling. – Chaturvedi
4. Rolling Mill- ASM
5. Manufacturing Technology- C K Singh

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Understand the deformation behaviour of materials to external loads
CO–02	Understand the importance and use of various rolling mills
CO–03	Understand the use of various metal forming processes
CO–04	Solve numerical problems encountered in various forming processes
CO–05	Understand various defects and failures in metal forming processes

CO-PO & PSO Correlation

Course Name: Metal forming Processes												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO–01	2	1				3			2	1		1
CO–02	2	1	1			3			1	1		1
CO–03						3			2	2		
CO–04	3					3			2			3
CO–05	2					2			1			1

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VI**
Name of the Course: Transport Phenomena in Metallurgical Processes
Code: SOE-B-MME603 **Credit:4**
Max. Marks: 100 **No of Hours: 4 hours/week**

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Course Description:
This course will introduce the concepts of fluid flow, heat transfer and mass transfer with respect to the behavior and processing of engineering materials as the main focus.

Course Objectives:
To learn the concepts behind energy and mass flow in metallurgical furnaces and chimneys. Solve numerical based on these phenomena to evaluate the missing parameter.

Syllabus:

UNIT-I
Fluid Dynamics: classification of fluids, properties of fluids, nature of the fluid flow, continuity equation, analysis of fluid flow- equation of continuity, laminar flow and the momentum equation, flow of a falling film, boundary layer theory, flow between parallel plates, fully developed flow through a circular tube, creep flow around a solid sphere, turbulent flow and complex flows, friction loss in pipe flow, calculating the friction factor using moody chart, flow through porous media, flow through packed bed of solids. Bernoulli's equation, flow measuring devices- venturimeter, orifice meter, rotameter, pitot tube.

UNIT-II
Heat Transfer-Conduction: Fourier's law of heat conduction, general heat conduction equation in Cartesian coordinates, heat conduction through plane wall, Heat conduction through composite wall, general heat conduction equation for spherical coordinates, steady state heat conduction to a spherical pellet from an infinite stagnant fluid medium, transient heat conduction, Newtonian heating or cooling, Heisler charts, heat conduction with moving heat source, solidification of metals, continuous casting.

UNIT-III
Heat Transfer-Convection: Flow over a body, classification of flow over the flat plate, thermal boundary layer, forced convection, application of dimensional analysis for forced convection problems, significance of dimensionless groups, empirical correlation for forced convection, free convection.

UNIT-IV
Heat Transfer- Radiation: Surface emission properties, absorptivity, reflectivity and transmissivity, Stefan-Boltzmann law, Kirchhoff's law, Planck's law, solid angle and Intensity of radiation, Lamberts cosine law,

metals and alloys.

Text Books:

1. Surface Engineering & Heat Treatment Past, present and Future, Edited by P. H. Morton, Published by the Institute of Metals, London, 1991.
2. Electroplating and other surface treatments, A Practical Guide, CD Varghese, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.

Reference Books:

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

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Have fundamental knowledge on surface technologies.
CO–02	Learn to analyze the surface engineering issues.
CO–03	Understand electroplating, electroless coating, and hot-dip methods used for protective layers.
CO–04	Comprehend advanced coating methods like CVD, PVD, thermal spray, and laser surface engineering.
CO–05	Apply surface engineering techniques in industrial applications related to metals and polymers.

CO-PO & PSO Correlation

Course Name: Surface Engineering (PE-I)												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**					**1**		**1**	**2**			**1**
CO–02	**1**	**1**				**1**	**1**			**2**		**1**
CO–03	**2**	**1**	**1**					**1**		**2**		**1**
CO–04	**2**	**1**	**2**	**1**		**1**			**3**	**2**	**1**	**2**
CO–05	**2**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**3**	**3**	**1**	**2**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VI**
Name of the Course: Fracture Mechanics and Failure Analysis (PE-I)
Code: SOE-B-MME605 (4) **Credit:3**
Max. Marks: 100 **No of Hours: 3 hours/week**

Course Descriptions:
The focus of this course is to develop an understanding of the mechanics of fracture of engineering materials and structures under static and dynamic conditions. Students have been taught the principles of linear elastic and elastic-plastic fracture mechanics and their application to engineering design. This course will also introduce key applications of fracture mechanics in industry including damage detection, failure analysis, and experimental techniques.

Course Objectives:
1. Study about types of fracture.
2. Study the principles of fracture mechanics and their applications to structural design;
3. Fracture phenomena in metals and nonmetals will be discussed and Testing methods will be highlighted;
4. In the end computer assisted techniques for fracture study will be discussed.

Syllabus:

UNIT-I
Introduction to fracture, mechanisms of fracture, a crack in structure, the Griffith's criterion, stiffness and toughness, stress intensity approach, linear elastic fracture mechanics, crack tip stress and deformations, relation between stress intensity factor and fracture toughness, stress intensity based solutions.

UNIT-II
Elastic – plastic fracture mechanics, elasto–plastic factor criteria, crack resistance curve, J-integral, crack opening displacement, crack tip opening displacement.

UNIT-III
Dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness, fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue

crack growth laws.

UNIT-IV

Fracture Resistance of materials, fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure.

UNIT- V

Fracture toughness testing of metals, specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness.

Text Books:

1. Mechanical Metallurgy, George E. Dieter, McGraw Hill Publication.
2. Testing of Metallic Materials, A. V. K. Suryanarayan, B. S. Publication.

Reference Books:

1. Elements of Fracture Mechanics, Prashant Kumar, Tata McGraw Hill, New Delhi, India, 2009.
2. Fracture Mechanics for Modern Engineering Design, K. R. Y. Simha, Universities Press (India) Limited, 2001.
3. Elementary Engineering Fracture Mechanics, D. Broek, Kluwer Academic Publishers, Dordrecht, 1986.
4. Fracture Mechanics - Fundamentals and Applications, T. L. Anderson, Taylor and Francis Group, 3rd Edition, 2005.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Predict material failure for any combination of applied stresses.
CO–02	Estimate failure conditions of a structure.
CO–03	Determine the stress intensity factor for simple components of simple geometry.
CO–04	Predict the likelihood of failure of a structure containing a defect.
CO–05	Analyze fracture toughness testing results.

CO-PO & PSO Correlation

Course Name: Fracture Mechanics and Failure Analysis (PE-I)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO–01	2					1			2	1		1
CO–02		1	1		1				1	1		2
CO–03	2		1			1			1	1		
CO–04				1	2	1			1	1		2
CO–05	1		1	1	2	1				1		2

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VI**
Name of the Course: Materials Characterization Lab **Code: SOE-B-MME606**
Credit:2 **No of Hours: 4 hours/week**
Max. Marks: 50

Course Objectives:

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

List of Experiments:

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

List of Equipment:

1. Rockwell Hardness
2. Vickers Hardness
3. B-H Curve
4. Wear Test Machine
5. SEM
6. XRD

Recommended Books:

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

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Have knowledge on basic principles of the advanced equipment.
CO–02	Solve and analyze a problem from an industry/Institute.
CO–03	Select and redesign the material problem.

CO-PO & PSO Correlation

Course Name: Material Characterization Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO–01	2	2				2			2			1
CO–02	1	1			1	1			2	2		1
CO–03	1	1	2		1	1			2	2		1

Note: 1.: Low 2.: Moderate 3.: High

OPJU

Program: B.Tech **Semester: VI**
Name of the Course: Welding Metallurgy Lab **Code: SOE-B-MME607**
Credit:2 **No of Hours: 4 hours/week**
Max. Marks: 50

Course Objectives:

1. To get the hands on practice of various welding process.
2. To gain hands on experience on inspection and testing of weld elements.

List of Experiments:

1. To analyze various joints and positions used in welding as per AWS and ISO.
2. To analyze the welding drawing and study the nomenclature of welding symbols and their representation.
3. To prepare a lap joint using Resistance spot welding.
4. To prepare a butt joint using gas welding in mild steel.
5. To prepare a butt joint using shielded metal Arc welding (SMAW) in mild steel.
6. To prepare a butt joint using Gas metal arc welding (MIG).
7. To perform soldering and Brazing operation for various components.
8. To identify, and analyze, various welding defects and learn their remedies.
9. To perform metallography of the weld joint of steels.
10. To perform inspection/testing of weld joints.

List of Equipment:

1. Resistance welding set up
2. Gas welding set up
3. Arc welding set up
4. MIG welding set up

Recommended Books:

1. Welding Technology by R.S. Parmar.
2. Welding Technology by N.K. Srinivasan.
3. Welding metallurgy by Sindo Kou.
4. Welding and Welding Technology by R. L. Little.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Have practical exposure of various welding processes.
CO–02	Understand the various parameters used in Welding.
CO–03	Able to inspect weld properties, defects and identify welding joints

CO-PO & PSO Correlation

Course Name: Welding Metallurgy Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO–01	2		1			1	1		2			1
CO–02	1	1				1			1	1		1
CO–03	1	1	1			1			1	1		1

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech **Semester: VI**
Name of the Course: Transport Phenomena in Metallurgical Processes Lab
Code: SOE-B-MME608 **Credit:2**
Max. Marks: 50 **No of Hours: 4 hours/week**

....

Course Objectives:
To provide practical knowledge about the application of momentum transfer and heat transfer concepts allied to theoretical, in various metallurgical processes.

List of Experiments:

1. Apparatus for verification of Bernoulli's Theorem.
2. Calibration of Venturimeter Apparatus.
3. Calibration of Orifice meter.
4. Pitot Static Tube Apparatus.
5. Flow Measurement by Rotameter.
6. Determination of thermal conductivity of insulating powder.
7. Determination of heat transfer through composite wall.
8. Determination of heat transfer in natural convection.
9. Determination of heat transfer in forced convection.
10. Determination of Emissivity by Emissivity measurement apparatus.
11. Determination of thermal radiation by Steffen Boltzmann.

List of Equipment:

1. Natural convection unit
2. Thermal conductivity unit
3. Flow measuring devices
4. Stefan-Boltzmann apparatus.
5. Emissivity measurement apparatus
6. Thermocouple
7. Ammeter
8. Voltmeter

Recommended Books:

1. G. H. Geiger and D. R. Poirier, Transport Phenomena in Materials Processing, Addison Wesley, Mass, 1994.
2. N. J. Themelis, Transport and Chemical Rate Phenomena, Gordon Breach, New York, 1995.
3. Rate Processes in Metallurgy. – A.K. Mohanty.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Understand the significance of Transport phenomena concept in various metallurgical processes.
CO–02	Analyze the various principles in heat and mass transfer in metallurgical process.
CO–03	Analyze experimental data and validate theoretical models related to transport phenomena.

CO-PO & PSO Correlation

Course Name: Transport Phenomena in Metallurgical Processes Lab												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01	**2**					**1**			**2**			**1**
CO–02	**1**	**1**			**1**	**1**				**2**		**1**
CO–03	**1**		**1**		**1**				**2**	**1**		**1**

Note: 1.: Low 2.: Moderate 3.: High

Program: B.Tech
Name of the Course: Professional Development
Credit:1
Max. Marks: 50

Semester: VI
Code: SOE-B-MME609
No of Hours: 2 hours/week

Course Description:

Leadership, delegation, motivation, communication, and vision are key components that make up an effective and successful shipboard leader. As a leader, a large part of the responsibility is anticipating issues and implementing directives and standard operating practices. Managerial Skills course is designed to blend theoretical and practical skills necessary to be an effective shipboard leader. Students will learn tools and management techniques to manage workload and resources, assess situations and manage risk within a team environment. This course covers self-awareness, communication theory, listening and nonverbal, interpersonal problem-solving, stress and stress management, persuasion and influence, oral presentations, and meetings and interviews.

Course Objectives:

The objectives of this course are:

1. To facilitate students' understanding of their own managerial skills.
2. To explain the basic concepts and processes of management.
3. To expose students to the managerial skills.
4. To expose students to several models of leadership and team building.
5. To explain the organizational culture and the complexity of managing in a global world.
6. To develop an ability to work with moral and ethical dilemmas and make decisions using critical thinking.
7. To facilitate students' understanding of time management, empowerment and delegation.

Syllabus:

UNIT-I: Management and Managerial Skills

Management- Meaning, Nature and Concept of Management, Function of Management- Planning, Organizing, Staffing and Controlling, Importance of Management- Role of Managers in Organization, Managerial Skills.

UNIT-II: Leadership and Decision-Making Skills

Leadership, Qualities of a Good Leader, Leadership Styles, Concept of Decision making, Importance of Decision-making, Decision-making Process, Decision making Techniques.

UNIT-III: Problem Solving Skills

Problem-solving, Concept of Problem-solving, Process of Problem-Solving, Technique for Problem Solving. Challenges in Generating Creative Ideas.

UNIT-IV: Team Building and Time Management
Team building. Developing Teams and Team Work. Leading Team, Team Membership. Time Management. Steps and Techniques of Time Management. Importance of Time Management.

UNIT-V: Empowerment and Delegation
Empowering and Delegating: Meaning of Empowerment. Dimensions of Empowerment, how to Develop Empowerment. Inhibitors of Empowerment. Delegating Works.

Text Books:

1. Leadership and Self-Deception. Arbinger Institute, Berrett-Koehler Publishers: Second Edition, 2010, ISBN: 978-1576759776.
2. Gover Handbook of Leadership and Management Development. Jeff Gold. Richard Thorpe, and Alan Mumford.
3. The Powerful Personality, Dr. Ujjawal Patni & Dr. Pratap Deshmukh Fusion Books. 2006.
4. Basic Managerial skills for all, E.H. McGrawth, Prentice Hall India Pvt Ltd, 2006.
5. How to develop a pleasing personality. Atul John Rego, Better yourself bools, Mumbai, 2006

Reference Books:

1. On Becoming a Leader. Bennis, Warren. Rev. ed. Cambridge, Mass.: Perseus. 2003.
2. Learning to Lead: A Workbook on Becoming a Leader, Bennis, Warren, and Joan Goldsmith, 3d ed. Cambridge, Mass.: Perseus, 2003.
3. Getting Things Done When You Are Not in Charge. Bellman. Geoffrey M. Berrett Kochler Publishers, 2001.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO–01	Distinguish between leadership and management.
CO–02	Recognize their own leadership style.
CO–03	Identify and understand various approaches in leading others.
CO–04	Employ key competencies of visioning, aligning, delegation, motivating and inspiring others.
CO–05	Recognize the need for collective problem solving and apply appropriate techniques.
CO–06	Understand time pressures and the need for time management.
CO–07	Apply core management skills and techniques to deliver results.

CO-PO & PSO Correlation

Course Name: Professional Development												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO–01				**2**	**2**	**1**					**2**	**2**
CO–02				**2**	**1**	**1**					**2**	**1**
CO–03	**1**	**1**		**1**	**1**	**1**			**1**		**1**	**1**
CO–04				**1**	**1**	**1**	**1**				**1**	**2**
CO–05		**1**			**1**	**1**					**1**	**1**
CO–06					**2**	**2**					**2**	**2**
CO–07				**1**	**3**	**1**					**2**	**1**

Note: 1.: Low 2.: Moderate 3.: High

Teaching Scheme and Syllabus
of
B. Tech in Metallurgical and Materials Engineering

(PROGRAM CODE: 01NUG050)

DEPARTMENT OF METALLURGICAL ENGINEERING

SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2024-28

Curriculum and Credit Framework for Undergraduate Programme (CCFUP)

<table>
<tr><th rowspan="2">Semester</th><th colspan="2">MAJOR</th><th rowspan="2">MINOR</th><th rowspan="2">AEC</th><th rowspan="2">SEC</th><th rowspan="2">Internship/ Apprentice-ship/Project/ Community outreach</th><th rowspan="2">VAC</th><th rowspan="2">MDC</th><th rowspan="2">Total Credits</th></tr>
<tr><th>DSC</th><th>DSE</th></tr>
<tr><td>I</td><td>16</td><td></td><td></td><td>2</td><td>2</td><td></td><td>2</td><td></td><td>22</td></tr>
<tr><td>II</td><td>13</td><td></td><td></td><td>2</td><td>2</td><td></td><td>2</td><td>3</td><td>22</td></tr>
<tr><td colspan="10">Students on exit after First Year shall be Awarded Undergraduate Certificate (in the Field of Study/ Discipline) after securing the requisite 44 credits in Semesters I and II and complete one additional Vocational course/Summer internship of 4 credits.</td></tr>
<tr><td>III</td><td>11</td><td></td><td>4</td><td>2</td><td>2</td><td></td><td>2</td><td>3</td><td>24</td></tr>
<tr><td>IV</td><td>14</td><td></td><td>4</td><td>2</td><td>3</td><td></td><td></td><td>3</td><td>26</td></tr>
<tr><td colspan="10">Students on exit after the Second year shall be Awarded Undergraduate Diploma (in the Field of Study/ Discipline) after securing the requisite 94 credits on completion of Semester IV and complete one additional Vocational course/Internship of 4 credits during the summer vacation of Second Year.</td></tr>
<tr><td>V</td><td>15</td><td>3</td><td>4</td><td></td><td></td><td>2</td><td></td><td></td><td>24</td></tr>
<tr><td>VI</td><td>14</td><td>3</td><td>4</td><td></td><td></td><td></td><td></td><td></td><td>21</td></tr>
<tr><td colspan="10">Students on exit after the Third year shall be Awarded Bachelor of (in the Field of Study/Discipline) (Major and Minor) (3 years) after securing the requisite 139 credits on completion of Semester VI.</td></tr>
<tr><td>VII</td><td>11</td><td>3</td><td>4</td><td></td><td></td><td>6</td><td></td><td></td><td>24</td></tr>
<tr><td>VIII (Honors)*</td><td>12</td><td>3</td><td>4</td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">19</td></tr>
<tr><td>VIII (Honors with Research)**</td><td></td><td>3</td><td>4</td><td></td><td></td><td>12</td><td></td><td></td></tr>
<tr><td colspan="9">TOTAL</td><td>182</td></tr>
<tr><td colspan="10">Students on exit after the fourth year shall be Awarded Bachelor of (in the Field of Study/Discipline) (Honours) or (Honours with Research) after securing the requisite 182 credits on completion of Semester VIII.</td></tr>
</table>

***All the admitted students are eligible for the Honors degree**

****Students who secure 75% or more marks up to the 6th semester will only be eligible for the honors with research degree.**

B. Tech (Metallurgical and Materials Engineering)

PROGRAMME OUTCOME (PO)

Currently OP Jindal University is offering undergraduate programmes (3/4 Years), postgraduate and doctoral programmes in the field of engineering, management, and science. OPJU aims to bring high quality education to its students based on a world class industry- based curriculum, the latest teaching methodology, research, innovation, and entrepreneurship developed by committed faculty members. The outcome of each of the programme in detail are summarized below:

PO-1	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO-2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO-3	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO-4	Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
PO-5	Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO-6	The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)
PO-7	Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO-8	Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO-9	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO-10	Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO-11	Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOME (PSO):

PSO1: Fundamentals and Processing of Metals & Alloys Graduates will be able to apply metallurgical principles to develop sustainable, efficient, and cost-effective solutions for metal extraction, refining, and manufacturing industries while addressing environmental and economic considerations.

PSO2: Materials Characterization and Property Evaluation Graduates will be equipped to analyze structure–property–processing–performance relationships in materials, enabling them to design and improve sustainable, eco-friendly materials with customized properties for various engineering applications.

PSO3: Advanced Materials and Industrial Applications Graduates will be capable of optimizing and innovating manufacturing and characterization techniques by designing and implementing advanced material processing and testing methods to address industrial challenges and develop high-performance, reliable, and sustainable materials

Scheme of Teaching and Examination
B. Tech (Metallurgical and Materials Engineering)
Academic Semester-III

S. No.	Course Code	Course Category	Name of the Course	Hours per week			Scheme of Examination and Marks				Credit L+(T+P)/2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1.	MME24-B-MJ201	MAJOR	Introduction to Physical Metallurgy	3	0	0	15	15	70	100	**3**
2.	MME24-B-MJ202	MAJOR	Mineral Dressing	3	0	0	15	15	70	100	**3**
3.	MME24-B-MJ203	MAJOR	Metallurgical Thermodynamics and Kinetics	3	0	0	15	15	70	100	**3**
4.	MME24-B-MJ204	MAJOR	Physical Metallurgy Lab	0	0	2	0	15	35	50	**1**
5.	MME24-B-MJ205	MAJOR	Mineral Dressing Lab	0	0	2	0	15	35	50	**1**
6.		MINOR	Choose from pool	4	0	0	15	15	70	100	**4**
7.		AEC	Choose from pool	2	0	0	7.5	7.5	35	50	**2**
8.		SEC	Choose from pool	0	0	4	7.5	7.5	35	50	**2**
9.		VAC	Choose from pool	2	0	0	7.5	7.5	35	50	**2**
10.		MDC	Choose from pool	3	0	0	15	15	70	100	**3**
TOTAL				**20**	**0**	**8**	**97.5**	**127.5**	**525**	**750**	**24**

L: Lecture, T: Tutorial, P: Practical, C: Credit
* End Semester Examination
** Progress Review Examination

Scheme of Teaching and Examination
B. Tech (Metallurgical and Materials Engineering)
Academic Semester-IV

S. No.	Course Code	Course Category	Name of the Course	Hours per week			Scheme of Examination and Marks				Credit L+(T+P)/2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1.	MME24-B-MJ206	MAJOR	Deformation Behavior & Testing of Materials	3	0	0	15	15	70	100	**3**
2.	MME24-B-MJ207	MAJOR	Heat Treatment of Materials	2	0	0	7.5	7.5	35	50	**2**
3.	MME24-B-MJ208	MAJOR	Iron Making	3	0	0	15	15	70	100	**3**
4.	MME24-B-MJ209	MAJOR	Ancient Metallurgy	4	0	0	15	15	70	100	**4**
5.	MME24-B-MJ210	MAJOR	Deformation Behavior & Testing of Materials Lab	0	0	2	0	15	35	50	**1**
6.	MME24-B-MJ211	MAJOR	Heat Treatment of Materials Lab	0	0	2	0	15	35	50	**1**
7.		MINOR	Choose from pool	4	0	0	15	15	70	100	**4**
8.		AEC	Choose from pool	2	0	0	7.5	7.5	35	50	**2**
9.		SEC	Choose from pool	0	0	6	0	30	70	100	**3**
10.		MDC	Choose from pool	3	0	0	7.5	7.5	35	50	**3**
TOTAL				**21**	**0**	**10**	**82.5**	**142.5**	**525**	**750**	**26**

L: Lecture, T: Tutorial, P: Practical, C: Credit
* End Semester Examination
** Progress Review Examination

Exit option to qualify for Undergraduate Diploma: (after completion of Semester 2nd year)

1. An Exit option is available for students those who have earned the total 94 credits at the end of Fourth Semester.
2. Student who wants to avail the exit option after second year have to earn additional 4 credits from the list of courses shown below.
3. These courses student have to complete within summer vacation after 2nd Year.
4. After fulfilment as mentioned in 1 to 3 above, Students can earn U.G Diploma and same will be issued by the University.

List of Exit Courses (Choose Any TWO Skill-based Course)

S. No.	Course Code	Name of the Course	Hours per week			Scheme of Examination and Marks				Credit L+(T+P)/2
			L	T	P	PRE**		ESE*	Total Marks	
						Mid Sem	TA			
1.	MME24-B-EC201	Basic Metallography & Testing	0	0	4	---	15	35	50	**2**
2.	MME24-B-EC201	Mini Project	0	0	4	---	15	35	50	**2**
3.	MME24-B-EC203	Industrial Training	0	0	4	---	15	35	50	**2**
4.	MME24-B-EC204	Furnace Technology and Heat Treatment	0	0	4	---	15	35	50	**2**

B. Tech Semester-III
(Detailed Syllabus)

Scheme of Teaching and Examination
B. Tech (Metallurgical and Materials Engineering)
Academic Semester-III

S. No.	Course Code	Course Category	Name of the Course	Hours per week			Scheme of Examination and Marks				Credit L+(T+P)/2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1.	MME24-B-MJ201	MAJOR	Introduction to Physical Metallurgy	3	0	0	15	15	70	100	**3**
2.	MME24-B-MJ202	MAJOR	Mineral Dressing	3	0	0	15	15	70	100	**3**
3.	MME24-B-MJ203	MAJOR	Metallurgical Thermodynamics and Kinetics	3	0	0	15	15	70	100	**3**
4.	MME24-B-MJ204	MAJOR	Physical Metallurgy Lab	0	0	2	0	15	35	50	**1**
5.	MME24-B-MJ205	MAJOR	Mineral Dressing Lab	0	0	2	0	15	35	50	**1**
6.		MINOR	Choose from pool	4	0	0	15	15	70	100	**4**
7.		AEC	Choose from pool	2	0	0	7.5	7.5	35	50	**2**
8.		SEC	Choose from pool	0	0	4	7.5	7.5	35	50	**2**
9.		VAC	Choose from pool	2	0	0	7.5	7.5	35	50	**2**
10.		MDC	Choose from pool	3	0	0	15	15	70	100	**3**
TOTAL				**20**	**0**	**8**	**97.5**	**127.5**	**525**	**750**	**24**

L: Lecture, T: Tutorial, P: Practical, C: Credit
* End Semester Examination
** Progress Review Examination

Program: B. Tech **Semester: III**
Name of the Course: Introduction to Physical Metallurgy **Code: MME24-B-MJ201**
Credit: 3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:
This courses an introduction to physical metallurgy is principally aimed to introduce the students about the relationships between physical metallurgy, materials science and solid state physics. This course comprises the concept of structure property correlation, crystal structure, grain size, yield point phenomena, plastic deformation. The slip system for different crystal structure, the solidification processes for pure metals and alloys, imperfection arises during solidification process, the concept of iron –carbon diagram, TTT and CCT diagram and its application, physical metallurgy of some non-ferrous alloys will be discussed.

Course Objectives:
1. At some point of time an engineering problem involves issues related to material selection. The objective of this course to understanding the behavior of materials, particularly structure-property correlation, will help selecting suitable materials for a particular application.
2. To provide a basic understanding of the underlying principles that determines the evolution of structures in metals and alloys during their processing and its relation with their properties & performance in service.
3. Provide a smooth link between the basic knowledge of science and engineering courses.

Syllabus:

UNIT-I
Characteristics of metals; Atomic bonding, crystalline and amorphous materials; Common crystal structure of metals; Crystal systems and Bravais lattices; Crystallographic planes and directions; Atomic packing in crystals; linear and planer density; Voids in crystal structures.

UNIT-II
Solidification: Nucleation and Growth; Solidification of metals in ingot mould; Cooling curve; Imperfections in crystals; Concept of plastic deformation of metals; Yield point phenomena; Plastic deformation in polycrystalline metals; Critical resolved shear stress; Dislocation theory; Recovery, Recrystallization and Grain Growth.

UNIT-III
Solid solutions; Factors affecting solid solubility; electron compound; intermediate compound; Phase rule; Binary phase diagrams: Isomorphous, Eutectic, Peritectic, Eutectoid systems; Lever rule and its application; Effects

of non-equilibrium cooling; Coring and homogenization.

UNIT-IV

Iron – iron carbide diagrams; Time Temperature Transformation diagram; Continuous cooling Transformation diagram; Influence of alloying elements on iron carbon equilibrium diagram, TTT and CCT diagrams; Types of steel and cast iron; Metallographic inspection of steels and cast irons; Etching reagent used for different metals and alloys.

UNIT-V

Physical metallurgy and phase diagram of non-ferrous alloy system like Brass; Bronze; Al-Cu; Al-Mg and Al-Si.

Text Books:

1. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mc Grow Hill Publishing Co.
2. Elements of Physical Metallurgy, Lakhtin., MIR Publication, Moscow.
3. Material Science & Engineering, W. D. CalisterJr. Willy India Pvt. Ltd.
4. Physical Metallurgy, Vijendra Singh, SPD, Pvt Ltd

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.
2. Material Science & Engineering, W.F.Smith & Javed.Hashemi, Ravi Prakash, Tata Mc Grow Hill
3. Phase Transformation in Metals and Alloys: David A. Porter, Kenneth E. Easterling and Mohamed Y. Sherif.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand the crystal structure and behavior of materials.
CO-02	Understand the kinetics of phase transformation.
CO-03	Understand the properties of materials and their applications.
CO-04	Understand the concept of relationships between physical metallurgy, materials science and solid state physics.
CO-05	Understand the physical metallurgy of non-ferrous alloys

Program: B. Tech
Name of the Course: Mineral Dressing
Credit: 3
Max. Marks: 100

Semester: III
Code: MME24-B-MJ202
No of Hours: 3 hours/week

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Course Description:
Mineral Dressing is core engineering paper in metallurgical engineering. This combines knowledge of chemistry, mathematics with physical principles of ores and minerals above all real world economic considerations. This course involves the science and technology of adding value to raw mined products through the extraction of valuable minerals and their subsequent conversion into products. The application of process principles of minerals processing operations includes ore preparation, pre-blending, size reduction, separation and concentration, sorting, flotation, hydrometallurgy, pyro-metallurgy and electrometallurgy. This course will prepare students for careers especially in metallurgy, mining or mineralogy and provide a firm foundation for the pursuit of graduate studies in engineering

Course Objectives:
1. To familiarize the students with fundamentals of mineral source, properties and applications.
2. To understand the basics of mineral beneficiation.
3. To understand the communition laws and size reduction processes.
4. To understand the basic parameters and related processes of mineral dressing.
5. Able to implement the knowledge as effective engineers or scientists the related fields with respect to advanced level equipment.

Syllabus:

UNIT-I
Fundamental concept of ores and minerals, their properties and identification, metallic and non-metallic minerals emphasising its properties and industrial uses, performances of coal in metallurgical applications. Sampling methodology and equipment and related flowsheets, laboratory sizing and reporting the data.

UNIT-II
Laws of crushing and grinding, simple problems on energy estimations, concept of reduction ratio, work index and liberation of minerals, crushing circuits, primary, secondary and special crushers and their performances and efficiency calculations, Dry and wet grinding processes, grinding mills - their performances and efficiency calculations, related numerical.

UNIT-III

Concept of particle size distribution, performance of screens and graphical representations of screen results, screening factors, types and screen efficiency parameters, sizing and its performances, concept of terminal velocity, movement of solids in fluids emphasizing Stroke's law and Newton's law; free and hindered settling ratio; classifiers and their principles, types and operational processes.

UNIT-IV

Principles of Jigging, tabling and heavy media separation, their processes, controlling factors and applications, principles of electrostatic and magnetic separation (Dry and Wet Type) processes, related physics, sedimentation, dewatering techniques.

UNIT-V

Physico-chemical principles of forth flotation, role of chemicals in floatation, flotation mechanics, role of bubbles in flotation process, flotation process for sulphide ores and related numerical, definition, importance and applications of ore microscopy, software used in mineral dressing.

Text / Reference Books:

1. Principles of Mineral Dressing: A. M. Gaudin, Tata McGraw Hill Edition.
2. A Text Book of Geology: P. K. Mukherjee, the World Press Private Limited.
3. Ore Processing, S. K. Jain, Oxford- IBH Publishing Company, 2005.
4. Elements of Ore Dressing; Taggart A. F, J. Wiley & Sons, 1951, London/NY.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand the characteristics of different ores and minerals.
CO-02	Familiar with the different ore dressing processes utilized in industrial practices.
CO-03	Use the techniques, skills, and modern engineering tools necessary for industrial practices.
CO-04	Learn how scientific knowledge can be used for mineral dressing
CO-05	Learn about froth floatation process

Program: B. Tech **Semester: III**
Name of the Course: Metallurgical Thermodynamics and Kinetics
Credit: 3 **Code: MME24-B-MJ203**
Max. Marks: 100 **No of Hours: 3 hours/week**

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Course Description:
This course deals with the understanding of different laws of thermodynamics and will provide deep understanding of the basic principles of thermodynamics and kinetics which is must for understanding of any metallurgical processes involving chemical reactions and physical changes at high temperature.

Course Objectives:
1. To understand various thermo-dynamical concepts.
2. To understand the concept of thermodynamics and kinetics.
3. To understand the various chemical reactions occurring in metallurgical processes.
4. To understand the various physical changes in materials at high temperatures.

Syllabus:

UNIT-I
Importance of thermodynamics; laws of thermodynamics; definition of thermodynamic terms; concept of system, states and equilibrium; types of system; extensive and intensive properties; homogeneous and heterogeneous systems; quasistatic process.

UNIT-II
Internal energy, heat capacity; specific heat and latent heat; enthalpy; isothermal and adiabatic processes; state properties; heat of reaction; heat of formation; Kirchhoff's law; Sievert's law-residual gases in steel.

UNIT-III
Entropy of irreversible processes; Maxwell's relations; Clausius-Clapeyron equation; Gibb's-Helmholtz relations; Gibb's-Duhem equation; partial molar properties of mixing, ideal solution; Raoult's law; Henry's law; non-ideal solution.

UNIT-IV
Temperature dependence of entropy; stastical interpretation of entropy; Relation between Cp and Cv, Nernst heat theorem; equilibrium constant; Van-Hoff equation; concept of fugacity; activity and mole fraction.

UNIT-V

Ellingham diagram in detail for metal oxides; activity, gas phase reactions, reaction kinetics: homogeneous and heterogeneous reactions; diffusion in gases; adhesion; metastable products and partial equilibrium; melting and solidification; precipitation; eutectoid, massive, spinodal, martensitic and order disorder transformations.

Text Books:

1. Introduction to Thermodynamics of Materials, D.R Gaskell, Taylor and Francis, 2003.
2. Metallurgical Thermodynamics Kinetics and Numerical, Dr. S.K.Dutta and Prof A B Lele published by S.Chand.
3. Introduction to Metallurgical Thermodynamics, D.R. Gaskel published by McGraw Hill, NY.
4. Introduction to Materials and Metallurgical Thermodynamics by A. Ghosh published, PHI Pub.
5. Problems in Metallurgical Thermodynamics and Kinetics by G. S. Upadhyaya and R.K. Dube, Pergamon Press.

Reference Books:

1. Advanced Thermodynamics for Engineers, Kenneth Wark Jt.m, McGrew Hill Inc., 1995.
2. Advanced Engineering Thermodynamics, Bejan, A., John Wiley and Cons, 1988.
3. Thermodynamics, Fourth Edition, Holman, J.P., McGraw Hill Inc., 1988.
4. Introduction to Thermodynamics, Classical Sonntag, R.E., and Van Wylen.G,
5. Statistical Thermodynamics, Third Edition, John Wiley and Sons, 1991.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand concepts and laws of thermodynamics.
CO-02	Derive different thermodynamic relations and solve problems.
CO-03	Comprehend the concept and applications of energy and entropy.
CO-04	Interpret Ellingham Diagram for oxides.
CO-05	Applications of Ellingham Diagram in Industries

Program: B. Tech
Name of the Course: Physical Metallurgy Lab
Credit: 1
Max. Marks: 50

Semester: III
Code: MME24-B-MJ204
No of Hours: 2 hours/week

Course Description:

The course will provide the students an insight into importance of sample preparation for microstructural examination, effect of heat treatment processing on the microstructure and properties of steels.

Course Objective:

This lab is typically focuses on providing students with hands-on experience and a deeper understanding of the microstructural characteristics of metals and alloys, and how these relate to their physical and mechanical properties.

List of Experiments:

1. To prepare the hot mounting and cold mounting of the samples.
2. To prepare the metallic samples for metallographic examination.
3. To observe the microstructure of various steel samples.
4. To observe the microstructures of brass and bronze.
5. To observe the metallurgical microscope and its components.
6. To perform the etching process and etching reagents.
7. To observe the microstructures of pure metals.
8. To find the grain size by ASTM method.
9. To observe the microstructure of cold worked samples
10. To observe the microstructures of annealed and normalized steels.

Equipment Required:

1. Hot Mounting
2. Cold Mounting
3. Metallurgical Microscope
4. Muffle Furnace

Text/Reference Books:

1. The Principles of Metallographic Laboratory Practice by George L. Khel.
2. Hand Book of Metallography and Microstructure, ASM Handbook, Vol. 9.
3. Introduction to Physical Metallurgy, Sidney H. Avner.
4. Material Science by S P Gupta.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Conduct and analyze internal characteristics of metals and alloys.
CO-02	Able to know the concept of grain size and related mechanical properties correlation.
CO-03	Solve the problems through experiments and reach a solution related to a specified metal or alloy.

Program: B. Tech
Name of the Course: Mineral Dressing Lab
Credit: 1
Max. Marks: 50

Semester: III
Code: MME24-B-MJ205
No of Hours: 2 hours/week

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Course Description:
The Mineral Dressing Laboratory course is designed to provide students with hands-on experience in the physical and mechanical processes involved in the beneficiation of ores. This lab focuses on the characterization, separation, and concentration techniques used to extract valuable minerals from gangue. Through a series of practical experiments, students will become familiar with unit operations such as crushing, grinding, screening, classification, and various concentration methods including gravity, magnetic, and froth flotation techniques.

Course Objectives:
To adapt well-rounded individuals who both understand the principles and undertake the practical challenges related to mineral dressing.

List of Experiments:

1. Petrographic identification of as received igneous, metamorphic and sedimentary rocks.
2. Crushing of ore/minerals using jaw crusher.
3. Crushing of ore/minerals using roll crusher.
4. Grinding of ore/minerals using ball mill.
5. Separation of minerals on the basis of density in Wilfley Table.
6. Laboratory sizing of minerals/materials using sieve analysis.
7. Milling of minerals/materials using vibratory cup mill.
8. Pulverizing of minerals/materials using disc pulverizer.
9. Concentration of ore using froth flotation cell.
10. Separation of metallic and non-metallic minerals/materials using magnetic separator.

Equipment Required:

1. Jaw Crusher.
2. Roll Crusher.
3. Rod Mill.
4. Ball Mill.
5. Sieve Analyzer.
6. Jiggs.
7. Classifier.

8. Froth Flotation Cell.
9. Muffle Furnace.

Text/Reference Books:

1. Introduction to mineral processing, Kelly E.G., Spottiswood, D., J.,
2. Mineral Processing Technology, Wills, B.A.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Perform the experiments related to a specified mineral or ore.
CO-02	Conduct and analyze minerals' size reduction processes.
CO-03	Select and redesign a problem in extraction of minerals.

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Program: B. Tech **Semester: III**
Name of the Course: Fundamentals of Metallurgy **Code: MME24-B-MN201**
Credit: 4 **No of Hours: 4 hours/week**
Max. Marks: 100

Course Description:
Fundamentals of Metallurgy is an introductory Minor course designed to provide students with a solid understanding of the principles governing the behavior, processing, and performance of metals. The course covers essential topics including the structure and classification of metals, thermodynamic principles relevant to metallurgical reactions, extraction processes for commonly used metals, mechanical properties and their evaluation, and basic forms of corrosion and their prevention. Through this course, students will gain foundational knowledge crucial for advanced studies in materials science and engineering, and for practical applications in industries such as manufacturing, construction, automotive, and aerospace.

Course Objectives:
1. Understand the Fundamentals of Metallurgy
2. Apply Thermodynamic Principles to Metallurgical Processes
3. Evaluate Extraction Techniques for Industrial Metals
4. Assess Mechanical Properties and Testing of Metals
5. Recognize and Prevent Different Forms of Corrosion

Syllabus:

UNIT-I: Introduction to Metallurgy
Overview of metallurgy, introduction to various branches including physical, mechanical, and extractive metallurgy. The historical evolution of metallurgy and its relevance to modern applications. Classification of metals and alloys, the basic structure of metals at the atomic level, and key concepts such as crystal structure, grain boundaries, and imperfections. The role of metallurgy in various industries and its importance in material selection and design.

UNIT-II: Metallurgical Thermodynamics
The fundamental thermodynamic principles relevant to metallurgical processes. The laws of thermodynamics, enthalpy, entropy, and Gibbs free energy, and how these concepts apply to chemical reactions and phase changes in metals. Ellingham diagrams for the feasibility of reduction processes in metal extraction. Equilibrium concepts and the role of thermodynamics in predicting phase stability and transformation behavior during alloy production and heat treatment.

UNIT-III: Extraction of Common Metals
Primary extraction methods used for obtaining common industrial metals such as iron, aluminum, copper, and zinc. Pyro-metallurgical and

hydrometallurgical techniques, including roasting, smelting, electrolysis, leaching, and refining processes. Hall-Heroult process for aluminum.

UNIT-IV: Mechanical Properties of Metals
The mechanical behavior of metals under different types of loads and conditions. Stress-strain relationships, elasticity, plasticity, ductility, toughness, hardness, fatigue, and creep. tensile testing, hardness testing (Brinell, Rockwell, Vickers), and impact testing. The relationship between microstructure and mechanical performance.

UNIT-V: Basic Forms of Corrosion
The fundamental types and mechanisms of corrosion, uniform corrosion, galvanic corrosion, pitting corrosion, crevice corrosion, intergranular corrosion, and stress corrosion cracking. The electrochemical basis of corrosion along with the environmental and material factors that affect corrosion rates. Methods for corrosion prevention and control—such as coatings, cathodic protection, and material selection.

Text/Reference Books:

1. Callister, W.D. & Rethwisch, D.G. Materials Science and Engineering: An Introduction, 10th Edition, Wiley, 2018.
2. Raghavan, V.Physical Metallurgy: Principles and Practice, 3rd Edition, PHI Learning, 2015.
3. Davis, J.R. (Ed.) Metals Handbook: Desk Edition, 2nd Edition, ASM International, 1998.
4. Ray, H.S. Extraction of Nonferrous Metals, Affiliated East-West Press, 2004.
5. Fontana, M.G. Corrosion Engineering, 3rd Edition, McGraw-Hill Education, 1986.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Explain the basic concepts of metallurgy.
CO-02	Apply Metallurgical thermodynamic principles.
CO-03	Describe and compare the methods used for the extraction and refining of common industrial metals.
CO-04	Identify and evaluate key mechanical properties of metals.
CO-05	Recognize various types of corrosion, mechanisms.

Program: B. Tech **Semester: III**
Name of the Course: Materials Science and Technology **Code: MME24-B-AE201**
Credit: 2 **No of Hours: 2 hours/week**
Max. Marks: 50

Course Description:
This course aims to provide students with a foundational understanding of material classes, their structures, properties, processing, and performance. The course integrates theory with modern applications in sectors such as aerospace, automotive, and energy, while also exploring emerging trends like sustainable and smart materials.

Course Objectives:
1. Introduce fundamental concepts of various material classes and their intrinsic properties.
2. Understand the interrelationship between structure, properties, processing, and performance of materials.
3. Explore the role of materials in modern technological applications, emphasizing aerospace, automotive, and energy sectors.
4. Familiarize with traditional and advanced ceramic processing techniques and their applications.
5. Expose students to emerging materials, including sustainable, functional, and quantum materials.

Syllabus:

UNIT-I Classification of materials:
Metals, Ceramics, Polymers, Composites, Semiconductors, and Smart Materials. Historical development and significance of materials in modern society. Atomic structure and electronic configuration. Periodic table and periodic trends. Types of chemical bonding: metallic, covalent, ionic, van der Waals, hydrogen bonding.

UNIT-II Crystallography:
Crystal structures, unit cells, and lattice systems. Miller indices for planes and directions. Atomic packing: hcp, ccp, bcc structures, and packing efficiency. Radius ratio rule and common ceramic structures (e.g., NaCl, ZnS, perovskites).

UNIT-III Materials Characterization:
Introduction to characterization techniques: importance and classification (destructive vs. non-destructive). Microscopy techniques: Optical Microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM).), Mechanical testing: tensile, hardness, impact, creep, and fatigue

testing. crystallography applications (XRD basics).

UNIT-IV Degradation mechanisms in materials:
Corrosion, wear, oxidation, and radiation damage. Types of corrosion: uniform, galvanic, pitting, crevice, intergranular, and stress corrosion cracking. Corrosion control methods: material selection, coatings, inhibitors, cathodic and anodic protection. Wear and friction: adhesive, abrasive, erosive, and fretting wear; tribology fundamentals. Creep and fatigue failure: mechanisms, Environmental effects on material performance and service life prediction.

UNIT-V Advanced Materials:
Materials in aerospace and automotive applications. Mg alloys, Titanium alloys, Super alloy and Shape memory alloys. Steels tailored for automotive and aerospace sectors. Metal Matrix Composites (Al, Ti-based), Polymer Matrix Composites. Ceramic Matrix Composites (C/C, C/SiC). Sustainable materials and recycling strategies.

Text Books:

1. W.D. Callister, Fundamentals of Materials Science and Engineering; John Wiley & Sons.
2. V. Raghavan, Introduction to Materials Science and Engineering; PHI Learning.
3. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill.
4. W.D. Kingery, Introduction to Ceramics; Wiley.

Reference Books:

1. Robert Reed-Hill, Physical Metallurgy Principles; Cengage.
2. S.O. Kasap, Principles of Electronic Materials and Devices; Tata McGraw Hill.
3. K.G. Budinski, Engineering Materials – Properties and Selection; Prentice Hall.
4. J.F. Shackelford, Introduction to Materials Science for Engineers; Pearson.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Classify and describe various engineering materials based on their structure and properties.
CO-02	Analyze crystallographic structures and comprehend their influence on material behavior.
CO-03	Interpret diffraction data for basic crystal structure determination.
CO-04	Evaluate degradation mechanisms for materials.
CO-05	Select appropriate materials for specific applications in aerospace, automotive, energy, and development of sustainable materials.

Program: B. Tech
Name of the Course: Material Science Lab
Credit: 2
Max. Marks: 50

Semester: III
Code: MME24-B-SE201
No of Hours: 4 hours/week

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Course Description:

1. Fully qualified as entry-level materials engineers, with an ability to adapt and progress in a rapidly changing field.
2. Able to an understanding of both theoretical as well as experimental aspects of materials principles through advanced techniques.
3. Well-rounded individuals who both understand the principles and can undertake the practice of the science and engineering of materials.
4. Able to operate as effective engineers or scientists in materials industries, academia, or related fields.

Course Objectives:

1. Provide practical exposure to the fundamental properties and behaviors of engineering materials.
2. Develop hands-on skills in the testing and characterization of materials, including metals, polymers, and ceramics.
3. Understand the correlation between a material's structure, processing, properties, and performance.

List of Experiments:

1. Electrical conductivity measurement of ferrous and non-ferrous metals.
2. Measuring magnetic hysteresis, retentivity, coercivity, and saturation magnetization by tracing B-H curves.
3. Determining wear rate of different materials using a wear testing machine.
4. Creating crystal model structures of materials using software/physical models and identifying imperfections.
5. Determining heat transfer through composite walls.
6. Preparing composite materials.
7. Measuring density and porosity of materials.
8. Preparing metal specimens for microscopy.
9. Measuring mechanical properties of Metal Matrix Composites.
10. Analysing microstructure of materials using optical microscopy (qualitative and quantitative).

Equipment Required:

1. Disc Wear Testing Machine
2. B-H Curve Tracer

3. Optical Microscope.
4. Metal Conductivity meter for Non Ferrous material analysis.

Text/Reference Books:

1. Raghavan V, Materials Science and Engineering, 4th Edition, Prentice Hall of India, 1998.
2. Kittel C, Introduction to Solid State Physics, 6th Edition, Wiley Eastern, New International Publishers, 1997.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Select and redesign the problem of material science.
CO-02	Experimentally evaluate the mechanical properties of advanced materials.
CO-03	Interpret and analysis microstructural features of materials using optical microscopy.

Program: B. Tech
Name of the Course: Materials Informatics
Credit: 3
Max. Marks: 100

Semester: III
Code: MME24-B-MD201
No of Hours: 3 hours/week

Course Description:
This course provides an interdisciplinary introduction to the application of data science, machine learning, and digital tools in materials research and development. Students will learn how computational methods and data-driven approaches accelerate the design, discovery, and deployment of advanced materials. Topics include the Materials Genome Initiative, high-throughput simulations, machine learning algorithms, scientific visualization, and autonomous materials discovery. Practical exposure to tools like Python libraries, databases, and informatics workflows will prepare students for modern materials innovation environments.

Course Objectives:
To understand the role of data science in modern materials research and design.

1. To introduce computational frameworks such as DFT, MD, and phase-field modeling.
2. To explore data acquisition, feature engineering, and dimensionality reduction techniques in materials datasets.
3. To apply machine learning and deep learning methods for materials property prediction and classification.
4. To develop skills in scientific visualization and reproducible data pipelines.
5. To understand cutting-edge topics like inverse design, autonomous discovery, and ethical AI in materials science.

Syllabus:

UNIT-I
Role of data science in materials research, Digital transformation in materials design, The Materials Genome Initiative (MGI), The SPPP framework and its digital encoding, Overview of computational materials science: DFT, MD, phase-field models, Terminology: descriptors, features, surrogate models, high-throughput screening.

UNIT-II
High-throughput experimentation and simulation data, Public and proprietary materials databases: Materials Project, Citrination, NOMAD, AFLOW, OQMD, Feature engineering: structural, thermodynamic, electronic, and mechanical descriptors, Dimensionality reduction techniques (PCA, t-SNE), Data integrity: normalization, imputation, outlier detection, Data storage formats: JSON, HDF5, CIF, database schema design (SQL/NoSQL).

UNIT-III
Regression and classification algorithms: linear models, SVM, decision trees, ensemble methods, Model selection and hyperparameter tuning (grid search, Bayesian optimization), Model interpretability: SHAP values, feature importance, Uncertainty quantification in materials predictions, Deep learning applications: convolutional neural networks (CNNs) for microstructure analysis, Case studies: property prediction, phase stability classification, materials failure prediction.

UNIT-IV
Scientific visualization techniques for complex materials data, Software tools: Matplotlib, Plotly, Bokeh, Paraview, VTK, 3D visualization of crystal structures, phase spaces, and microstructures, Interactive dashboards for real-time data exploration (Dash, Streamlit), Building reproducible informatics pipelines (Jupyter, Snakemake, Git, Docker).

UNIT-V
Inverse design and generative models (GANs, VAEs), Autonomous materials discovery (closed-loop systems, robotic experimentation), Multi-fidelity modeling and transfer learning in materials datasets, Materials informatics in additive manufacturing and alloy design, Data-driven approaches for sustainability, recycling, and lifecycle assessment, Ethical considerations and data stewardship in scientific AI.

Text/Reference Books:

1. **Materials Informatics: Data-Driven Discovery in Materials Science**
   By Krishna Rajan
2. **Materials Informatics: Methods, Tools, and Applications**
   Edited by Tiago Albano and J. Paulo Davim

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Analyze the principles of data-centric approaches in materials science and the Materials Genome Initiative.
CO-02	Construct and manage structured materials datasets for predictive and exploratory analysis.
CO-03	Apply statistical learning and machine learning techniques for modeling structure–property–processing–performance (SPPP) relationships.
CO-04	Develop customized data pipelines and visualization tools to interpret high-dimensional materials datasets.
CO-05	Formulate informatics-driven frameworks for materials design, discovery, and sustainability optimization.

B. Tech Semester-IV
(Detailed Syllabus)

Scheme of Teaching and Examination
B. Tech (Metallurgical and Materials Engineering)
Academic Semester-IV

S. No.	Course Code	Course Category	Name of the Course	Hours per week			Scheme of Examination and Marks				Credit L+(T+P)/2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1.	MME24-B-MJ206	MAJOR	Deformation Behavior & Testing of Materials	3	0	0	15	15	70	100	**3**
2.	MME24-B-MJ207	MAJOR	Heat Treatment of Materials	2	0	0	7.5	7.5	35	50	**2**
3.	MME24-B-MJ208	MAJOR	Iron Making	3	0	0	15	15	70	100	**3**
4.	MME24-B-MJ209	MAJOR	Ancient Metallurgy	4	0	0	15	15	70	100	**4**
5.	MME24-B-MJ210	MAJOR	Deformation Behavior & Testing of Materials Lab	0	0	2	0	15	35	50	**1**
6.	MME24-B-MJ211	MAJOR	Heat Treatment of Materials Lab	0	0	2	0	15	35	50	**1**
7.		MINOR	Choose from pool	4	0	0	15	15	70	100	**4**
8.		AEC	Choose from pool	2	0	0	7.5	7.5	35	50	**2**
9.		SEC	Choose from pool	1	0	4	0	30	70	100	**3**
10.		MDC	Choose from pool	3	0	0	7.5	7.5	35	50	**3**
TOTAL				**21**	**0**	**10**	**82.5**	**142.5**	**525**	**750**	**26**

L: Lecture, T: Tutorial, P: Practical, C: Credit
* End Semester Examination
** Progress Review Examination

Program: B. Tech **Semester: IV**
Name of the Course: Deformation Behavior & Testing of Materials
Credit: 3 **Code: MME24-B-MJ206**
Max. Marks: 100 **No of Hours: 3 hours/week**

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Course Description:
This course Deformation behaviour and Testing of material is principally aimed to introduce the students about mechanical properties, deformation behaviour and testing of materials. This course comprises the concept of destructive as well as non-destructive testing processes. The destructive testing processes will comprise Tensile test, Torsion test, Fracture test, Fatigue and Creep test. The destructive testing processes will comprise Dye penetrant, Radiography, Magnetic particle and Ultrasonic testing. The importance, scope advantages and disadvantages will be discussed.

Course Objectives:
1. At some point of time an engineering problem involves issues related to material selection. The objective of this course to understanding the behavior of materials, particularly Mechanical properties correlation, will help selecting suitable materials for a particular application.
2. To provide a basic understanding of the underlying principles that determines the evolution of structures in metals and alloys during their processing and its relation with their properties & performance in service.
3. The students will get basic concept of different destructive and non-destructive testing.
4. This course provides a smooth link between the basic knowledge of science and engineering courses.

Syllabus:

UNIT-I
Mechanical properties of materials; Stress and strain; Elastic, An elastic and Viscoelastic properties of materials; Tensile Test; Yield stress; Ultimate tensile stress; Necking phenomenon and conditions of necking; Universal testing machine; Numerical problems on test data; Flow curve; Proof stress; Engineering and true stress-true strain curve.

UNIT-II
Dislocation theory: Types of dislocations; Observation of dislocations; Significance of burger vector; Multiplication and dissociation of dislocation; Force on dislocation; Force between dislocations; Torsion test; Determination of strength of a solid and hollow shaft under torsion; Hardness test: Principles and machines used – Brinell, Vickers, Rockwell, Scleroscope and micro hardness testing.

UNIT-III

Fracture: Types of fracture, Fracture mechanism, theoretical cohesive strength of meterials, Griffith theory of Brittle fracture, Impact Test, Notched bar impact tests, DTBT; Metallurgical factors affecting ductile to brittle transition.

UNIT-IV

Fatigue and Creep Testing – Basics of fatigue phenomenon; S – N curve and corrosion fatigue; Fatigue testing; Signification of Creep; Testing procedure; Creep curve and its interpretation; Metallurgical and mechanical factors affecting creep and fatigue failures.

UNIT-V

Non-destructive testing: Importance, scope, advantages and limitations – Dye penetrant; Radiography; Magnetic particle; Ultrasonic and electrical methods of testing and their application.

Text Books:

1. Mechanical Metallurgy: George E. Dieter
2. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", John Wiley and Sons, 1976.
3. Material Science & Engineering, W. D. Calister Jr. Willy India Pvt. Ltd.
4. Physical Metallurgy, Vijendra Singh, SPD, Pvt Ltd
5. Testing of Metallic Materials: A. V. K. Suryanarayan

Reference Books:

1. Testing and Inspection of Engineering Materials- Davies, Taroxall and Wiscosil
2. Mechanical Testing of Metallic Materials: D. A. Beument.
3. Engineering Materials Science: C. W. Richards
4. Non Destructive testing: Louis Cartz, ASM International Materials Park. Destructive testing: ASM International Materials Park.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Know about elastic and plastic deformation of metallic materials .
CO-02	Understand effect of deformation behavior of ductile & brittle material.
CO-03	Understand various strengthening methods of metals & alloys.
CO-04	Understand various concepts of fracture, creep, fatigue behaviors in metals.
CO-05	Have understanding on various destructive and non-destructive tests.

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Program: B. Tech | **Semester: IV**
Name of the Course: Heat Treatment of Materials | **Code: MME24-B-MJ207**
Credit: 2 | **No of Hours: 2 hours/week**
Max. Marks: 50

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Course Description:
This course Heat Treatment of Materials is principally aimed to introduce the students about basic concept of the theory and practice of heat treatment of metals and alloys. It provides a comprehensive understanding of the various transformation reactions associated with the changes in microstructure and property that occur due to controlled heat treatment. The course introduces different heat treatments process and its uses to improve the mechanical properties etc. The students also will get idea to use the Iron-cementite diagram, TTT & CCT for different purposes.

Course Objectives:
1. To understand the role of Heat treatment in the metal processing techniques which can play a significant role to tailor material properties.
2. To provide a basic understanding of principles that determines the evolution of structures in metals and alloys during heat treatment and phase transformation which enhances the performance of materials during entire service condition.

Syllabus:

UNIT-I
Purpose of heat treatment, heat treatment parameters, Classification of Heat treatment methods, Iron-Carbon equilibrium diagram, Mechanism of formation of Austenite, Pearlite, Bainite, Martensite. Recovery, recrystallization and grain growth.

UNIT-II
Introduction to TTT diagrams, TTT diagram of eutectoid, hypo and hyper eutectoid steels, Development of phases under isothermal transformation, effect of Carbon and alloying elements on Iron-Carbon and TTT diagrams, CCT curves, Applications of TTT diagram: Austempering and Martempering.

UNIT-III
Annealing, Normalizing and Hardening, Quenching types, Severity of Quench, Tempering process and metallurgical effects, Concept of hardenability; measurement of hardenability, Introduction to Precipitation /age hardening, thermos-mechanical treatment, intercritical heat treatment, polymer quenching, sub-zero treatment – cryogenic quenching, patenting.

UNIT-IV

Surface Hardening methods, Thermal – flame hardening, induction hardening, and advanced techniques like plasma, electron beam etc. Thermo-chemical processes – carburizing, nitriding, carbonitriding.

UNIT-V

Heat treatment furnaces, atmospheres and defects, Heat treatment of special steels: spring, stainless, tool steels, Rail steels, Heat treatment of Non-ferrous alloys.

Text Books:

1. Phase transformation in metal and alloys- David A. Porter, E. Easterling & M. Y. Sherif.
2. Principles of Heat Treatment of Steels, ASM.
3. Heat Treatment: Principles and Techniques by T.V Rajan, C.P Sharma & Ashok Sharma.
4. Physical Metallurgy, Vijendra Singh, SPD, Pvt Ltd
5. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mc Grow Hill Publishing Co.

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.
2. Material Science & Engineering, W.F.Smith & Javed.Hashemi, Ravi Prakash, Tata Mc Grow Hill
3. Vijendra Singh, "Heat Treatment of Metals", Second Edition, Standard Publishers Distributors New Delhi, 2009.
4. Novikov, "Theory of Heat Treatment of Metals", MIR Publishers, Moscow, 1978.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand the different types of phases present in the materials.
CO-02	Know about various steels and their heat treatment methods.
CO-03	Understand the role of heat treatment in enhancing the material properties.
CO-04	Understand the surface heat treatment processes.
CO-05	Understand defects in the heat treatment processes.

Program: B. Tech | **Semester: IV**
Name of the Course: Iron Making | **Code: MME24-B-MJ208**
Credit: 3 | **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:
This course 'Iron making' is principally aimed to introduce the students about concepts related to iron making process from beneficiation of burden material to the production of solid and molten iron through Blast Furnace and other alternatives methods.

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

Syllabus:

UNIT-I
Raw Materials for iron making: iron ore, evaluation of iron ore, preparation of ores; Agglomeration processes: Sintering, Pelletisation, Briquetting and Nodulation; Testing of ores, sinters and pellets; Blast Furnace Fuels: Specification of Metallurgical coal; Preparation of Coke; physical and chemical properties of coke; other solid fuels; Fluxes; Air supply; Problems of Indian raw materials; Numericals.

UNIT-II
Blast Furnace design and constructional features; Blast Furnace cooling systems; Blast Furnace refractories; charging system of Blast Furnace; Operation of Blast Furnace; Burden Calculation and Mass Balances.

UNIT-III
Modern concept of Blast Furnace process; Temperature profile in Blast furnace; Aerodynamics; Blast Furnace reactions; Injection of Coal, Oil and Gas; Numericals.

UNIT-IV
Modern trends of Blast Furnace Practice; Hot metal and Slag; Cast house operations; Furnace Auxiliaries; Operational Problems of Blast Furnace; Blast Furnace Productivity and efficiency.

UNIT-V
Alternate Methods of Iron Making: Raw material for DR process; Sponge iron process; Coal based process: Rotary kiln and Rotary Hearth process; Gas

based processes; characteristics of sponge iron; Use of sponge iron; Environmental benefits of sponge iron; Smelting Reduction Processes: Classification of SR Processes; Major Smelting Reduction (SR) Processes; Advantages and Limitations of SR process; Alternate Ironmaking; Numericals.

Text Books:

1. Principles of Blast Furnace Iron Making– Dr. A. K Biswas.
2. Modern Blast Furnace Ironmaking an introduction- Renard Chaigneau, Tim Vander, Jennifer Wise
3. The manufacture of Iron and Steel– G.R. Bashforth.
4. An Introduction to modern Iron making by R H Tupkary.

Reference Books:

1. Iron making and steel making; theory and practice- Ahindra Ghosh and Amit Chatterjee.
2. Basic Concepts of Iron and Steel Making- Sujay Kumar Dutta, Yakshil B. Chokshi.
3. A First Course in Iron and Steel Making- Dipak Mazumdar.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Understand various concepts related to Iron Making processes.
CO-02	Learn to perform BF charge calculations.
CO-03	Understand the various alternate routes of iron making.
CO-04	Learn the Modern trends of Blast Furnace Practice.
CO-05	Learn Alternate Methods of Iron Making.

4. Brinell, Rockwell and Vickers Hardness Tester
5. Torsion Test
6. Ultrasonic Tester

Text/Reference Books:

1. Mechanical Metallurgy: George E. Dieter
2. Testing of Metallic Materials: A. V. K. Suryanarayan
3. Destructive testing: ASM International Materials Park.
4. Non Destructive testing: Louis Cartz, ASM International Materials Park.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Conduct and analyze various mechanical properties of materials.
CO-02	Understand the need of non-destructive testing for different types of materials.
CO-03	Understand various destructive testing of materials.

Program: B. Tech | **Semester: IV**
Name of the Course: Heat Treatment of Materials Lab | **Code: MME24-B-MJ211**
Credit: 1 | **No of Hours: 2 hours/week**
Max. Marks: 50

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Course Description:
This lab introduces students to various heat treatment processes such as annealing, hardening, tempering, and normalizing. Through hands-on experiments, students learn how heat treatment alters the microstructure and mechanical properties of metals. The course includes hardness testing and microstructural analysis to evaluate treatment effects.

Course Objectives:
This Laboratory course is designed to make the student understand and demonstrate the various types of heat treatment processes, process variables used for heat treatment of ferrous and non-ferrous alloys.

List of Experiments:

1. To observe the hardness and microstructure of annealed plain carbon steel sample.
2. To observe the hardness and microstructure of normalized plain carbon steel sample.
3. To observe hardness and microstructure of a plain carbon steel sample by quenching in different media.
4. To observe hardness and microstructure of steel samples by varying tempering temperatures and duration.
5. To observe the microstructure of a Thermo-mechanically Treated (TMT) steel bar samples.
6. To observe the microstructure of heat-treated rail steel samples.
7. To observe the effect of cooling parameters on hardness of a rail steel samples.
8. To determine the hardenability of plain carbon and alloy steels by Jominy end quenching.
9. To observe the microstructural changes in Aluminum alloys during aging treatment.
10. To perform case carburizing on steel samples and study its microstructure and hardness.

Equipment Required:

1. Muffle Furnace
2. Hardness Tester
3. Optical Microscope with Image Analyzer
4. Hardenability Apparatus

Program: B. Tech **Semester: IV**
Name of the Course: Metallurgical Practices **Code: MME24-B-SE202**
Credit: 3 **No of Hours: 5 hours/week**
Max. Marks: 100

Course Description:
This laboratory course is designed to equip students with hands-on skills in metallurgical specimen preparation, material characterization, and testing methods. The experiments cover fundamental and advanced metallurgical techniques, including mechanical testing (tensile, impact, hardness, and fatigue), microstructural analysis (optical microscopy, SEM, and XRD), corrosion testing, and heat treatment operations. Through practical engagement with metallurgical instruments and procedures, students will develop competencies in analyzing material properties, behavior, and performance under different conditions.

Course Objectives:
1. To develop hands-on expertise in specimen preparation, metallurgical testing, and material characterization techniques.
2. To introduce the students with analysis of the mechanical, microstructural, and corrosion behavior of materials using industry-standard testing methods.
3. To obtain basic understanding of the role of heat treatment, wear, and fatigue in material performance and failure analysis.

List of Experiments:
1. Selection and Sampling of Test Specimens
2. Metallographic Specimen Preparation
3. Specimen Preparation for Tensile and Compression Testing
4. Specimen Preparation for Impact Testing (Charpy, Izod)
5. Specimen Preparation for Hardness Testing (Brinell, Rockwell, Vickers)
6. Specimen Preparation for XRD and SEM Analysis
7. Specimen Preparation for Corrosion Testing
8. Furnace Operation and Heating Techniques
9. Specimen Preparation for Jominy End-Quench Test
10. Specimen Preparation for Fatigue Testing
11. Specimen Preparation for Wear Testing
12. Temperature Measurement using Thermocouples/Pyrometer

Equipment Required:

1. Abrasive Cut-off Machine
2. Belt Grinder
3. Polishing Machine

4. Ultrasonic Cleaner
5. Universal Testing Machine (UTM)
6. Impact Testing Machine
7. Hardness Testers: Brinell, Rockwell, Vickers
8. Fatigue Testing Machine
9. Wear Testing Machine
10. Jominy End-Quench Test Setup
11. Optical Microscope with Image Analysis Software
12. Scanning Electron Microscope (SEM) with EDS
13. X-Ray Diffractometer (XRD)
14. Metallurgical Specimen Mounting Press
15. Surface Roughness Tester
16. Electrochemical Workstation (Potentiostat/Galvanostat)
17. Muffle Furnace
18. Induction Furnace
19. Jominy Quenching Setup
20. Ultrasonic Testing (UT) Machine
21. Dye Penetrant Testing (DPT) Kit
22. Magnetic Particle Testing (MPT) Setup
23. Thermocouples
24. Infrared Pyrometer
25. Digital Temperature Indicators

Text Books:

1. ASM Handbook, Volume 8 - Mechanical Testing and Evaluation
2. ASM Handbook, Volume 9 - Metallography and Microstructures
3. M. G. Fontana - Corrosion Engineering
4. G.F. Vander Voort - Metallography: Principles and Practice
5. J. R. Davis - Surface Hardening of Steels: Understanding the Basics
6. R.A. Higgins - Engineering Metallurgy (Part 1 & Part 2)

Reference Books:

1. B.D. Cullity & S.R. Stock - Elements of X-ray Diffraction
2. Robin E. Bentley - Theory and Practice of Thermoelectric Thermometry
3. Temperature Measurement by L. Michalski, K. Eckersdorf, J. Kucharski, and J. McGhee
4. Barrie Jenkins & Peter Mullinger - Industrial and Process Furnaces: Principles, Design and Operation

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Demonstrate proficiency in metallurgical sample preparation techniques.
CO-02	Utilize metallurgical instruments effectively for research and industrial applications.
CO-03	Apply temperature measurement techniques to monitor and control heat treatment and metallurgical processes accurately.

Program: B. Tech | **Semester: After 4th Sem**
Name of the Course: Basic Metallography & Testing | **Code: MME24-B-EC201**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

Course Description:
This course focuses on microstructural characterization and mechanical testing of metallic materials. Students will gain practical and theoretical knowledge in preparing and analyzing metallurgical specimens, understanding structure-property relationships, and conducting mechanical and non-destructive tests in accordance with industry standards.

Course Objectives:
1. To develop a clear understanding of metallographic techniques and their importance in material science.
2. To train students in standard procedures of mechanical and non-destructive testing.
3. To equip students to identify and interpret microstructures of common engineering materials.
4. To establish a foundation for materials characterization, quality control, and failure analysis.
5. To prepare students for advanced studies and industry roles in testing and inspection.

Syllabus:

UNIT-I
Objectives of metallography and historical context, Selection of representative samples, Sectioning tools: abrasive cutter, hacksaw, precision cutting, Mounting: hot and cold mounting materials, thermosetting resins, Grinding: abrasive papers, techniques, troubleshooting, Polishing: polishing cloths, alumina/silica suspensions, diamond pastes, Etching principles: chemical vs electrolytic etching, Common etchants and their reactions (Nital, Keller's reagent, etc.), Cleaning and preservation of polished specimens, Safety and best practices in metallographic labs

UNIT-II
Principles of light microscopy: reflection, magnification, resolution, Components and working of an optical microscope, Microscopy techniques: bright field, dark field, polarized light, Grain boundaries, twins, inclusions, second-phase particles, ASTM grain size measurement (comparison and intercept methods), Microstructure of: Low, medium, high carbon steels, Cast irons: gray, white, ductile, malleable, Stainless steels: ferritic, austenitic, martensitic, Non-ferrous alloys: Al-Si, Al-Cu, Cu-Zn, Cu-Sn, Ni-base, Common metallurgical defects visible under microscope

UNIT-III

Tensile testing: stress-strain curve, yield strength, UTS, elongation, modulus, True stress-strain and necking phenomenon, Hardness testing: Brinell: formula, applications, limitations, Rockwell: B, C scales, conversion between scales, Vickers: micro/macro, diagonal measurement, Factors affecting hardness test results (load, dwell time, surface finish), Compression testing: stress-strain behavior in ductile vs brittle materials, Introduction to creep testing: mechanisms and curve stages

UNIT-IV

Impact testing: principles, energy absorption, test setup, Charpy and Izod: notched specimens, standards, Ductile-to-brittle transition curve for BCC materials, Fracture types: ductile vs brittle fracture features, Fatigue failure mechanism and crack propagation, S-N diagram, fatigue limit, endurance ratio, Factors affecting fatigue life: surface finish, stress concentration, environment, Fractography basics using SEM, Introduction to fracture toughness (K_IC)

UNIT-V

Introduction to Scanning Electron Microscopy (SEM): imaging and resolution, Energy Dispersive X-ray Spectroscopy (EDS): elemental analysis, X-Ray Diffraction (XRD): crystal structure and phase identification, Image analysis software for quantitative metallography, Non-Destructive Testing (NDT): Visual inspection, Liquid penetrant testing (LPT): procedure, sensitivity, Magnetic particle testing (MPT): ferromagnetic materials only, Ultrasonic testing (UT): sound wave principles, flaw detection, Radiographic testing (RT): X-ray/Gamma ray imaging, Comparison: Destructive vs. Non-destructive testing, Applications of NDT in aerospace, automotive, and heavy industries.

Reference Books:

1. Metallography and Microstructures" from ASM International.
2. "Materials Science and Engineering: An Introduction" by William D. Callister.
3. "Mechanical Metallurgy" by George E. Dieter.
4. "Physical Metallurgy: Principles and Practice" by V. Raghavan

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Explain the procedures and relevance of metallographic sample preparation.
CO-02	Recognize and analyze microstructures of common engineering alloys.
CO-03	Apply standard mechanical testing methods and interpret results.
CO-04	Correlate material microstructure with mechanical properties and service behavior.
CO-05	Demonstrate knowledge of basic non-destructive testing methods and advanced characterization tools.

Program: B. Tech **Semester: After 4th Sem**
Name of the Course: Mini Project **Code: MME24-B-EC202**
Credit: 2 **No of Hours: 4 hours/week**
Max. Marks: 50

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Course Description:
The Mini Project course enables students to identify, plan, and execute a small-scale engineering project that reflects real-world problems or innovative solutions. It provides hands-on experience in applying engineering principles, tools, and methodologies in a collaborative team environment. The course emphasizes project planning, design, analysis, implementation, testing, and documentation. Through this, students enhance their technical competence, teamwork, communication, and problem-solving skills, while preparing for industry challenges and larger capstone projects.

Course Objectives:
The Mini Project undertaken during the summer vacation after the 4th semester provides students with an opportunity to apply the knowledge and skills gained in the first two years of engineering in a practical, hands-on environment. It encourages students to work individually or in small teams to identify a real-world problem or explore an innovative idea and develop a technical solution using basic engineering tools and software.

This project enhances creative thinking, problem-solving ability, and technical proficiency. Students are expected to document their work through a project report and may present their outcomes in front of a faculty panel. This experience serves as a foundation for more advanced projects in the later semesters and helps students gain confidence and industry-relevant skills.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Identify real-world engineering problems and formulate a project objective with a well-defined scope and constraints.
CO-02	Apply engineering knowledge and technical skills to design and develop functional solutions using appropriate tools, techniques, and methodologies.
CO-03	Demonstrate the ability to work effectively in a team, with appropriate division of tasks, collaboration, and conflict resolution.
CO-04	Document and present the project development process and outcomes clearly and professionally through reports and presentations.
CO-05	Analyze project outcomes and reflect on challenges, limitations, and improvements while demonstrating an attitude for continuous learning and innovation.

Program: B. Tech | **Semester: After 4th Sem**
Name of the Course: Industrial Training | **Code: MME24-B-EC203**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

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Course Description:

Industrial Training is a vital part of the engineering curriculum, aimed at enhancing students' practical knowledge and industry readiness. Conducted typically during the summer vacation after the 4th semester, this training provides students with exposure to real-time industrial operations, professional practices, and technological applications in their respective engineering fields. It bridges the gap between theoretical education and industrial requirements by allowing students to observe, learn, and participate in various departmental functions. The training also fosters professional skills such as teamwork, communication, and problem-solving. Students are required to submit a detailed report and presentation upon completion.

Course Objectives:

Industrial Training undertaken during the summer vacation after the 4th semester is a key component of the Engineering program. It aims to bridge the gap between academic learning and industry practices by exposing students to real-time industrial environments.

This training allows students to gain firsthand experience in the functioning of various departments, technologies, and workflows within an industry relevant to their field of study. It enhances their understanding of professional practices, safety standards, teamwork, and project execution in a real-world setting. Students are encouraged to take up training in core industries, manufacturing units, service organizations, or R&D institutions where they can observe and participate in day-to-day operations, maintenance, and development activities.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Apply theoretical knowledge to practical tasks and real-time industrial processes.
CO-02	Demonstrate an understanding of industrial operations, safety standards, workflow, and management practices.
CO-03	Develop technical skills and hands-on experience in using tools, machines, and software relevant to the engineering domain.
CO-04	Communicate and collaborate effectively with professionals, showcasing teamwork and interpersonal skills.
CO-05	Prepare and present a professional report summarizing the training experience, learning outcomes, and reflections.

Program: B. Tech **Semester: After 4th Sem**
Name of the Course: Furnace Technology and Heat Treatment
Credit: 2 **Code: MME24-B-EC204**
Max. Marks: 50 **No of Hours: 4 hours/week**

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Course Description:
This course provides students with a thorough understanding of the design, operation, and control of industrial furnaces and various heat treatment processes. Emphasis is placed on furnace components, heat transfer principles, thermal instrumentation, refractory materials, and the transformation behavior of materials during thermal processing.

Course Objectives:
To introduce the basic principles of flame structure, furnace design, and modes of heat transfer, to understand pyrometry and process control in furnace operations, to study various industrial furnaces and their related refractory systems, to examine the effects of heat treatment on microstructure and properties of metals and alloys, and to explore practical heat treatment methods and industrial processing furnaces.

Syllabus:

UNIT-I
Structure of flame, types of flames, components of a furnace, basic principles of furnace design, modes of heat transfer in furnaces, heat loss in furnaces and minimization techniques, waste heat recovery systems – types, construction and working principles, chimney height calculation and related numerical problems

UNIT-II
Principle of pyrometry, types of pyrometers – optical, radiation, thermocouple-based, construction and functioning of pyrometers, process instrumentation and control (PIC) systems, cupola furnace – principle, zones, construction and operation, blast furnace – principle, thermal profile, reactions and design, electric arc furnace (EAF) – construction, working, temperature control, induction furnace – principle, coil design, thermal efficiency, refractories related to different furnace architectures

UNIT-III
Classification of refractories, properties of refractories, selection criteria for different furnace conditions, thermal conductivity, porosity, density, refractoriness under load (RUL), thermal insulation materials and applications, degradation mechanisms in refractories, life enhancement techniques, testing of refractories, heat-resistant materials for furnace linings

UNIT-IV
Objectives and scope of heat treatment, iron-carbon equilibrium diagram, TTT

and CCT diagrams, annealing, normalizing, hardening, tempering, austempering, martempering, surface hardening techniques – carburizing, nitriding, carbonitriding, cyaniding, selection of quenching media and quenching methods

UNIT-V

Heat treatment of plain carbon steels, heat treatment of alloy steels, tool steels, stainless steels, cast irons, Aluminium alloys, magnesium alloys, titanium alloys, induction hardening, flame hardening, laser hardening, industrial heat treatment furnaces – batch, continuous, salt bath, sealed quench, heat treatment quality control and testing methods

Text Books:

1. Phase transformation in metal and alloys- David A. Porter, E. Easterling & M. Y. Sherif.
2. Principles of Heat Treatment of Steels, ASM.
3. Heat Treatment: Principles and Techniques by T.V Rajan, C.P Sharma & Ashok Sharma.
4. Physical Metallurgy, Vijendra Singh, SPD, Pvt Ltd
5. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mc Grow Hill Publishing Co.

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.
2. Material Science & Engineering, W.F.Smith & Javed.Hashemi, Ravi Prakash, Tata Mc Grow Hill
3. Vijendra Singh, “Heat Treatment of Metals”, Second Edition, Standard Publishers Distributors New Delhi, 2009.
4. Novikov, “Theory of Heat Treatment of Metals”, MIR Publishers, Moscow, 1978.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CO-01	Analyze the components, performance, and efficiency of industrial furnaces.
CO-02	Understand and apply thermal measurement techniques in metallurgical operations.
CO-03	Select and apply suitable refractory and insulation materials for different furnace conditions.
CO-04	Interpret phase transformation diagrams and apply knowledge in heat treatment cycle design.
CO-05	Recommend and control heat treatment processes for ferrous and non-ferrous materials.

Teaching Scheme and Syllabus
of
M.Tech in Material Science and Technology

(PROGRAM CODE: 01NPG051)

DEPARTMENT OF METALLURGICAL ENGINEERING
SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2025-27

<u>**SCHEME OF TEACHING AND EXAMINATION**</u>

M. Tech (Material Science and Technology)
(REVISED APR 25)

PROGRAMME OUTCOME (PO)

Currently, OP Jindal University is offering undergraduate programmes (3/4 Years), postgraduate and doctoral programmes in the field of engineering, management, and science. OPJU aims to bring high-quality education to its students based on a world-class industry-based curriculum, the latest teaching methodology, research, innovation, and entrepreneurship developed by committed faculty members. The outcome of each of the programme in detail are summarized below:

PROGRAM OUTCOMES FOR ENGINEERING POST GRADUATE PROGRAM

1. **Disciplinary knowledge**: Accomplish vertical expertise in chosen discipline and enhance the ability to function in multidisciplinary domains.
2. **Research aptitude**: Ability and aptitude to exercise research intelligence in investigations/ innovations and to communicate the findings in a clear, concise manner.
3. **Project management**: Develop and apply knowledge of engineering and management principles to manage a project in a multidisciplinary environment.
4. **Ethics**: Gain knowledge of ethical principles and commit to professional ethics
5. **Self-directed lifelong learning**: Ability to identify appropriate resources and learn independently for projects, research, etc. using online resources.

PROGRAM SPECIFIC OUTCOME

PSO	Engineering Post Graduates will be able to:
PSO1	Design and develop new materials using concepts of physics, chemistry, metallurgy, and other related disciplines to meet the end users' objectives.
PSO2	Test and analyze the quality of various materials and integrate the same to assure quality in the materials industry.
PSO3	Ensure holistic growth through the awareness of effective communication, ethical responsibilities and physical/mental fitness.
PSO4	Build a solid foundation in the domain of metallurgy for developing analytical, technical, professional & management skills.

Curriculum and Credit Framework for Postgraduate Programme (M. Tech) as per NEP

Semester	Core Courses	Professional Elective	Common Course	Industrial Training / Research Internship	Dissertation	Total Credits
I	16	3	1			20
II	13	3	4			20
Exit Point: For 2-year PG programs, there shall only be one exit point. Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma.						
III				8	12	20
IV					20	20
TOTAL						80
Students on exit shall be awarded a Master of Technology (in the Field of Study/ Discipline) after securing the requisite 80 credits on completion of Semester IV.						

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Material Science and Technology)
Academic Semester I

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MST101	Iron Making	3	0	0	15	15	70	100	3
2	MME25-M-MST102	Physical Metallurgy of Steel	3	0	0	15	15	70	100	3
3	MME25-M-MST103	Thermodynamics and Kinetics	3	0	0	15	15	70	100	3
4	MME25-M-MST104	Advances in Materials Characterization	3	0	0	15	15	70	100	3
5	MME25-M-MST105 (1-5)	Program Elective-I	3	0	0	15	15	70	100	3
6	MME25-M-MST106	Material Characterization Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST107	Metallography & Heat Treatment Laboratory	0	0	4	-	15	35	50	2
8	FROM SOM	Intellectual Property Rights	0	0	2	-	15	35	50	1
Total			**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective I (Annexure - I)

S. No.	Subject Code	Name of the Courses
1	MME25-M-MST105 (1)	Surface Engineering
2	MME25-M-MST105 (2)	Material Recycling and Waste Management
3	MME25-M-MST105 (3)	Powder Materials and Processing
4	MME25-M-MST105 (4)	Six Sigma in Manufacturing Industry
5	MME25-M-MST105 (5)	Fracture Mechanics

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SCHEME OF TEACHING AND EXAMINATION

M. Tech (Material Science and Technology)
Academic Semester II

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MST108	Materials Modelling and Simulation	3	0	0	15	15	70	100	3
2	MME25-M-MST109	Advances in Steel Making Technology	3	0	0	15	15	70	100	3
3	MME25-M-MST110	Advances in Corrosion Engineering	3	0	0	15	15	70	100	3
4	MME25-M-MST111 (1-4)	Program Elective- II	3	0	0	15	15	70	100	3
5	FROM SOS	Research Methodology	3	0	0	15	15	70	100	3
6	MME25-M-MST112	Process Metallurgy Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST113	Materials Modelling and Simulation Laboratory	0	0	4	-	15	35	50	2
8	FROM SOS	Scientific Paper Writing	0	0	2	-	15	35	50	1
Total			**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective II (Annexure - II)

S. N	Subject Code	Name of the Courses
1	MME25-M-MST111 (1)	Nanomaterials and Technology
2	MME25-M-MST111 (2)	Artificial Intelligence in Steel Industries
3	MME25-M-MST111 (3)	Introduction to Industry 4.0 and Industrial Internet of Things
4	MME25-M-MST111 (4)	The Future of Manufacturing Business: Role of Additive Manufacturing

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Material Science and Technology)
Academic Semester III

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MST201	Industrial Training/ Research Internship	0	0	16	-	60	140	200	8
2	MME25-M-MST202	Dissertation I	0	0	24	-	90	210	300	12
Total			**0**	**0**	**40**	**0**	**150**	**350**	**500**	**20**

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Material Science and Technology)
Academic Semester IV

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination			Total Marks	Credit L+(T+P)/2
						Theory / Practical				
			L	T	P	MID	TA	ESE		
1	MME25-M-MST203	Dissertation II	0	0	40	-	150	350	500	20
Total			**0**	**0**	**40**	**-**	**150**	**350**	**500**	**20**

UNIT-III

Numericals: Dead-man cleanliness index, Calculation of Fe from FeO in slag, Density of BF top gas calculation, BF-Co volume calculation in top gas, BF top gas volume calculation, BF CO/THM calculation, BF exit gas calorific value, Depth of blast penetration calculation, BF fuel rate/THM calculation, Slag volume & its % calculation, calculation of % carbon burnt in front of tuyers, Calculation of BF oxygen enrichment, Hearth drainage rate calculation, BF minimum tapping open/day calculation, BF top gas velocity calculation, Exit gas volume calculation, BF permeability calculation, RAFT calculation.

UNIT-IV

Alternate Routes of Iron Making: Various coal-based and Gas based DRI process; Numericals: Filling degree calculation, calculation of refractory quantity required in rotary kiln, calculation of anchors required in kiln, Calculation of angle of cone, Calculation of angle of rotary kiln.

UNIT-V

Numericals: Calculation of sponge iron Fe(T), Calculation of oxygen % in Fe_2O_3 ore, Theoretical calculation of sponge iron yield in iron ore, Calculation of O2 remove in sponge iron, Carbon balance in DRI process, Fe(T) balance in DRI process, Calculation of coal required for DRI process, Iron ore required for DRI making, Calculate DRI kiln inlet, outlet C/Fe and carbon.

Text/ Reference Books:

1. An Introduction to Modern Iron Making - R.H. Tupkary V.R. Tupkary.
2. Iron Making and Steel Making Theory and Practice - Ahindra Ghosh, Amit Chatterjee.
3. Principles of Blast Furnace Ironmaking - A.K. Biswas.
4. A First Course in Iron and Steel Making - Dipak Mazumdar.
5. Basic Concepts of Iron and Steel Making – Sujay Kumar Dutta and Yakshil B. Chokshi

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand various concepts related to Iron Making processes
CO-02	Learn to perform BF charge calculations
CO-03	Learn to perform BF by products calculation
CO-04	Understand the various alternate routes of iron making
CO-05	Learn to understand DRI charge calculations

Program: M. Tech **Semester: I**
Name of the Course: Physical Metallurgy of Steel
Code MME25-M-MST102 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

The courses 'Physical Metallurgy of Steel' is principally aimed to introduce the students about atomic arrangement and crystal structure steel and cast iron. This course comprises the concept of structure property correlation, crystal structure, grain size, the solidification processes for pure metals and alloys and imperfection arises during solidification process. The concept of iron– carbon diagram, TTT and CCT diagram and its application and microstructure of various steel and cast iron provide the fundamentals of this course.

Course Objectives:

1. To understand the atomic and crystal structures of metals.
2. To understand components and phases in different metallic systems and laws governing the same.
3. To understand the solidification, deformation and kinetics of phase transformation.
4. To study the phase diagrams and phase transformation of some metallurgical systems and their applications.

Syllabus:

UNIT-I

Ferrous and Nonferrous metals, crystalline and amorphous materials, crystal structure of metals, imperfections in crystals, allotropy and isotropy in metals, grain boundaries and shapes of metal grains, effect of grain size over properties of metals and alloys.

UNIT-II

Solidification of metals and alloys, nucleation and growth, constitutional supercoiling, eutectic solidification, rules of formation of various types of solid solutions, intermediate phases, intermetallic compounds, strengthening mechanisms: dislocation, solid solution, precipitation, dispersion, grain refinement.

UNIT-III

Iron-carbon system, Fe-Fe_3C diagram, TTT diagram, CCT diagram, effect of common alloying elements on iron carbon equilibrium diagram, TTT and CCT diagrams.

UNIT-IV
Phase diagram and phase transformation, fundamentals of heat treatments of steels, annealing, normalizing, hardening and tempering, austenite to pearlite, austenite to bainite, austenite to martensite transformation.

UNIT-V
Microstructures of plain carbon steels, HSLA, tool steels, hadfield steel, stainless steels, rail steels, dual phase steel etc.

Text/Reference Books:

1. R.E. Reed Hill, Physical Metallurgy Principles.
2. G.E. Kehl and H. Davis, Principles of Metallographic Laboratory Practice.
3. F.N. Rhines, Phase Diagrams in Metallurgy.
4. Y. Lakhtin, Engineering Physical Metallurgy.
5. A. Gulyaev, Physical Metallurgy Vol I-I.
6. D. S. Clark and W.R. Varneys, Physical Metallurgy for Engineers.
7. R. E. Smallman, Modern Physical Metallurgy.
8. T. V. Rajan, C. P. Sharma and A. Sharma, Heat Treatment Principles and Techniques.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand the crystal structure, steel microstructures, thermodynamics, and kinetics of phase transformations of steels.
CO-02	Understand structure - properties correlation of materials to test and analyze the quality of various steels.
CO-03	Understand the concept of physical metallurgy, materials science, and solid-state physics of steel.
CO-04	Know about various phase diagrams of different steels
CO-05	Know the microstructure of special steels.

Program: M. Tech **Semester: I**
Name of the Course: Thermodynamics and Kinetics
Code: MME25-M-MST103 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

This course deals with the understanding of different laws of thermodynamics and will provide deep understanding of the basic principles of thermodynamics and kinetics which is must for understanding of any metallurgical processes involving chemical reactions and physical changes at high temperature.

Course Objectives:

1. To understand various thermo-dynamical concepts,
2. To understand the concept of thermodynamics and kinetics,
3. To understand the various chemical reactions occurring in metallurgical processes,
4. To understand the various physical changes in materials at high temperatures.

Syllabus:

UNIT-I
Basic terms used in thermodynamics-system & surrounding, Concept of syste (isolated, closed, open), Homogeneous and heterogeneous systems, State of system, Equation of state, properties of a system (extensive, intensive), Enthalpy, Entropy, Internal energy, Heat capacity, heat of reaction, heat of formation, heat of combustion, latent heat, Heat of solution; Laws of thermodynamics – 1st law, 2nd Law, 3rd law, Zeroth Law.

UNIT-II
Inter-relations between thermodynamic variables- Gibbs-Helmholtz equation, clausius clapeyron equation; Solutions and Partial Molar quantities-Ideal and non-ideal solution, Raoults law, henrys law, Sieverts law. Phase rule and phase diagrams.

UNIT-III
Free energy-Temperature diagram- Ellingham diagram for oxides, Determination of point O, H, C and equilibrium gas pressure, Advantages and limitations of Ellingham diagrams. Predominance area diagram and its significance.

UNIT-IV
Reaction Kinetics- Types of reactions, rate of reaction, order of reaction- zero order, first order and second order, determination of order and rate constant of a

reaction, half-life period, reaction rates for homogeneous and heterogeneous reactions; Diffusion-Fick's law of diffusion; Melting and solidification, precipitation, eutectoid, spinodel decomposition, order disorder transformations.

UNIT-V

Functions of slags, Slag compositions, Structure of molten slags, Molecular theory, Concept of basicity index, Thermodynamics of slag-metal reactions, Thermodynamics of electro-chemical cell.

Text/Reference Books:

1. David R. Gaskell, Introduction to the thermodynamics of Materials.
2. Ahindra Ghosh, Textbook of Materials and Metallurgical Thermodynamics.
3. G. S. Upadhyaya and R. S. Dube, Problems in Metallurgical Thermodynamics and Kinetics.
4. S. K. Dutta and A.B. Le, Metallurgical Thermodynamics Kinetics & Numericals.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Ability to derive different thermodynamic relations and solve related problems.
CO-02	Grasp the fundamental concepts of thermodynamics and apply the same for research/projects in the materials domains.
CO-03	Apply the concepts and laws of thermodynamics to solve various industrial problems.
CO-04	Know about the reaction kinetics.
CO-05	Know about the slag in steels.

Program: M. Tech **Semester: I**
Name of the Course: Advances in Materials Characterization
Code: MME25-M-MST104 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**
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Course Description:

Material Characterization focuses on the theoretical basic knowledge of material synthesis and its application to engineering systems. The main objective of this course is to provide students with a systematic and critical study of basic scientific principles for technical problem-solving materials areas. This course will cover the basic principles and techniques like thermal analysis techniques, principle, construction and working principles of optical microscopy and electron microscopy like TEM, SEM. This course also covers the topics like atomic absorption spectrometer (AAS), atomic emission spectroscopy (AES), XPS, auger electron spectroscopy (AES) and FTIR, EDS and WDS. Beside these, emphasized has been incorporated for the techniques like electron probe micro analysis (EPMA) and nuclear magnetic resonance (NMR). X-ray diffraction processes also added in this course. This course also deals with the sample preparation techniques for the microstructural analysis with practical examples through lecture and videos.

Course Objectives:
1. To understand the basics of mechanical properties.
2. To get the in depth knowledge about the scanning electron microscope
3. Application of XRD technique to determine crystal structure, lattice parameter,crystallite size, lattice strain, residual stress, and order-disorder transformation.
4. To understand the significance of corrosion principles.
5. Select the appropriate corrosion protection approach for engineering applications.
6. To understand the factors responsible for changes in the thermal properties of the materials.

Syllabus:

UNIT-I
Basics of Mechanical Properties: Definition and measurement of stress and strain; Types of stress: tensile, compressive, shear; Types of strain: axial, shear, volumetric; Stress-strain relationship and Hooke's Law; Plastic deformation: yield strength, slip, twinning, dislocation theory; Critical resolved shear stress (CRSS); Edge and screw dislocations and their properties; Work hardening and recovery; recrystallization and grain growth; Strengthening mechanisms: solid solution strengthening, precipitation strengthening, grain refinement; Hardness testing: concept and significance, types of hardness tests; Fatigue behaviour: fatigue failure, fatigue life prediction, fatigue crack initiation and propagation; Creep

behaviour: time-dependent deformation at high temperatures, factors influencing creep behaviour.

UNIT-II

Scanning Electron Microscope: Introduction to SEM, Interaction between the electron beam and sample surface, Secondary, electron, backscattered electron, auger electron, X-ray.

Principles of operation of SEM, advantages of SEM over light microscope, electron gun filament, energy dispersive X ray spectroscopy, applications of electron microscopy

UNIT-III

X-Ray Diffraction Technique and its Applications: Properties of X-rays, absorption, Filters, Bragg's Law; Diffraction methods: Laue method, rotating crystal method, and powder method; Factors affecting intensities of diffracted beam; Determination of crystal structure, particle size, and lattice parameter; Qualitative and quantitative phase analysis; Analysis of residual stress/strain; Determination of phase diagram; Order-disorder transformation.

UNIT- IV

Corrosion: Principles of Electro-Chemistry, Electrode Potential, EMF Series, Galvanic series, Half-cell reaction, Nernst's equation, Free Energy, corrosion of metals & alloys in various environments, Pourbaix diagram of common metals, Electrolytes, Cost of Corrosion, potentiostatic polarization curves, Types of Corrosion-atmospheric corrosion, galvanic corrosion, Intergranular corrosion, crevice corrosion, pitting corrosion, dealloying corrosion, erosion corrosion, Corrosion prevention methods, and applications.

UNIT-V

Thermal analysis: Thermal events in materials, enthalpy changes, working principle, instrumentation and applications of differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermogravimetry (TG), factors affecting the results of DTA/DSC/TG and their interpretations.

Text/Reference Books:

1. B. D. Cullity and S. R. Stock, Elements of X – Ray Diffraction, Prentice-Hall, New Jersy,2001.
2. C. Suryanarayana and M. Grant Norton, X-ray Diffraction A Practical Approach, Springer
3. Corrosion Engineering, M. G. Fontana, McGraw-Hill Book Company, 3rd Edition.
4. Corrosion and Corrosion Control, H. H. Uhlig and R. W. Revie, Wiley (NY) (1985).

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand and describe the fundamental principles behind the methods of characterization.
CO-02	Analyze, interpret the different characterization methods.
CO-03	Assess which methods of characterization are appropriate for different material problems.
CO-04	Know principle of corrosion engineering and it's applications
CO-05	Know about various thermal analysis techniques

Program: M. Tech **Semester: I**
Name of the Course: Surface Engineering (PE-I)
Code: MME25-M-MST105 (1) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

To familiarize the students with basic concepts of various surface modification in engineering materials. To provide real life importance of surface engineering techniques and their uses in industrial applications.

Course Objectives:

1. To learn application of corrosion & Wear with emphasis on basic concepts.
2. To understand the significance of wear and corrosion laws and relationships.
3. To understand the behavior of tribology in various environment.
4. To understand the energy conversion in chemical cells and electrochemical cells.

Syllabus:

UNIT-I
Introduction of surfaces and wear surface properties, types of wear, roles of friction Fretting wear, Adhesive wear, Seizure, Galling, Oxidative wear, Slurry erosion, Impingement erosion.

UNIT-II
Fundamentals of electroplating, Electroless plating, Selective plating, Electrodeposition from plating baths, anodizing of aluminum alloys, Other plating processes, plating for wear resistance.

UNIT-III
Surface pre-treatment, thermal evaporation, deposition of copper, zinc, nickel and chromium, PVD and CVD, Sputter coating, Ion plating, Thin film for wear application, Coating specifications, electroless composite plating, test standards (ASTM) for assessment of quality deposits.

UNIT-IV
Rebuilding and surface cements, Wear tiles, Electrospark deposition coatings, Fused carbide cloth ceramic coatings, Wear sleeves, Wear plates.

UNIT-V
Thermal spraying, advanced spraying techniques - plasma surfacing, hard facing processes (Shielded metal arc welding, Gas tungsten arc welding, Gas metal arc

welding, Submerged arc welding, oxyacetylene welding), tests for assessment of wear and corrosion behavior, industrial applications.

Text/Reference Books:

1. K. G. Budinski, Surface Engineering for Wear Resistance, Prentice Hall (1988).
2. A. Mathews, Advanced Surface Coatings: A Handbook of Surface Engineering, Spinger (1991).
3. M.G. Hocking, Metallic and Ceramic Coatings, John Wiley (1989).
4. K. N. Strafford, P. K. Datta, and J. S. Gray, Surface Engineering Practice, Processes, Fundamentals and Applications in Corrosion and Wear, Ellis Harwood (1990).

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Learn the cost and energy effective surface engineering techniques for surface protection of materials.
CO-02	Understand the applications of thermal spraying as well as other advanced spraying techniques.
CO-03	Apply the acquired knowledge in developing wear and thermal protection of surfaces.
CO-04	Know about different coatings.
CO-05	Know about various thermal spraying techniques.

Program: M. Tech **Semester: I**
Name of the Course: Material Recycling and Waste Management (PE-I)
Code: MME25-M-MST105 (2) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

This course 'Material Recycling and Waste Management' is principally aimed to introduce the students about the different types of ferrous, non-ferrous and precious metals wastes produced in the industries. This course also provides the knowledge of waste minimization, recycling and reuses of the metallurgical wastes pertaining to ferrous and non-ferrous industries.

Course Objectives:

To provide basic understanding of various metallurgical methods associated with recovery and reuse of useful metals from the industrial wastes.

Syllabus:

UNIT-I
Reduction, Reuse, Recycling, Types of Metallurgical Wastes, their Sources and Effects on Human and Social Life, Economic Incentives for Recycling and Resource Recovery, Environmental Incentives for Recycling, Physical and Physico-Chemical Processes.

UNIT-II
Metal Recycling: Iron and Steel- Recovery and Recycling Technologies, Recovering Iron Powder from Scrap, Intermediary Products and Waste Treatment, Flue Dust, Slag, Sludge; Stainless Steel- General Description of Recovery Technologies, Secondary Recovery of Super alloy Elements.

UNIT-III
Metal Recycling: Copper- Scrap, By- Products, Waste, Copper Scrap Processing by Physical Separation Technique, Copper Recovery by Smelting Reduction Operation, Recovery of Copper from Printed Circuit Board Scrap, Recovery of Copper from Electronic Scrap, Recycling Copper Using Particle Shape.

UNIT-IV
Metal Recycling: Zinc- Current Recycling Methods, Recycling Technologies, Dezincing Technologies; Aluminum- Recycling Methods, Scrap, By- Products, Waste, recycling from Aluminum Turning Scrap, Secondary Smelting and Refining.

UNIT-V
Metal Recycling of Precious Metals: Review of Recovery and Recycling Technologies, Platinum Group Metals; Gallium and Indium; Cadmium, Mercury,

Tin, Magnesium, Chromium, Molybdenum, Tungsten, Tantalum, Niobium, Titanium.

Text/Reference Books:

1. S. Ramachandra Rao, Resource Recovery and Recycling from Metallurgical Wastes.
2. K. E. Noll, C. N. Haas, C. Schmidt, P. Kodukula, Recovery, Recycle and Reuse of Industrial Wastes.
3. J. Kroschivtz, Encyclopedia of Chemical Tech. (Vol. 1-25)
4. J. Mcketta and W. A. Cunnghain, Enclyclopedia of Chemical Processing & Design, Volume (1-32).

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Comprehend the knowledge about various physio-chemical metals recycling processes and related techniques.
CO-02	Understand the concepts of various waste management.
CO-03	Apprehend the holistic knowledge and the awareness of various waste recycling and their management.
CO-04	Know about various recycling techniques.
CO-05	Know about various recycling of different metals.

Program: M. Tech **Semester: I**
Name of the Course: Powder Materials and Processing (PE-I)
Code: MME25-M-MST105 (3) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

This course has been intended to improve the students related to their career in the field of metallurgical and materials engineering and provide them an insight into the emerging technology of powder metallurgy as an alternative route to conventional metal processing. This course describes the fundamental aspects of advanced ceramic powder preparation, densification and microstructure evolution during sintering procedure. The course provides thorough knowledge of powder production and processing as well as to choose the right technical method to suit applications. The major goal is to establish the powder fabrication route as a technologically and economically viable means of materials production.

Course Objectives:

1. Assess the emergence and importance of powder metallurgy, scope and limitations,
2. Gain familiarity with fundamental concepts associated with powdered metals or non-metal powders,
3. Explain the physical and physico-chemical phenomena underlying the processes of shaping of massive bodies from metal or ceramics powders via dry, wet, or plastic methods,
4. Increase the knowledge of powder production techniques and characteristics,
5. Encourage the knowledge of knowledge of compaction and sintering techniques and related applications.

Syllabus:

UNIT-I
Concept of particles, particle size, shape and size distribution of powders, powder production methods, blending of powders and related fabrication processes, advantages and limitations of powder metallurgy, design considerations in powder metallurgy.

UNIT-II
Production of metal powders following reduction of oxides, electrolyting methods, chemical processes, atomization methods, characterization of powders emphasizing apparent density, tap density, flow rate, friction index, surface area, porosity measurements properties of green compacts and sintered compacts.

UNIT-III
Purpose of compaction, phenomena of compaction, design consideration for die compaction, techniques of cold and hot isotactic pressing, powder rolling, injection moulding etc., compaction tooling and role of lubricants, preparation of cermets.

UNIT-IV
Definition of sintering, theory of sintering, stages of sintering, driving forces for sintering, mechanism of sintering, sintering atmospheres and furnaces, sintering zones, effect of variables, post sintering applications.

UNIT-V
Powder metallurgy applications especially porous metals, cermets, cemented carbides, electrical and magnetic materials; dispersion strengthened materials, metal filters and related standards, Mechanical alloying and types of phases formed, reactive milling.

Text/Reference Books:

1. A. Upadhyaya, G. S. Upadhyaya, Powder Metallurgy: Science, Technology, and Materials, Universities Press.
2. R.M German, Powder Metallurgy Science, MPIF, NJ, USA.
3. A. K. Sinha, Introduction to Powder Metallurgy, Dhanpatrai Publication.
4. U. D, Kodgire, Material Science and Metallurgy, 37th edition, Everest Publishing House.
5. M. N. Rahaman, Sintering of Ceramics, CRC Press.
6. Powder Metallurgy, ASM Handbook, Vol-VII.
7. H. H. Hausner, Handbook of Powder Metallurgy.
8. W. D. Jones, Powder Metallurgy.
9. R. M. German, Sintering Theory and Practice, Metal Powder Industries Federation.
10. T. Shukerman, Principles of Powder Metallurgy.
11. W.D. Kingery, Introduction to Ceramics, Wiley & Sons (second edition).

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand the fundamental principles and physio-chemical properties of powder materials and related structure-property relations.
CO-02	Understand the powder metallurgy processes and techniques, scope, and limitations in the research/project domains.
CO-03	Build up a conceptual blend between theory and practical knowledge.
CO-04	Know sintering process of powders
CO-05	Know the applications of powder metallurgy.

Program: M. Tech **Semester: I**
Name of the Course: Six Sigma in Manufacturing Industry (PE-I)
Code: MME25-M-MST105 (4) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

Course Description:

This course provides an introduction to Six Sigma principles and their application in the manufacturing industry to improve quality, reduce defects, and enhance process efficiency. It covers key concepts such as DMAIC (Define, Measure, Analyze, Improve, Control), statistical tools, and process improvement techniques. Students will learn how to apply Six Sigma methodologies to solve real-world manufacturing problems and drive continuous improvement.

Course Objectives:

Quality that specifies the variability required of a process in terms of the specification of the product so that the products quality and reliability meet and exceed the customer's requirements.

Syllabus

Unit 1: Introduction to Six Sigma
Covers the fundamentals of Six Sigma, its history, key concepts like DMAIC, and its importance in manufacturing for improving quality and reducing defects. Introduces Six Sigma roles and integration with Lean and TQM.

Unit 2: Define and Measure Phases
Focuses on defining project goals, identifying customer requirements (CTQs), and mapping processes. Covers data collection, measurement systems analysis, and establishing process baselines.

Unit 3: Analyze Phase
Teaches tools to identify root causes of defects, including cause-and-effect diagrams, Pareto analysis, and statistical methods like regression and hypothesis testing.

Unit 4: Improve Phase
Covers developing and testing solutions to eliminate root causes using tools like brainstorming, Design of Experiments (DOE), and Lean methods such as 5S and Kaizen.

Unit 5: Control Phase
Focuses on maintaining improvements through control plans, Statistical Process Control (SPC), audits, and continuous monitoring to ensure sustained performance.

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Reference Book:

1. D. Singh, R. Singh, H. Kaur, Enactment of Six-Sigma in Manufacturing Industry by Chandan.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand to use related tools and data to improve efficiency in service.
CO-02	Understand the basic statistical knowledge required to determine faster results.
CO-03	Collect relevant data to define the processes and required metrics behind the operation in the industry.
CO-04	improve the phase.
CO-05	control the phase.

Program: M. Tech **Semester: I**
Name of the Course: Fracture Mechanics (PE-I)
Code: MME25-M-MST105 (5) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Descriptions:

The focus of this course is to develop an understanding of the mechanics of fracture of engineering materials and structures under static and dynamic conditions. Students have been taught the principles of linear elastic and elastic-plastic fracture mechanics and their application to engineering design. This course will also introduce key applications of fracture mechanics in industry including damage detection, advance analysis of failure analysis and experimental techniques.

Course Objectives:

1. Study about types of fracture;
2. Study the principles of fracture mechanics and their applications to structural design;
3. Fracture phenomena in metals and nonmetals will be discussed and testing methods will be highlighted;
4. In the end computer assisted techniques for fracture study will be discussed.

Syllabus:

UNIT-I
Introduction and historical review, sources of micro and macro cracks, mechanisms of fracture, stress concentration due to elliptical hole, linear elastic fracture mechanics, Griffith's energy balance approach, stiffness and toughness, stress intensity approach, fracture mechanics approach to design, NDT and various NDT methods used in fracture mechanics, linear elastic fracture mechanics, crack tip stress and deformations, relation between stress intensity factor and fracture toughness, numerical problems.

UNIT-II
Elastic – plastic fracture mechanics, Irwin plastic zone correction. Dugdale's approach, J-integral, use of J integral, crack resistance curve, crack opening displacement, crack tip opening displacement, various stages of crack propagation.

UNIT-III
Fracture beyond general yield. The crack-tip opening displacement, the use of CTOD criteria. experimental determination of CTOD, parameters affecting the critical CTOD, dynamic stress intensity and elastic energy release rate, crack

branching, the principles of crack arrest, crack growth integration, fatigue crack growth laws.

UNIT-IV

Fracture resistance of materials, fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, factors affecting crack propagation.

UNIT-V

Fracture toughness testing of metals, specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. variable amplitude service loading means to provide fail-safety, Paris law, required information for fracture mechanics approach, closure.

Text Books:

1. Elements of Fracture Mechanics, Prashant Kumar, McGraw Hill Education (India) Private Limited, New Delhi
2. Mechanical Metallurgy, George E. Dieter, McGraw Hill Publication.
3. Testing of Metallic Materials, A. V. K. Suryanarayan, B. S. Publication.

Reference Books:

1. Fracture Mechanics for Modern Engineering Design, K. R. Y. Simha, Universities Press (India) Limited, 2001.
2. Elementary Engineering Fracture Mechanics, D. Broek, Kluwer Academic Publishers, Dordrecht, 1986.
3. Fracture Mechanics - Fundamentals and Applications, T. L. Anderson, Taylor and Francis Group, 3rd Edition, 2005.

Course Outcome:

CO	**Material Science and Technology Post Graduates will be able to:**
CO-01	Predict material failure for any combination of applied stresses;
CO-02	Estimate failure conditions of a structure;
CO-03	Determine the stress intensity factor for simple components of simple geometry;
CO-04	Predict the likelihood of failure of a structure containing a defect along with process of testing.
CO-05	Know about the fracture toughness of metals/alloys

Program: M. Tech **Semester: I**
Name of the Course: Material Characterization Laboratory
Code: MME25-M-MST106 **Credit: 2**
No of Hours: 4 hours/week **Max. Marks: 50**
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Course Description:
This lab course introduces students to essential techniques for analyzing the structure, composition, and properties of materials. Experiments may include X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and hardness testing. The course emphasizes hands-on experience, data interpretation, and understanding the relationship between material structure and performance.

Course Objectives:

1. Fully qualified as entry-level materials engineers, with an ability to adapt and progress in a rapidly changing field.
2. Well-rounded individuals who both understand the principles and can undertake the practice of the engineering materials.
3. Able to operate as effective engineers or scientists in materials industries, academia, or related fields with respect to advanced level equipment.
4. Able to an understanding of both theoretical as well as experimental aspects of corrosion principles through advanced techniques.

List of Experiments:

1. To determine the impact strength of materials by Izod and Charpy Impact test.
2. To determine the hardness of materials by Vickers and Rockwell Test.
3. Electrochemical impedance, cyclic potentiodynamic polarization and polarization resistance test of metallic specimen in seawater.
4. Corrosion rate measurement by immersion test.
5. To determine the internal surface defects by Ultrasonic Test.
6. Obtain x-ray scattering patterns for all materials and perform peak fitting.
7. To determine percent crystallinity and crystallite size.
8. To study the constructional arrangement of SEM.
9. To study the constructional arrangement of DTA, TGA and DSC.
10. To calculate thermal expansion and volume changes associated with phase transformations, using a dilatometer.

Equipment required
1. Image analyzer.
2. Electron microscope like SEM.
3. XRD Machine.
4. Vicker's Hardness Machine
5. Rockwell Hardness Machine
6. Potentiometer

Text/Reference Books:

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

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Acquire knowledge on the basic principles of functioning of the advanced equipment.
CO-02	Perform experiments and identify the Material Characteristics.
CO-03	Select and redesign the problem related to corrosion and protection practices.

Program: M. Tech **Semester: I**
Name of the Course: Metallography and Heat Treatment Laboratory
Code: MME25-M-MST107 **Credit: 2**
No of Hours: 4 hours/week **Max. Marks: 50**

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Course Description:
This lab focuses on the preparation, examination, and analysis of metallic microstructures and the effects of heat treatment processes. Students learn sample preparation techniques, optical microscopy, and perform various heat treatments (annealing, quenching, tempering) to study changes in microstructure and mechanical properties. The course emphasizes the structure–property relationship in metals.

Course Objectives:

Heat treatment processes develops desired microstructure to meet set of properties to Metals and Alloys. The syllabus is designed to get hand on experience of heat treatment processes in laboratory.

List of Experiments:

1. To prepare the hot mounting and cold mounting of the samples
2. To prepare the metallic samples for metallographic examination
3. To observe the microstructure of various steel samples
4. To observe the microstructures of annealed and normalized steels
5. To find the grain size by ASTM method
6. To perform the etching process and etching reagents
7. To determine the hardenability of Plain carbon steel and alloy steel by Jominy end quenching
8. To observe the microstructure of hardened and Tempered steel
9. To observe the microstructure of cold worked samples
10. Case carburizing of steel sample

Equipment Required:

1. Hot Mounting
2. Metallurgical Microscope
3. Muffle Furnace
4. Jominy end quench Test

Text/Reference Books:

1. G. L. Khel, The Principles of Metallographic Laboratory Practice.
2. T. V. Rajan, C. P. Sharma and A. Sharma, Heat Treatment Principles and Techniques.
3. Handbook of Metallography and Microstructure, ASM Handbook, Vol. 9.
4. S. H. Avner, Introduction to Physical Metallurgy.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Comprehend the fundamentals of microstructural modification of metals and alloys through heat treatment practices.
CO-02	Correlate heat treatment processes towards microstructure and property analysis and applications point of view.
CO-03	Provide professional development to demonstrate the solution.

M.Tech Semester-II
(Detailed Syllabus)

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Material Science and Technology)
Academic Semester II

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MST108	Materials Modelling and Simulation	3	0	0	15	15	70	100	3
2	MME25-M-MST109	Advances in Steel Making Technology	3	0	0	15	15	70	100	3
3	MME25-M-MST110	Advances in Corrosion Engineering	3	0	0	15	15	70	100	3
4	MME25-M-MST111 (1-4)	Program Elective- II	3	0	0	15	15	70	100	3
5	FROM SOS	Research Methodology	3	0	0	15	15	70	100	3
6	MME25-M-MST112	Process Metallurgy Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST113	Materials Modelling and Simulation Laboratory	0	0	4	-	15	35	50	2
8	FROM SOS	Scientific Paper Writing	0	0	2	-	15	35	50	1
Total			**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective II (Annexure - II)

S. N	Subject Code	Name of the Courses
1	MME25-M-MST111 (1)	Nanomaterials and Technology
2	MME25-M-MST111 (2)	Artificial Intelligence in Steel Industries
3	MME25-M-MST111 (3)	Introduction to Industry 4.0 and Industrial Internet of Things
4	MME25-M-MST111 (4)	The Future of Manufacturing Business: Role of Additive Manufacturing

Program: M. Tech **Semester: II**
Name of the Course: Materials Modelling and Simulation
Code: MME25-M-MST108 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

Course Description:

Introduction to modelling & simulation, description of certain metallurgical processes like heat treatment processes, metal joining and metal forming processes. This course also gives the overview of various modelling processes related to iron and steel making, foundry, casting and solidification. It also includes the fundamentals of molecular dynamics and simulations.

Course Objectives:

1. Fundamental principles, methods, and approaches of simulation and modelling,
2. To have the students search for the effect of certain parameters on metallurgical processes with the help of modelling software and have them evaluate engineering problems with different techniques.

Syllabus:

UNIT-I

Introduction and fundamentals of modelling and simulation, mathematical and physical basis of modelling, methodology, Application of simulation and modelling in metallurgical and materials processes. Mass and energy balances, solutions.

UNIT-II

Hot and cold forming; Forging; Rolling; various heat treatment processes; Mechanical joining processes: punch riveting, self-piercing riveting or blind riveting, various welding processes: spot and friction welding.

UNIT-III

The selection of suitable mathematical models to describe transient metallurgical processes Charge calculation for heat in LD converter Static and dynamic model of heat management in basic oxygen steel making process, Introduction to ANSYS fluent 14.0 software package, Applications of CFD modelling in iron making and steel making process (some examples based on relevant case studies).

UNIT-IV

Introduction to castings: Solid modelling of castings, pattern, mould and core design: pattern design, core print design and analysis; Feeder design and analysis, Gating design and analysis.

UNIT-V

Molecular dynamics: Introduction, Atomic model in MD, melting of Ni cluster, sintering of Ni nano particles, speed distribution of Ar gas, SiC deposition on Si

(001), Yield mechanism of an Au wire, Si-tension, Si-CNT composite under tension, ZrO_2-Y_2O_3-MSD.

Text/Reference Books:

1. S. Pal, A. Patra and P. R. Padhee, Process Modelling for Steel Industry.
2. B. Ravi, Metal Casting Computer- aided Design and Analysis.
3. J. G. Lee, Computational Materials Science an introduction.
4. Software: Ansys, Fluent and SimuFact.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand the theoretical background in simulation and modelling of metallurgical systems.
CO-02	Comprehend the data processing and process control mechanisms in the research/Project domains.
CO-03	Acquire professional hands-on experience on modelling software for innovative applications.
CO-04	Know about the modelling of casting process.
CO-05	Know about the molecular dynamics used in simulation.

Program: M. Tech **Semester: II**
Name of the Course: Advances in Steel Making Technology
Code: MME25-M-MST109 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

The course provides fundamental knowledge about the history of steel making, the raw materials required for steel making process. Also, it gives knowledge about the construction and design of LD converter, EAF, and Tundish along with various reactions inside these metallurgical reactors. Apart from these, this course will give information about the post-processing of various continuous casting products.

Course Objectives:

1. Students will become familiar with iron making and steel making;
2. To become conversant with the role of thermodynamics and kinetics in Iron & Steel Making;
3. To get the idea of producing Iron & Steel through different route.

Syllabus:

UNIT-I
History of the steelmaking process, Raw materials for LD steel-making process, Charge calculations, Reactions in LD converter and its thermodynamics; Raw materials for EAF steel-making process, charge calculations, Reactions in EAF steel-making process and its thermodynamics; Raw materials for induction steel making process, charge calculations, Desulphurization & Dephosphorization at its thermodynamics in induction furnace.

UNIT-II
Secondary steel-making process: Ladle metallurgy, charge calculations for Deoxidation & Desulphurization, Ar purging rate calculations, Vacuum Degassing principles: Tank degassing process and its degassing rate calculations, RH degassing process and its calculations. Refining by remelting: ESR process.

UNIT-III
Continuous casting of steels: Design aspects of Tundish & its accessories, Tundish preheating process, Details of Continuous casting machine, Mechanism of solidification, source of inclusions, procedure to identify and calculate inclusion rating, effect of inclusion on properties of steel, inclusion engineering, Quality control in continuous casting.

UNIT-IV
Continuous casting products and their post-processing, Numericals on continuous casting & solidified products, Stainless steel-making process,

UNIT-V

Ferro Alloy Technology: Principles of ferroalloy making, reserves of ores in India, Production of Ferro-manganese, Ferro-Silicon, Silico-Manganese, Ferro-chrome.

Text/References Books:

1. Basic Concepts of Iron and Steel Making – Sujay Kumar Dutta and Yakshil B. Chokshi
2. Steel Making- A.K. Chakrabarti Making, shaping & treating of steels- R.J. Fruehan

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Have fundamental knowledge on basic principles of steel making;
CO-02	Understand the working process of open hearth, Bessemer, LD and Q-BOP steel making processes;
CO-03	Describe the secondary refining techniques of steel making;
CO-04	Understand the principle of continuous casting of steel.
CO-05	Know about the ferro alloys technology.

Program: M. Tech **Semester: II**
Name of the Course: Advances in Corrosion Engineering
Code: MME25-M-MST110 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:
The Advances in Corrosion Engineering provides fundamental knowledge and applies it through training in corrosion and its prevention. Initially, students will study the basic chemistry, physics, and metallurgy behind corrosion processes and learn about approaches to corrosion control, including material selection, cathodic protection, corrosion inhibition, and microbial. The course covers industrial scenarios where knowledge of corrosion and its control is crucial, such as the oil and chemical industry. This master's program is ideal preparation for a career in industry as a corrosion scientist or engineer or for advanced academic research.

Course Objectives:
1. Learn advanced corrosion topics with a focus on fundamental concepts.
2. Understand the importance of corrosion laws and relationships.
3. Study corrosion behavior in acidic environments.
4. Understand energy conversion in chemical and electrochemical cells.
5. Apply electrochemical reactions to solve corrosion and control problems.

Syllabus:

UNIT-I
Principles of Electro-Chemistry, Electrode Potential, Reference Electrode, EMF Series, Galvanic series, Half-cell reaction, Nernst's equation, Free Energy, corrosion of metals & alloys in various environments, Pourbaix diagram of common metals, Electrolytes, Cost of Corrosion.

UNIT-II
Corrosion Rate Expressions, Exchange Current Density, Polarization Experimental Techniques, Tafel equation, Mass Transport Control, Mixed Potential Theory, Behavior of Galvanic Couples in Acidic Environments, Different Factors - Velocity, Temperature, Concentration. Passivity, Potentiostatic Polarization Curves, Factors Affecting Passivity, Mechanism of Action of Passivators.

UNIT-III
Forms of Corrosion, atmospheric corrosion, galvanic corrosion, Intergranular corrosion, crevice corrosion, pitting corrosion, Dealloying corrosion, Erosion corrosion, Environmentally Induced Cracking, mechanism of stress corrosion cracking (SCC).

UNIT-IV

Selection of corrosion-resistant materials, such as stainless steel, nickel and nickel alloys, and other metal alloys. Cathodic and anodic protection methods, use of coatings, inhibitor applications, and protection of composite materials.

UNIT-V

Implant materials and the corrosivity of the human body, medical implants - current status and developments, passivity and its influencing parameters, passivity and design of corrosion-resistant alloys, metallurgical properties that influence corrosion.

Text/Reference Books:

1. Fontana M.G, Corrosion Engineering, Tata McGraw Hill, 3rd Edition, 2005
2. Sudarshan T.S, Surface Modification Technologies-An Engineers guide, Marcel Dekker, Newyork, 1989.
3. Electroplating and other surface treatments, A Practical Guide, CD Varghese, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
4. C. A. C. Sequeira, Microbial Corrosion, European Federation of Corrosion, Maney Pub. (2000).

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	To understand the principles of electrochemistry.
CO-02	Development of electrochemical reaction of alloys and cathodic and anodic relations for multi-component in various atmospheres.
CO-03	Analysis of Tafel curve in acid, gases and mixture of both.
CO-04	Construction of a system for protection of materials through various coating.
CO-05	Application of cathodic, anodic and microbial corrosion protection to engineering systems and understand eddy current relations.

Program: M. Tech **Semester: II**
Name of the Course: Nanomaterials and Technology (PE-II)
Code: MME25-M-MST111 (1) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:
This course introduces the conceptual and analytical challenges for developing nano-materials and the respective scientific role.

Course Objective:
This course aims to provide a comprehensive overview of nano-materials in terms of the synthesis, characterization, properties, and applications. It will cover the fundamental scientific principles for the different synthesis techniques, assembly of nano-structured materials and, new physical and chemical properties at the nano-scale. Existing and emerging applications will also be discussed through case studies.

Syllabus:

UNIT-I
Definition of Nano, Atomic Structure and atomic size, scale/dimensional aspects, properties of nano materials, carbon age-new form of carbon (CNT to Graphene), advantages and limitations at the nano level, Nano-Physics, health and environmental issues.

UNIT-II
Long range and short-range order forces, Van der Waal forces, solvation forces, electrostatic forces, hydrophobic forces, electric double layer forces, steric forces; Relevant theories, advantages and limitations.

UNIT-III
Top down and bottom-up approaches for preparing nano materials, Sol Gel processing, high energy ball milling, plasma assisted deposition, CVD, Langmuir-Blodgett (LB) films, Spin coating.

UNIT-IV
X-ray diffraction technique -Nano Particle size analyses, peaks of nano-particles, Electron Microscope and surface analysis techniques.

UNIT-V
Various applications of Nano Materials: Electronic Devices, Solar Cells, Drug delivery, coating.

Text/Reference Books:

1. T. Pradeep, Nano: The essentials, McGraw Hill.
2. M. Wilson, Nano Technology, Overseas Press.
3. C. P. Poole and J. F. Owens, Introduction to Nano Technology, Wiley.
4. G. Schmid, Nano Particles: from Theory to Applications, Wiley VCH Verlag GmBH and Co.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Acquire the knowledge of theoretical prerequisites of nano-materials and related chemical and physical approaches.
CO-02	Understand the important properties, techniques, and applications of nano-materials.
CO-03	Apply the knowledge for future generations' product development and the ability to demonstrate continuous upgrading knowledge for technological upgradation.
CO-04	Know about various characterization techniques used in nano technology
CO-05	Know various applications of nano technology.

Program: M. Tech **Semester: II**
Name of the Course: Artificial Intelligence in Steel Industries (PE-II)
Code: MME25-M-MST111 (2) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:
Students have to register for the Open Electives in the departments offering the electives. Every student shall earn 4 credits by choosing the open elective courses from the list. The syllabus contents of which are similar to the departmental core/elective courses. Further students from a program, say Metallurgical and Materials Engineering, shall not opt for open electives offered by their own program. Rather can opt from other departments' program. Students may consult their faculty coordinators before opting for an open elective course. The open elective courses will be to availability of time table slot of the faculty members, class rooms and minimum class strength specified from time to time.

Course Objectives:
Choice Based Credit System (CBCS) is widely being practiced by many Institutions since it has become signatory of the University Grants Commission (UGC). This has promoted in such a way that different open elective courses should be offered by every department in engineering to other departments. This interdisciplinary of learning open elective courses by other department students especially in engineering education will have learning awareness and job oriented benefits. Choice based credit system is one of them. Engineering students require the opportunity to choose any open elective course from different departments and apply their knowledge to acquire jobs in that field of course. Learning and employment benefits are not only through their own course subjects but also through open elective courses.

Syllabus:

UNIT-I
Introduction to Modeling and simulation; Mathematical and Physical models: Advantages and Limitations; Data-driven model; Predictive model based on statistics: Advantages and Limitations; Data-driven model based on concepts of artificial intelligence; Modeling applications in metallurgical and materials engineering.

UNIT-II
Artificial Intelligence; Machine Learning: Supervised and Unsupervised Machine Learning; Supervised Machine Learning: Artificial Neural Network, Deep Learning; Unsupervised Machine Learning: Clustering analysis; Theory of Pareto-optimality; Modeling at different length and time scales.

UNIT-III
Iron making: Blast furnace and alternate routes; Blast furnace iron making: Mathematical Modeling and Data-driven modeling; Application of AI-algorithm in blast furnace and alternate routes.

UNIT-IV
Steel making: Electric arc furnace (EAF), LD/BOF, Induction furnace; Steel Refining: Ladle furnace; Heat and mass balance; Application of AI-algorithm in EAF, LD/BOF, Induction furnace.

UNIT-V
Casting of steel: Ingot and Continuous casting route; Rolling mill: Plate and Coils; Mathematical and Data driven model for estimation of rolling force and torque; Introduction/overview of Industry 4.0, Internet of Things (IoT).

Text/Reference Books:

1. Datta, S. (2016). Materials Design Using Computational Intelligence Techniques (1st ed.). CRC Press. https://doi.org/10.1201/9781315373003
2. Chen, Y., Wang, T., Zhang, G.: Artificial Intelligence for Materials Science. Springer International Publishing, Cham (2021)
3. Tayal, S., Singla, P., Nandi, A., & Davim, J.P. (Eds.). (2021). Computational Technologies in Materials Science (1st ed.). CRC Press. https://doi.org/10.1201/9781003121954
4. Pal, S. et al. Process Modeling for Steel Industry April 2018 Edition: Publisher: I.K. International Publishing House ISBN: 9789385 909399
5. Jha, R., & Jha, B.K. (2022). Artificial Intelligence-Aided Materials Design: AI-Algorithms and Case Studies on Alloys and Metallurgical Processes (1st ed.). CRC Press. https://doi.org/10.1201/9781003167372

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Develop a deep understanding of artificial intelligence algorithms.
CO-02	Learn application of AI-algorithms from industrial point of view.
CO-03	Employability opportunity will be significantly improved.
CO-04	Will learn to frame and solve industrial problems through AI- based algorithms.
CO-05	Enhanced commitment towards environment and responsibility to the society.

Program: M. Tech **Semester: II**
Name of the Course: Introduction to Industry 4.0 & Industrial Internet of Things (PE-II)
Code: MME25-M-MST111 (3) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

Course Description:
This course provides an overview of Industry 4.0 concepts and the role of the Industrial Internet of Things (IIoT) in modern manufacturing. Topics include smart factories, cyber-physical systems, data analytics, cloud computing, and automation. Students learn how digital technologies integrate physical processes to enhance efficiency, productivity, and decision-making in industrial environments.

Course Objectives:
This course concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Technologies such as Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics are considered to be the different drivers necessary for the transformation. Industrial Internet of Things (IIoT) is an application of IoT in industries to modify the various existing industrial systems. IIoT links the automation system with enterprise, planning and product lifecycle.

Syllabus:

UNIT-I
Introduction: Sensing & actuation, Communication-Part I, Part II, Networking-Part I, Part II. Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories.

UNIT-II
Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis.

UNIT-III
Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes-Part I, Part II, Industrial Sensing & Actuation, Industrial Internet Systems. IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models-Part I, Part II, IIoT Reference Architecture-Part I, Part II.

UNIT-IV
Industrial IoT- Layers: IIoT Sensing-Part I, Part II, IIoT Processing-Part I, Part II, IIoT Communication-Part I. Industrial IoT- Layers: IIoT Communication-Part II, Part III, IIoT Networking-Part I, Part II, Part III. Industrial IoT: Big Data Analytics and Software Defined Networks: IIoT Analytics - Introduction, Machine Learning

and Data Science - Part I, Part II, R and Julia Programming, Data Management with Hadoop.

UNIT-V

Industrial IoT: Big Data Analytics and Software Defined Networks: SDN in IIoT-Part I, Part II, Data Center Networks, Industrial IoT: Security and Fog Computing: Cloud Computing in IIoT-Part I, Part II. Industrial IoT: Security and Fog Computing - Fog Computing in IIoT, Security in IIoT-Part I, Part II, Industrial IoT-Application Domains: Factories and Assembly Line, Food Industry. Industrial IoT-Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies.

Text/Reference Books:

1. A. Gilchrist, Industry 4.0: The Industrial Internet of Things, (Apress).
2. S. Jeschke, C. Brecher, H Song, D. B. Rawat, Industrial Internet of Things: Cyber Manufacturing Systems, (Springer).

Course Outcomes:

CO	**Material Science and Technology Post Graduates will be able to:**
CO-01	Understand the modern technologies such as sensors, communication, and computational processing used in Industry 4.0
CO-02	Understand and implement the Technologies like Cyber-Physical Systems (CPS), Internet of Things (IoT), Cloud Computing, Machine Learning, and Data Analytics for transformation practices.
CO-03	Application of IoT in industries to modify the various existing industrial systems.
CO-04	Learn about different networks .
CO-05	Learn about Industrial IOT.

Program: M. Tech **Semester: II**
Name of the Course: The Future of Manufacturing Business: Role of Additive Manufacturing (PE-II)
Code: MME25-M-MST111 (4) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks:100**
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Course Description:
This course explores the transformative impact of Additive Manufacturing (AM), commonly known as 3D printing, on the manufacturing industry. It covers how AM is reshaping product design, supply chains, and business models, with a focus on innovation, customization, and sustainability. Ideal for students and professionals interested in future-ready manufacturing strategies.

Course Objectives:
Manufacturing is one of the key engines of a nation's progress. In recent years, the manufacturing paradigm is changing due to availability of data, improvements in communication, advancements in materials and rapid realization of end-use parts from digital data. The objective of the course is to understand future of modern manufacturing, in the context of advancements in metal additive manufacturing and delineate the consequential technology entablements and business models.

Syllabus:

UNIT-I: Manufacturing Paradigms and Significance
Significance of manufacturing, craft production, mass production, mass customization, distributed manufacturing, laws of manufacturing.

UNIT-II: Advanced and Intelligent Manufacturing
Additive manufacturing and its impact on product development cycles, reconfiguring of supply chain models, advanced manufacturing (USA), e-factory (Japan), Industry 4.0 (Germany), intelligent manufacturing (China), Make in India (India), technology basics and classification of additive manufacturing, build environment and process window, input data formats and data generation from physical artefacts, common pitfalls and corrective measures.

UNIT-III: Economics and Business Aspects of Manufacturing
Firms' market microstructure for manufacturing, economies of scale, unscale and scope, manufacturing production functions, mathematics of complementarities, complementarities in production, economic characteristics of additive manufacturing, impact of additive manufacturing on firms' payoff functions and market microstructure.

UNIT-IV: Additive Manufacturing Technologies and Applications
Metal additive manufacturing, significance of laser powder bed fusion, challenges in realizing metal AM parts with adequate strength and integrity, industrial applications including part substitution, prototyping, tooling and reengineering,

product design and development models based on metal AM, spare part management for legacy systems, MRO and refurbishment models based on metal additive manufacturing.

UNIT-V: AM Materials, Quality, and Future Manufacturing Models
AM material types-metals, plastics, ceramics, composites; certified materials and adaptation challenges; comparison with traditional alloys; common defects and implications. AM plant infrastructure, post-processing, dimensional accuracy, surface finish, powder handling, and recycling. Value addition: light weighting, part consolidation, topology optimisation, functional integration. Certification and quality: process/part certification, monitoring, industry standards, repeatability, and reliability. Part selection, techno-commercial assessments, business use cases. Road mapping for AM adoption, organizational benchmarking. Emerging models: cloud manufacturing, cooperative and data-driven systems, digital and human-centered factories, Manufacturing-as-a-Service (MaaS), and XaaS.

Text/Reference Books:

1. Y. Koren, The Global Manufacturing Revolution, John Wiley & Sons, 2010.
2. R. D'Aveni, The 3-D Printing Revolution, Harvard Business Review, 2015.
3. J. O. Milewski, Additive Manufacturing Technologies, Springer, 2017.

Course outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Understand the future of modern manufacturing, in the context of advancements in metal additive manufacturing.
CO-02	Explain the consequential technology entitlements and business models.
CO-03	Understand professionally the rapid realization of end-use parts from digital data
CO-04	Learn about Additive Manufacturing Technologies and Application.
CO-05	Learn about AM Materials, Quality, and Future Manufacturing Models

Program: M. Tech **Semester: II**
Name of the Course: Process Metallurgy Laboratory
Code: MME25-M-MST112 **Credit: 2**
No of Hours: 4 hours/week **Max. Marks: 50**

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Course Description:
This lab course provides practical experience in the extraction and refining of metals from their ores. Students perform experiments related to pyrometallurgy, hydrometallurgy, and electrometallurgy, including processes like roasting, smelting, leaching, and electrorefining. Emphasis is placed on understanding the chemical principles, process control, and efficiency of metallurgical operations.

Course Objectives:
To provide practical knowledge about the various processes occur in iron and steel making and testing done for raw material.

List of Experiments:
1. Determination the effect of shape of iron ore and its agglomerates on the angle of repose.
2. Determination of Shatter and Tumbler strength.
3. Effect of moisture content on drop strength of green iron ore pellets.
4. Determination of Cold Crushing strength.
5. Effect of Time on Reduction and Swelling Behaviour of Iron Oxide Pellet reduced in a bed of carbon.
6. Determination of the hardness and strength of the coke using micum index test.
7. Determination of the Reactivity of carbon.
8. Determination of the % pipe volume, % pipe length and % yield of cast wax ingot.
9. Air Jet and water Interaction: A cold model study.
10. Determination of Inclusions.

Equipment/Machine Required:

1. Disc Pelletizer
2. Tumbler drum
3. Cold compression strength machine
4. Hot air oven
5. Muffle furnace
6. Mecum Drum
7. Digital Vernier callipers
8. Weighing machine

Recommended Books:

1. An Introduction to Modern Iron Making – R.H. Tupkary

Course Outcome:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Have practical knowledge about various testing processes related to iron and steel making;
CO-02	Analyse the BF charge calculations;
CO-03	Know the application of process metallurgy in industries.

Program: M. Tech **Semester: II**
Name of the Course: Materials Modelling and Simulation Lab
Code: MME25-M-MST113 **Credit: 2**
No of Hours: 4 hours/Week **Max. Marks: 50**

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Course Description:
This lab course introduces computational techniques for modeling and simulating material behavior at various scales. Students use software tools to study atomic structures, phase diagrams, mechanical properties, and thermodynamic behavior of materials. The course emphasizes understanding material phenomena through simulations such as molecular dynamics, finite element analysis (FEA), and phase field modeling.

Course Objectives:
This course deals with various simulation techniques related iron and steel making processes in blast furnace process, primary steel making through LD converter and electric arc furnace, secondary steel making, continuous casting and also various deformation processes.

List of Experiments:

1. Simulation of iron making process through Blast furnace.
2. Simulation of primary steel making process through Basic oxygen furnace.
3. Simulation of primary steel making process through Electric arc furnace.
4. Simulation of Secondary steel making process.
5. Simulation of Continuous casting process.
6. Simulation of plate rolling or section rolling process.
7. To study the effect of various alloying elements on the properties of steel.
8. To study various alternative routes for iron production.
9. Modelling of solidification process and optimisation of crack in casting.
10. Modelling and observation of the function of tuyeres design in blast furnace.

Software Required:
1. Related softwares like MatLab, ThermoCalc etc.

Text/Reference books:

1. *The Art of Molecular Dynamics Simulation*
   Author: D. C. Rapaport
2. *Multiscale Materials Modelling: Fundamentals and Applications*
   Editor: Z. X. Guo

Course Outcomes:

CO	**Material Science and Technology Post Graduates will be able to:**
CO-01	Understand the soft skill related to modelling and simulation processes in metallurgical and materials engineering domain.
CO-02	Gain through computational knowledge in ferrous and non-ferrous industries.
CO-03	Applications of computational knowledge in ferrous and non-ferrous industries.

Teaching Scheme and Syllabus
of
M.Tech in Metallurgy and Material Technology

(PROGRAM CODE: 01NPG052)

DEPARTMENT OF METALLURGICAL ENGINEERING

SCHOOL OF ENGINEERING

O.P. JINDAL UNIVERSITY, RAIGARH (C.G)

Session: 2025-27

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology)

PROGRAMME OUTCOME (PO)

Currently, OP Jindal University is offering undergraduate programmes (3/4 Years), postgraduate and doctoral programmes in the field of engineering, management, and science. OPJU aims to bring high-quality education to its students based on a world-class industry-based curriculum, the latest teaching methodology, research, innovation, and entrepreneurship developed by committed faculty members. The outcome of each of the programme in detail are summarized below:

PROGRAM OUTCOMES FOR ENGINEERING POST GRADUATE PROGRAM

1. **Disciplinary knowledge**: Accomplish vertical expertise in chosen discipline and enhance the ability to function in multidisciplinary domains.
2. **Research aptitude**: Ability and aptitude to exercise research intelligence in investigations/ innovations and to communicate the findings in a clear, concise manner.
3. **Project management**: Develop and apply knowledge of engineering and management principles to manage a project in a multidisciplinary environment.
4. **Ethics**: Gain knowledge of ethical principles and commit to professional ethics
5. **Self-directed lifelong learning**: Ability to identify appropriate resources and learn independently for projects, research, etc. using online resources.

PROGRAM SPECIFIC OUTCOME

PSO	Engineering Post Graduates will be able to:
PSO1	Design and develop new materials using concepts of physics, chemistry, metallurgy, and other related disciplines to meet the end users' objectives.
PSO2	Test and analyze the quality of various materials and integrate the same to assure quality in the materials industry.
PSO3	Ensure holistic growth through the awareness of effective communication, ethical responsibilities and physical/mental fitness.

Curriculum and Credit Framework for Postgraduate Programme (M. Tech) as per NEP

Semester	Core Courses	Professional Elective	Common Course	Industrial Training / Research Internship	Dissertation	Total Credits
I	16	3	1			20
II	13	3	4			20
Exit Point: For 2-year PG programs, there shall only be one exit point. Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma.						
III				8	12	20
IV					20	20
TOTAL						80
Students on exit shall be awarded a Master of Technology (in the Field of Study/ Discipline) after securing the requisite 80 credits on completion of Semester IV.						

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SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology)
Academic Semester I

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MMT101	Advanced Physical Metallurgy	3	0	0	15	15	70	100	3
2	MME25-M-MMT102	Industrial Corrosion and control	3	0	0	15	15	70	100	3
3	MME25-M-MMT103	Metal Forming Technology	3	0	0	15	15	70	100	3
4	MME25-M-MMT104	Heat Treatment Technologies	3	0	0	15	15	70	100	3
5	MME25-M-MMT105 (1-5)	Program Elective - I	3	0	0	15	15	70	100	3
6	MME25-M-MMT106	Physical Metallurgy Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST107	Metallography & Heat Treatment Laboratory	0	0	4	-	15	35	50	2
8	FROM SOM	Intellectual Property Rights	0	0	2	-	15	35	50	1
Total			**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective I (Annexure - I)

S. No.	Subject Code	Name of the Courses
1	MME25-M-MMT105 (1)	Failure Analysis of Engineering Components
2	MME25-M-MMT105 (2)	Non-Ferrous Extractive Metallurgy
3	MME25-M-MMT105 (3)	Computational Metallurgy
4	MME25-M-MMT105 (4)	Powder Metallurgy
5	MME25-M-MMT105 (5)	Ceramics Materials

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology)
Academic Semester II

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MMT107	Metal Casting Technology	3	0	0	15	15	70	100	3
2	FROM SOS	Research Methodology	3	0	0	15	15	70	100	3
3	MME25-M-MMT108	Material Characterization	3	0	0	15	15	70	100	3
4	MME25-M-MMT109	Advances in Iron & Steel Making	3	0	0	15	15	70	100	3
5	MME25-M-MMT110 (2-5), MST111(1)	Program Elective-II	3	0	0	15	15	70	100	3
6	MME25-M-MMT111	Metal Casting Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST106	Material Characterization Laboratory	0	0	4	-	15	35	50	2
8	FROM SOS	Scientific Paper Writing	0	0	2	-	15	35	50	1
Total			**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective II (Annexure - II)

S. N	Subject Code	Name of the Courses
1	MME25-M-MST111 (1)	Nanomaterials and Technology
2	MME25-M-MMT110 (2)	Non Destructive Evaluation
3	MME25-M-MMT110 (3)	Materials for Bio-implants
4	MME25-M-MMT110 (4)	Composite Materials
5	MME25-M-MMT110 (5)	Artificial Intelligence in Material Industries

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology)
Academic Semester III

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination			Total Marks	Credit L+(T+P)/2
						Theory / Practical				
			L	T	P	MID	TA	ESE		
1	MME25-M-MMT201	Industrial Training/ Research Internship	0	0	16	-	60	140	200	8
2	MME25-M-MMT202	Dissertation I	0	0	24	-	90	210	300	12
Total			**0**	**0**	**40**	**0**	**150**	**350**	**500**	**20**

SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology)
Academic Semester IV

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MMT203	Dissertation II	0	0	40	-	150	350	500	20
Total			**0**	**0**	**40**	**-**	**150**	**350**	**500**	**20**

M.Tech Semester-I
(Detailed Syllabus)

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SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology)
Academic Semester I

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MMT101	Advanced Physical Metallurgy	3	0	0	15	15	70	100	3
2	MME25-M-MMT102	Industrial Corrosion and control	3	0	0	15	15	70	100	3
3	MME25-M-MMT103	Metal Forming Technology	3	0	0	15	15	70	100	3
4	MME25-M-MMT104	Heat Treatment Technologies	3	0	0	15	15	70	100	3
5	MME25-M-MMT105 (1-5)	Program Elective - I	3	0	0	15	15	70	100	3
6	MME25-M-MMT106	Physical Metallurgy Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST107	Metallography & Heat Treatment Laboratory	0	0	4	-	15	35	50	2
8	FROM SOM	Intellectual Property Rights	0	0	2	-	15	35	50	1
Total			**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective I (Annexure - I)

S. No.	Subject Code	Name of the Courses
1	MME25-M-MMT105 (1)	Failure Analysis of Engineering Components
2	MME25-M-MMT105 (2)	Non-Ferrous Extractive Metallurgy
3	MME25-M-MMT105 (3)	Computational Metallurgy
4	MME25-M-MMT105 (4)	Powder Metallurgy
5	MME25-M-MMT105 (5)	Ceramics Materials

Program: M. Tech **Semester: I**
Name of the Course: Advanced Physical Metallurgy
Code MME25-M-MMT101 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**
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Course Description:

This course is designed to provide an in-depth understanding of the physical metallurgy principles governing the structure and behavior of metallic materials. Emphasis is laid on phase transformations, crystallography, defects, thermodynamics, and the mechanisms controlling microstructure evolution. The course bridges fundamental theories and practical applications relevant to industrial materials development, processing, and performance analysis.

Course Objectives:

1. To provide detailed knowledge of crystallography, dislocations, and diffusion phenomena.
2. To understand phase diagrams and transformation mechanisms in metallic systems.
3. To study the thermodynamics and kinetics behind microstructure evolution.
4. To analyze structure-property correlations for engineering applications.
5. To enable students to apply advanced physical metallurgy concepts in research and materials development.

Syllabus:

UNIT-I
Crystal structures of metals, unit cells and lattice parameters, Bravais lattices, Miller indices, atomic packing factors, crystallographic directions and planes, stereographic projections, symmetry operations, crystal defects, slip systems, role of defects in mechanical properties.

UNIT-II
Fick's laws of diffusion, diffusion mechanisms in solids, interstitial and substitutional diffusion, factors affecting diffusion, activation energy, Kirkendall effect, Gibbs free energy, entropy and enthalpy, chemical potential, phase stability, phase rule, thermodynamic driving force for transformations.

UNIT-III
Binary phase diagrams, isomorphous systems, other systems, phase rule, microstructural development during solidification, segregation and micro-segregation, dendritic growth, constitutional super cooling, Scheil's equation,

ternary phase diagrams, solidification of alloys in casting and welding.

UNIT-IV

Nucleation and growth mechanisms, homogeneous and heterogeneous nucleation, pearlitic, bainitic transformations, martensitic transformation, diffusionless transformations, order of transformations

UNIT-V

Precipitation hardening, orowan looping concepts, order-disorder transformations, spinodal decomposition, recovery, recrystallization, grain growth mechanisms, microstructural evolution in cold-worked materials, physical metallurgy and applications of Al-Cu, Al-Si, Cu-Zn, Cu-Sn, steels, advanced steels, and Ni-based super alloys, application-driven alloy design for various sectors.

Text Books:

1. Introduction to Physical Metallurgy, Sidney H. Avner, Tata Mc Grow Hill Publishing Co.
2. Elements of Physical Metallurgy, Lakhtin., MIR Publication, Moscow.
3. Material Science & Engineering, W. D. CalisterJr. Willy India Pvt. Ltd.
4. Physical Metallurgy, Vijendra Singh, SPD, Pvt Ltd

Reference Books:

1. Principles of Physical Metallurgy, Robert Reed Hill, East-West publication.
2. Material Science & Engineering, W.F.Smith & Javed.Hashemi, Ravi Prakash, Tata Mc Grow Hill
3. Phase Transformation in Metals and Alloys: David A. Porter, Kenneth E. Easterling and Mohamed Y. Sherif.

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Describe advanced concepts of crystallography, crystal imperfections, and their impact on material behaviour.
CO-02	Analyze phase diagrams and interpret equilibrium and non-equilibrium phase transformations.
CO-03	Explain the thermodynamic and kinetic principles behind diffusion and transformation mechanisms.
CO-04	Evaluate the microstructure-property relationships in various metallic systems.
CO-05	Apply physical metallurgy concepts in problem-solving and research in material design.

Program: M. Tech **Semester: I**
Name of the Course: Industrial Corrosion and Control
Code MME25-M-MMT102 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**
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Course Description:

The Corrosion program provides fundamental knowledge and applies it through training in corrosion and its prevention. Initially, students will study the fundamental chemistry, physics, and metallurgy underpinning corrosion processes and learn about approaches to corrosion control, ranging from material selection, through cathodic protection, to corrosion inhibition and protective coatings. The program covers industrial scenarios where knowledge of corrosion and its control is paramount, such as the oil and chemical industries. This master's program is the ideal preparation for a career either in industry as a corrosion scientist or engineer or for cutting-edge academic research.

Course Objectives:

1. To learn advanced topics of corrosion and advanced corrosion with emphasis on basic concepts.
2. To understand the significance of corrosion laws and relationships.
3. To understand the behaviour of corrosion in acid media.
4. To understand the energy conversion in chemical cells and electrochemical cells.
5. To solve the corrosion and control problems using the electrochemical reaction.

Syllabus:

UNIT-I
Principles of Electro-Chemistry, Electrode Potential, Reference Electrode, EMF Series, Galvanic series, Half-cell reaction, Nernst's equation, Free Energy, corrosion of metals & alloys in various environments, Pourbaix diagram of common metals, Electrolytes, Cost of Corrosion. Case studies based on various parameters, specifically focusing on steel industries.

UNIT-II
Corrosion Rate Expressions, Exchange Current Density, Polarization Experimental Techniques, Tafel equation, mass transport control, mixed potential theory and behavior of galvanic couples in acidic environments,

different factors- Velocity, Temperature, concentration. Passivity, potentiostatic polarization curves, factors affecting passivity, mechanism of action of passivates and industrial case studies, specifically focusing on steel and iron industries.

UNIT-III

Types of industrial Corrosion - atmospheric corrosion, galvanic corrosion, Industrial Intergranular corrosion, crevice corrosion, pitting corrosion, Erosion corrosion in power plant, environmentally induced cracking – mechanism of stress corrosion cracking. Case studies of various industries, specifically focusing on steel, iron, and power industries.

UNIT-IV

Selection of corrosion resistant materials for ferrous and non-ferrous industries–stainless steel, nickel and nickel alloys, Aluminium alloy and other metal alloys. Cathodic and anodic protection methods, Use of advanced coatings, inhibitor applications, protection of metals industries, specifically focusing on steel, iron, and power industries.

UNIT-V

Corrosion & its control in steel, construction and power industries, petrochemical industries, ship building and marine industries, in fertilizer industries, automobile industries.

Text Books:

1. Corrosion in Fertilizer Equipment, Corrosion of Metals by Liquid Mixed Fertilizers J. D. Hatfield, A. V. Slack, G. L. Crow, H. B. Shaffer Jr., J. Agric. Food Chem.
2. Corrosion Failures Theory, Case Studies, and Solutions K. Elayaperumal, V.S. Raja John Wiley & Sons, Inc., Hoboken, New Jersey
3. Corrosion of Constructional Steels in Marine and Industrial Environment, Saha, Jayanta Kumar, Springer.
4. Principles and Prevention of Corrosion, Denny A Jones, (second edition),
5. Prentice- Hall, N. J. (1996).
6. Corrosion and Corrosion Control, H. H. Uhlig and R. W. Revie, Wiley (NY) (1985).
7. Corrosion. L. L. Shreir, Butterworths, Vol I and II, Publication.
8. Atlas of Electrochemical Equilibria in aqueous solutions, M. Pourbaix, NACE,
9. Houston (1 Corrosion in Power Industry, Maroš Halama and Jan Stoulil, Trans Tech Publication974).

Reference Books:

1. Modern Electrochemistry, J. O. M. Bockris and A. K. N Reddy, Plenum Press (NY), Vol. I and II.
2. Microbial Aspects of Metallurgy, J. D. A Miller, Medical and Tech. Pub. Co. Lancaster (1971).

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Understand the concepts of material loss due to corrosion.
CO-02	Understand the various protection method to avoid corrosion.
CO-03	Test and analyze the electrochemical reactions of materials/alloys in various atmospheres.
CO-04	Apply the concepts of the subject to solve industrial problems.
CO-05	Test and apply corrosion control methods in various industries

Program: M. Tech **Semester: I**
Name of the Course: Metal Forming Technology
Code: MME25-M-MMT103 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

This course provides an in-depth study of advanced metal forming techniques used in modern manufacturing industries. It covers the fundamentals of plastic deformation, forming mechanics, process modeling, and recent advancements in bulk and sheet metal forming. Additionally, it covers emerging trends in metal forming, such as severe plastic deformation (SPD), and additive manufacturing (AM). By the end of this course, students will develop expertise in forming process selection, defect analysis, and process optimization, preparing them for careers in aerospace, automotive, biomedical, and advanced manufacturing industries.

Course Objectives:

1. To provide an in-depth understanding of advanced metal forming techniques.
2. To analyze and apply modern forming processes in manufacturing.
3. To study the mechanics, modeling, and simulation of forming operations.
4. To explore the latest advancements in metal forming, including micro- and nano-forming.
5. To understand process optimization, defects, and quality control in forming operations.

Syllabus:

UNIT-I
Fundamentals of Metal Forming: Overview of metal forming processes (bulk & sheet forming); Mechanics of plastic deformation & yield criteria (von Mises, Tresca); Classification of forming processes (hot, cold, and warm forming); and formability evaluation.

UNIT-II
Advanced Bulk Deformation Processes: Rolling: Process parameters, force calculations, defects; Forging: Open-die, closed-die, isothermal & precision forging; Extrusion: Types (direct, indirect, hydrostatic), metal flow, defects; Wire and tube drawing: Mechanics, process design, lubrication; Severe plastic deformation (SPD) techniques: Equal channel angular pressing (ECAP), high-pressure torsion (HPT).

UNIT-III

Advanced Sheet Metal Forming: Deep drawing, stretch forming, bending, spinning; Hydroforming, superplastic forming; High-speed forming methods: Electromagnetic, explosive, electrohydraulic forming; Incremental sheet forming (ISF).

UNIT-IV

Special and Modern Forming Processes: Powder forming: Hot and cold isostatic pressing (HIP, CIP); Micro-forming and nano-forming techniques; Ultrasonic-assisted forming; Hybrid forming processes: Combined forging & rolling, extrusion & shearing; Additive manufacturing & hybrid material processing.

UNIT-V

Defects in Metal Forming: Defects in metal forming and their remedies; Die design and material selection; Residual stresses in formed parts; Industrial applications.

Text/ Reference Books:

1. Dieter, G. E., "Mechanical Metallurgy", 3rd Ed., McGraw Hill 2010 Education India
2. Metal Working, Metals Handbook, Vol.14 A&B, 9th Ed., ASM
3. Rowe R., Principles of Metal Working, Edward Arnold Publications Ltd.
4. Burhanettin S. Altan (Ed.), Severe Plastic Deformation – Towards Bulk Production of Nanostructured Materials, Nova Publishers

Course Outcome:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Understand and analyze the mechanics of metal forming and its influence on material behavior.
CO-02	Apply advanced forming techniques such as superplastic forming, high-speed forming, and micro-forming in real-world applications.
CO-03	Understand and analyze the powder and hybrid forming processes
CO-04	Identify and solve process defects, optimize forming parameters, and enhance process efficiency.
CO-05	Explore emerging trends in metal forming and integrate advanced techniques into industrial applications.

Program: M. Tech **Semester: I**
Name of the Course: Heat Treatment Technologies
Code: MME-25-M-MMT104 **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

The course emphasizes on the important principles of heat treatment. It discusses the important heat treatment techniques and applications in Industries. The various defects generated during heat treatment is explained and the methods to minimize these defects is covered thoroughly in this course.

Course Objectives:

1. Students will learn basic principles used in heat treatment.
2. Students will important techniques of heat treatment.
3. Students will learn about various defects generated during heat treatment.

Syllabus:

UNIT-I
Heat treatment process variables, austenite, bainite, pearlite, martensite, TTT and CCT, Effect of alloying elements, carbon, and grain size on TTT curve, Hardenability, Jominy end quench test.

UNIT-II
Annealing, Normalizing, Spheriodizing, Hardening, Tempering, Austempering, Martempering, Subzero treatment, Patenting etc.

UNIT-III
Ausforming, Isoforming, Cryoforming, Carburizing, Cyaniding, Nitriding, Flame hardening, Induction hardening etc., Measurement of case depth.

UNIT-IV
Thermo-mechanical treatments, Thermo-mechanical controlled processing, Heat treatment furnaces, Heat treatment Defects.

UNIT-V
Heat Treatment of Commercial Steels, Alloys steels, tools steels, high speeds steels, stainless steels, spring steels, automotive steels, non-ferrous alloys.

Text/ Reference Books:

1. Heat Treatment: Principles and Techniques/Ashok Rajan, T.V. Sharma, C.P. Sharma, PHI Learning Private Limited, 2nd edition
2. Principle of Heat treatment of Steels/ R.C. Sharma/ New Age International (P) Limited
3. Heat Treatment of Steels, Vijender Singh

Course Outcome:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	learn basic principles used in heat treatment.
CO-02	learn important techniques of heat treatment.
CO-03	learn about various defects generated during heat treatment.
CO-04	understand about various heat treatment furnaces and defects.
CO-05	apply the gained knowledge in heat treatment of various alloys.

Program: M.Tech **Semester: I**
Name of the Course: Failure Analysis of Engineering Components (Elective-I)
Code: MME25-M-MMT105 (1) **Credit:3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Descriptions:

The focus of this course is to develop an understanding of different types fracture of engineering materials and structures under static and dynamic conditions. Students have been taught the principles of linear elastic and elastic-plastic fracture mechanics and their application to engineering design. This course will also introduce key applications of fracture mechanics in industry including damage detection, failure analysis, and experimental techniques.

Course Objectives:

1. Study about types of fracture.
2. Study the principles of fracture mechanics and their applications to structural design.
3. Fracture phenomena in metals and non-metals will be discussed and Testing methods will be highlighted.
4. In the end computer assisted techniques for fracture study will be discussed.

Syllabus:

UNIT-I
Introduction to fracture, mechanisms of fracture, a crack in structure, the Griffith's criterion, stiffness and toughness, stress intensity approach, linear elastic fracture mechanics, crack tip stress and deformations, relation between stress intensity factor and fracture toughness, stress intensity based solutions.

UNIT-II
Elastic – plastic fracture mechanics, elasto–plastic factor criteria, crack resistance curve, J-integral, crack opening displacement, crack tip opening displacement.

UNIT-III
Dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness, fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws.

UNIT-IV

Fracture Resistance of materials, fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure. Fracture toughness testing of metals, specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness.

UNIT- V

Procedure for Failure analysis, Crack initiation and crack propagation, Scanning electron microscopy investigation

Text Books:

1. Mechanical Metallurgy, George E. Dieter, McGraw Hill Publication.
2. Testing of Metallic Materials, A. V. K. Suryanarayan, B. S. Publication.

Reference Books:

1. Elements of Fracture Mechanics, Prashant Kumar, Tata McGraw Hill, New Delhi, India, 2009.
2. Fracture Mechanics for Modern Engineering Design, K. R. Y. Simha, Universities Press (India) Limited, 2001.
3. Elementary Engineering Fracture Mechanics, D. Broek, Kluwer Academic Publishers, Dordrecht, 1986.
4. Fracture Mechanics - Fundamentals and Applications, T. L. Anderson, Taylor and Francis Group, 3rd Edition, 2005.

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Predict material failure for any combination of applied stresses.
CO-02	Estimate failure conditions of a structure.
CO-03	Determine the stress intensity factor for simple components of simple geometry.
CO-04	Predict the likelihood of failure of a structure containing a defect.
CO-05	Know how to investigate failure of components.

Program: M. Tech **Semester: I**
Name of the Course: Non-Ferrous Extractive Metallurgy (Elective-I)
Code: MME25-M-MMT105(2) **Credit: 3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

The course provides fundamentals knowledge of extraction of different metals from their ores. The fundamentals princles are explained and how these principles are applied to extract ferrous and non- ferrous metals.

Course Objectives:

1. Students will become familiar with principles used in metal extraction.
2. Students will know the various ores of important metals.
3. Students will know the various techniques used in Industries for metal extraction.

Syllabus:

UNIT-I

Fundamentals of Extractive Metallurgy, Pyro-metallurgical Processes, Calcination, Roasting, Smelting, Converting, Refining.

UNIT-II

Hydrometallurgical Processes: Leaching, Purification of Leach-liquor, Recovery of values from l each-liquor, Electro-metallurgical Processes: Electro refining, Electro winning.

UNIT-III

Iron Making, Fundamentals, Blast Furnaces Iron making, DRI, Alternate route of Iron making.

UNIT-IV

Steel making, Fundamentals, LD steel making, EAF steel making, Ladle Refining Furnace, Casting, Hot rolling and cold rolling, Defects in steel making.

UNIT-V

Extraction of metals: like Magnesium, aluminum, tin, copper, lead, zinc, nickel, titanium, rare earths, uranium, thorium, plutonium, beryllium, zirconium, gold, silver and platinum.

Text/ Reference Books:

1. Bray J.L., Non-ferrous Production Metallurgy, Wiley.
2. Iron Making and Steel Making Theory and Practice - Ahindra Ghosh, Amit Chatterjee.
3. Biswas A.K. and Davenport W.G., Extractive Metallurgy of Copper, Pergamon Press.
4. H.S. Ray,A. Ghosh, Principles of extractive Metallurgy, New Age International Publisher.

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	To become familiar with principles used in metal extraction.
CO-02	To know the various ores of important metals.
CO-03	To know the various techniques used in Industries for metal extraction.
CO-04	Know defects in steel products.
CO-05	Know extraction of non-ferrous metals.

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Program: M.Tech **Semester: I**
Name of the Course: Computational Metallurgy (Elective-I)
Code: MME25-M-MMT105 (3) **Credit:3**
No of Hours: 3 hours/week **Max. Marks: 100**

Course Description:

Designing new materials or even improving multiple properties of existing material is a complex task. In the last decade, several initiatives were launched in order to minimize the discovery to deployment time period for a new material. Some of these initiatives include: Materials Genome Initiative (MGI), Integrated Computational Materials Engineering (ICME). These initiatives are focused on utilizing computational tools for understanding various aspects of materials design by utilizing concepts of mathematics, statistics, and artificial intelligence. This course will be a brief introduction of various computational tools that are utilized by materials scientists around the globe. Modeling and simulations are performed at various length and time scales. Thus, this course will help students in understanding various aspects of materials design through computational tools.

Course Objectives:

1. To expose students to the history of application of computational tools in materials design.
2. To help students develop the understanding of structure of materials at different length scales.
3. To help students understand a few important mathematical and statistical concepts.
4. To familiarize students with a few software related to materials science and programming languages.
5. To help students familiarize themselves with new initiatives in computational materials science and in the industry.

Syllabus:

UNIT-I
Introduction to Materials; Classification of materials; History of Computational Materials Science; Mathematical model; Physical models; Data-driven model; Modelling and simulation at different length and time scales.

UNIT-II
Crystal structure of metals: BCC, FCC, HCP, BCT etc; Visualization of crystal structure in VESTA; Microstructure and its importance; Visualization of microstructure obtained through Optical microscope; phase diagram in materials; Introduction to Thermo-Calc and other modeling software

(LAMMPS, VASP); Structure and properties of polymers, refrigerants and drugs: SMILES notations and visualization through materials modelling software.

UNIT-III

Statistical Concepts; Correlation coefficient: Pearson and Spearman; Analysis of variance (ANOVA); Introduction to Microsoft Excel: Statistical analysis and plotting; Case study of a blast furnace in MS Excel.

UNIT-IV

Introduction to common software: Origin, MATLAB and WEKA; Data analysis and plotting in Origin, MATLAB and WEKA; Introduction to Python programming language; Data analysis and plotting in Python.

UNIT-V

Introduction of artificial intelligence(AI); Overview of machine learning(ML): Supervised and unsupervised; Artificial neural network (ANN); Basic of genetic algorithm; Pareto-optimality; Industry 4.0; Internet of Things (IoT); Modeling applications in metallurgical and materials engineering.

Text/Reference Books:

1. Callister, WD. Materials Science and Engineering: An Introduction, ISBN: 978-1-119-40549-8
2. Peck et al (2008); Introduction to Statistics and Data Analysis, Duxbury, an imprint of Thomson Brooks/Cole
3. Pal, S., & Ray, B.C. (2020). Molecular Dynamics Simulation of Nanostructured Materials: An Understanding of Mechanical Behavior (1st ed.). CRC Press. https://doi.org/10.1201/9780429019845
4. Datta, S. (2016). Materials Design Using Computational Intelligence Techniques (1st ed.). CRC Press. https://doi.org/10.1201/9781315373003

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Apply knowledge of data science to problems in materials engineering.
CO-02	Get a multidisciplinary exposure.
CO-03	Employability significantly improved after studying.
CO-04	Apply technical skills (experimental, computational) and efficiently use data analysis tools for industrial problems in metallurgical engineering.
CO-05	Enhanced commitment towards environment and responsibility to the society.

Program: M.Tech **Semester: I**
Name of the Course: Powder Metallurgy (Elective-I)
Code: MME25-M-MMT105 (4) **Credit:3**
No of Hours: 3 hours/week **Max. Marks: 100**

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Course Description:

This course has been intended to improve the students related to their career in the field of metallurgical and materials engineering and provide them an insight into the emerging technology of powder metallurgy as an alternative route to conventional metal processing. This course describes the fundamental aspects of advanced ceramic powder preparation, densification and microstructure evolution during sintering procedure. The course provides thorough knowledge of powder production and processing as well as to choose the right technical method to suit applications. The major goal is to establish the powder fabrication route as a technologically and economically viable means of materials production.

Course Objectives:

This course aims to:

1. Assess the emergence and importance of powder metallurgy, scope and limitations.
2. Gain familiarity with fundamental concepts associated with powdered metals or non-metal powders.
3. Explain the physical and physico-chemical phenomena underlying the processes of shaping of massive bodies from metal or ceramics powders via dry, wet, or plastic methods.
4. Increase the knowledge of powder production techniques and characteristics.
5. Encourage the knowledge of knowledge of compaction and sintering techniques and related applications.

Syllabus:

UNIT-I
Concept of particles, particle size, shape and size distribution of powders, powder production methods, blending of powders and related fabrication processes, advantages and limitations of powder metallurgy, design considerations in powder metallurgy.

UNIT-II
Production of metal powders following reduction of oxides, electrolyting methods, chemical processes, atomization methods, characterization of powders emphasizing apparent density, tap density, flow rate, friction index, surface area, porosity measurements properties of green compacts and sintered compacts.

UNIT-III

Purpose of compaction, phenomena of compaction, design consideration for die compaction, techniques of cold and hot isotactic pressing, powder rolling, injection moulding etc., compaction tooling and role of lubricants, preparation of cermets.

UNIT-IV

Definition of sintering, theory of sintering, stages of sintering, driving forces for sintering, mechanism of sintering, sintering atmospheres and furnaces, sintering zones, effect of variables, post sintering applications.

UNIT-V

Powder metallurgy applications especially porous metals, cermets, cemented carbides, electrical and magnetic materials; dispersion strengthened materials, metal filters and related standards, Mechanical alloying and types of phases formed, reactive milling.

Text/Reference Books:

1. A. Upadhyaya, G. S. Upadhyaya, Powder Metallurgy: Science, Technology, and Materials, Universities Press.
2. R.M German, Powder Metallurgy Science, MPIF, NJ, USA.
3. A. K. Sinha, Introduction to Powder Metallurgy, Dhanpatrai Publication.
4. U. D, Kodgire, Material Science and Metallurgy, 37th edition, Everest Publishing House.
5. M. N. Rahaman, Sintering of Ceramics, CRC Press.
6. Powder Metallurgy, ASM Handbook, Vol-VII.
7. H. H. Hausner, Handbook of Powder Metallurgy.
8. W. D. Jones, Powder Metallurgy.
9. R. M. German, Sintering Theory and Practice, Metal Powder Industries Federation.
10. T. Shukerman, Principles of Powder Metallurgy.
11. W.D. Kingery, Introduction to Ceramics, Wiley & Sons (second edition).

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Understand the fundamental principles and physio-chemical properties of powder materials and related structure-property relations.
CO-02	Understand the powder metallurgy processes and techniques, scope, and limitations in the research/project domains.
CO-03	Build up a conceptual blend between theory and practical knowledge.
CO-04	Know sintering process of powders
CO-05	Know the applications of powder metallurgy.

Program: M.Tech **Semester: I**
Name of the Course: Ceramics Materials (Elective-I)
Code: MME25-M-MMT105 (5) **Credit:3**
No of Hours: 3 hours/week **Max. Marks: 100**

Course Description:

The course 'Ceramics Technology' has been blended with fundamental and advanced means. The course covers the basic structure proper correlation of ceramic materials emphasizing structure and bonds, mechanical behaviors, process of manufacturing and all types of sinter behaviors. The powder metallurgy is intended with powder production, compaction and shaping, and sintering of powder metallurgical components. The aim is to solve an application related problems. In addition, a detailed background into the microstructure, properties involving the fabrication and use have been illustrated.

Course Objectives:
This course aims to build the necessary background and importance to:

1. Gain familiarity with fundamental concepts associated with ceramic materials and processing;
2. Explain the principle physical and physico-chemical and sintering phenomena underlying the processes of ceramic bodies and related microstructural significances;
3. Emphasize the knowledge of powder production techniques and characteristics;
4. To encourage the knowledge of compaction and sintering techniques and related applications.
5. Able to operate as an effective engineer/scientist in metallurgical and materials domain.

Syllabus:

UNIT-I
Ceramics-Structure, chemical bonding, raw materials, classifications, oxide and other ceramics, silica, manufacturing process, mechanical, thermal, dielectric, magnetic and optical properties of ceramic materials. toughening mechanism, concept of phases like $Al_2O_3 - SiO_2$ system, $MgO - Al_2O_3 - SiO_2$ system, etc.

UNIT-II
Glass formation, composition as a variable, crystalline glazes, opacified enamels, glass ceramic materials, important glass ceramic systems, monolithic advanced, silicon nitride, silicon carbide, transformation-toughened zirconia, self-reinforced ceramic composites, effect of green

microstructure on sintered microstructures of the products. ceramic matrix composite fabrication approaches, bio ceramics, nano-phase ceramics.

UNIT-III
Mechanical powder preparation methods like attrition and planetary milling, Chemical methods like precipitation, sol-gel techniques, spray pyrolysis, CVD, combustion synthesis (SHS), Plasma synthesis, Conventional Process like dry and semi-dry pressing, slip casting, extrusion, Advanced process like cold isostatic pressing, hot isostatic pressing, tape casting, injection molding, hot-pressing etc. refractory materials, property, fabrication.

UNIT-IV
Concept of sintering, types of sintering of powders, driving force in sintering, solid, liquid diffusion based sintering, vitrification and solid-state sintering, microwave sintering, sintering additives, recent trends in sintering.

UNIT-V
Cemented carbides, cermet, Effect of green microstructure on sintered microstructures of the products, applications of powder metallurgy.

Text Books:

1. Introduction to Ceramics, W.D.Kingery, Wiley India Pvt Ltd; Second edition.
2. Ceramic Technology and Processing- Alan King, Standard Publishers Distributors, 2004.
3. Powder Metallurgy Technology, G. S. Upadhyaya, Cambridge international Publishing, UK.
4. Powder Metallurgy Science, Technology and Materials, Anish Upadhyaya, G S Upadhyaya, Universities Press, Hyderabad.
5. Introduction to Powder Metallurgy, American powder metallurgy Institute, 1976.
6. Powder Metallurgy, Science, Technology and Applications, P C Angelo, R Subramanian, PHI, New Delhi.

Reference Books:
1. Ceramic processing & Sintering – M. N. Rahaman, CRC Press, 2nd edition
2. Introduction to Principles of Ceramic Processing – J. S. Reed, Wiley, 1995.
3. Non-equilibrium Processing of Materials, Ed. C.Suryanarayana, Pergamon, 1999.
4. Hand book of powder metallurgy, H. H. Hausner, M. Kumar Mal, Chemical Publishing Company, New York, 1998.
5. Sintering, Grain Growth and Microstructure, Suk-Joong L Kang, Elsevier, 2005.

6. ASM Metal Hand book Vol 7, ASM International, Ohio, 1998.
7. Modern Developments in Powder Metallurgy, Editor -Henry H. Hausner Plenum Press, New York, 1966.
8. Hot Working Guide: A Compendium of Processing Maps, Ed Y. V. R. K. Prasad, S. Sasidhara, ASM International, 1997.
9. Composite Materials, Vol 1 & 2, Mel. M. Schwartz Prentice - Hall PTR, New Jersey, 1997.

Course Outcomes:

CO	Metallurgical and Material Engineering Post Graduates will be able to:
CO-01	Understand the fundamental concepts of ceramic materials.
CO-02	Comprehend the various processes including material qualification of ceramic materials.
CO-03	Conduct and determination of various processes related to production of powder materials.
CO-04	Grasp the various sintering mechanisms in powder metallurgy processes.
CO-05	Selection and applications of ceramics and powder metallurgical products.

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Program: M.Tech **Semester: I**
Name of the Course: Physical Metallurgy Lab
Code: MME25-M-MMT106 **Credit:2**
No of Hours: 4 hours/week **Max. Marks: 50**

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Course Objectives:

1. To develop practical skills in sample preparation and metallographic techniques including cutting, mounting, grinding, polishing, and etching, enabling students to analyze the microstructures of ferrous and non-ferrous metals and alloys.
2. To enable students to correlate microstructure with mechanical properties by interpreting the effects of various heat treatments and alloying elements.
3. To familiarize students with the principles and operation of optical microscopy and image analysis software for qualitative and quantitative microstructural characterization.

List of Experiments:

1. Study of Crystal Structures through Ball Models.
2. Characterize the microstructures of steel grades (0.2%C, 0.4%C and 0.8% C) and identify phases.
3. Examine the phase constituents and microstructural features of brass and bronze.
4. Study the construction, working principles, and calibration of metallurgical microscopes.
5. Investigate the principles of chemical and electrolytic etching, and evaluate suitable etchants for revealing specific microstructural features of steels.
6. Investigate the microstructure of the annealed and normalized steels in an optical microscopy.
7. Measure average grain size using ASTM E112 method and validate results with digital image analysis techniques.
8. Study the microstructure of cold worked material and understand the properties.
9. Microstructure analysis of Al-Cu alloys.
10. Study the Fe-Fe3C diagram and effect of alloying elements in Thermocalc software.

Equipment Required:

1. Metallurgical Microscope with image analyzer
2. High Temperature Muffle Furnace
3. Thermocalc software

4. Scanning Electron Microscope

Text/Reference Books:

1. The Principles of Metallographic Laboratory Practice by George L. Khel.
2. Hand Book of Metallography and Microstructure, ASM Handbook, Vol. 9.
3. Introduction to Physical Metallurgy, Sidney H. Avner.
4. Material Science by S P Gupta.

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Conduct and analyze internal characteristics of metals and alloys.
CO-02	Able to know the concept of grain size and related mechanical properties correlation.
CO-03	Solve the problems through experiments and reach a solution related to a specified metal or alloy.

Program: M.Tech **Semester: I**
Name of the Course: Metallography & Heat Treatment Lab
Code: MME25-M-MST107 **Credit:2**
No of Hours: 4 hours/week **Max. Marks: 50**

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Course Description:
This lab focuses on the preparation, examination, and analysis of metallic microstructures and the effects of heat treatment processes. Students learn sample preparation techniques, optical microscopy, and perform various heat treatments (annealing, quenching, tempering) to study changes in microstructure and mechanical properties. The course emphasizes the structure–property relationship in metals.

Course Objectives:

Heat treatment processes develops desired microstructure to meet set of properties to Metals and Alloys. The syllabus is designed to get hand on experience of heat treatment processes in laboratory.

List of Experiments:

1. To prepare the hot mounting and cold mounting of the samples
2. To prepare the metallic samples for metallographic examination
3. To observe the microstructure of various steel samples
4. To observe the microstructures of annealed and normalized steels
5. To find the grain size by ASTM method
6. To perform the etching process and etching reagents
7. To determine the hardenability of Plain carbon steel and alloy steel by Jominy end quenching
8. To observe the microstructure of hardened and Tempered steel
9. To observe the microstructure of cold worked samples
10. Case carburizing of steel sample

Equipment Required:
1. Hot Mounting
2. Metallurgical Microscope
3. Muffle Furnace
4. Jominy end quench Test

Text/Reference Books:

1. G. L. Khel, The Principles of Metallographic Laboratory Practice.
2. T. V. Rajan, C. P. Sharma and A. Sharma, Heat Treatment Principles and Techniques.

3. Handbook of Metallography and Microstructure, ASM Handbook, Vol. 9.
4. S. H. Avner, Introduction to Physical Metallurgy.

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Comprehend the fundamentals of microstructural modification of metals and alloys through heat treatment practices.
CO-02	Correlate heat treatment processes towards microstructure and property analysis and applications point of view.
CO-03	Provide professional development to demonstrate the solution.

M.Tech Semester-II
(Detailed Syllabus)

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SCHEME OF TEACHING AND EXAMINATION

M. Tech (Metallurgy and Material Technology) Academic Semester II

S. No.	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical			Total Marks	Credit L+(T+P)/2
			L	T	P	MID	TA	ESE		
1	MME25-M-MMT107	Metal Casting Technology	3	0	0	15	15	70	100	3
2	FROM SOS	Research Methodology	3	0	0	15	15	70	100	3
3	MME25-M-MMT108	Material Characterization	3	0	0	15	15	70	100	3
4	MME25-M-MMT109	Advances in Iron & Steel Making	3	0	0	15	15	70	100	3
5	MME25-M-MMT110 (2-5), MST111(1)	Program Elective-II	3	0	0	15	15	70	100	3
6	MME25-M-MMT111	Metal Casting Laboratory	0	0	4	-	15	35	50	2
7	MME25-M-MST107	Material Characterization Laboratory	0	0	4	-	15	35	50	2
8	FROM SOS	Scientific Paper Writing	0	0	2	-	15	35	50	1
		Total	**15**	**0**	**10**	**75**	**120**	**455**	**650**	**20**

Program Elective II (Annexure - II)

S. N	Subject Code	Name of the Courses
1	MME25-M-MST111 (1)	Nanomaterials and Technology
2	MME25-M-MMT110 (2)	Non Destructive Evaluation
3	MME25-M-MMT110 (3)	Materials for Bio-implants
4	MME25-M-MMT110 (4)	Composite Materials
5	MME25-M-MMT110 (4)	Artificial Intelligence in Material Industries

Program: M. Tech
Name of the Course: Metal Casting Technology
Credit: 3
Max. Marks: 100
Semester: II
Code: MME25-M-MMT107
No of Hours: 3 hours/week

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Course Description:

This course delves into the principles and practices of metal casting, covering various casting processes, materials, and design considerations. It aims to equip students with the knowledge to analyze and optimize casting operations, ensuring quality and efficiency in production.

Course Objectives:
Upon completion of this course, students would be able to:

1. Understand the fundamental principles of various casting processes.
2. Analyze the solidification process and its impact on casting quality.
3. Design effective gating and risering systems.
4. Identify and mitigate common casting defects.
5. Apply special casting techniques to meet specific production requirements.

Syllabus:

UNIT-I
Introduction to Casting Processes: Foundry industry practices and sequence of operations; Pattern making, moulding, and core making techniques; Properties and testing of moulding sands and core sands; Overview of casting processes: sand casting, die casting, investment casting, centrifugal casting, etc.

UNIT-II
Melting and Pouring Techniques: Types of furnaces: crucible, cupola, oil-fired, electric arc, and induction furnaces; Melting practices for various alloys: cast iron, SG iron, steel, aluminum, and copper alloys; Fluxing, degasification, and inoculation processes; Safety considerations in melting and pouring operations.

UNIT-III
Solidification and Casting Defects: Solidification mechanisms: nucleation, solidification variables, and directional solidification; Chvorinov's rule and chilling effects; Common casting defects: causes, features, and remedies; Fettling and cleaning of castings.

UNIT-IV
Gating and Risering Systems: Design principles of gating systems: sprue, runner, gate; Functions and types of risers; Design considerations for

directional solidification and minimizing distortion; Design challenges in junctions (L, T, V, X, Y).

UNIT-V

Special Casting Techniques: Shell moulding, investment casting, die casting, centrifugal casting, squeeze casting, and full mould process; Low pressure die casting, thixo and rheo casting, Environmental, health, and safety aspects in casting processes.

Text Books:

1. R. W. Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata McGraw Hill. Pub. Co, 1998
2. P. L. Jain, "Principles of Foundry Technology", Tata McGraw-Hill Publishing Co., Ltd, New Delhi 1995.
3. D. B. Goel and K. P. Sinha, Foundry Technology, Standard Publishers Distributors.

Reference Books:

1. R.W. Heine, C.R. Loper and P.C. Rosenthal, "Principles of metal casting".
2. R.W. Ruddle, Solidification of castings – Institute of Metals, London.
3. "Metal Casting" ASME Handbook

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Demonstrate proficiency in pattern making, moulding, and core making.
CO-02	Analyze thermal and metallurgical aspects during solidification.
CO-03	Design gating and risering systems for optimal casting quality.
CO-04	Identify and rectify casting defects through diagnostic methods.
CO-05	Implement special casting techniques for advanced manufacturing needs.

Program: M. Tech **Semester: II**
Name of the Course: Material Characterization **Code: MME25-M-MMT108**
Credit: 3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:

This course is designed to provide students with a comprehensive understanding of the principles, techniques, and applications used in the characterization of materials. This course integrates theoretical knowledge with practical laboratory experience, enabling students to analyse the structure, properties, and behaviour of various materials at both micro-and nanoscale levels.

Course Objectives:

1. To understand the basics of mechanical properties.
2. To get the in-depth knowledge about the scanning electron microscope
3. Application of XRD technique to determine crystal structure, lattice parameter, crystallite size, lattice strain, residual stress, and order-disorder transformation.
4. To understand the significance of corrosion principles.
5. Select the appropriate corrosion protection approach for engineering applications.
6. To understand the factors responsible for changes in the thermal properties of the materials.

Syllabus:

UNIT-I

Basics of Mechanical Properties: Definition and measurement of stress and strain; Types of stress: tensile, compressive, shear; Types of strain: axial, shear, volumetric; Stress-strain relationship and Hooke's Law; Plastic deformation: yield strength, slip, twinning, dislocation theory; Critical resolved shear stress (CRSS); Edge and screw dislocations and their properties; Work hardening and recovery; recrystallization and grain growth; Strengthening mechanisms: solid solution strengthening, precipitation strengthening, grain refinement; Hardness testing: concept and significance, types of hardness tests; Fatigue behaviour: fatigue failure, fatigue life prediction, fatigue crack initiation and propagation; Creep behaviour: time-dependent deformation at high temperatures, factors influencing creep behaviour.

UNIT-II

Scanning Electron Microscope: Introduction to SEM, Interaction between the electron beam and sample surface, Secondary, electron, backscattered electron, auger electron, X-ray. Principles of operation of SEM, advantages of SEM over light microscope, electron gun filament, energy dispersive X ray spectroscopy, applications of electron microscopy.

UNIT-III

X-Ray Diffraction Technique and its Applications: Properties of X-rays, absorption, Filters, Bragg's Law; Diffraction methods: Laue method, rotating crystal method, and powder method; Factors affecting intensities of diffracted beam; Determination of crystal structure, particle size, and lattice parameter; Qualitative and quantitative phase analysis; Analysis of residual stress/strain; Determination of phase diagram; Order-disorder transformation.

UNIT-IV

Corrosion: Principles of Electro-Chemistry, Electrode Potential, EMF Series, Galvanic series, Half-cell reaction, Nernst's equation, Free Energy, corrosion of metals & alloys in various environments, Pourbaix diagram of common metals, Electrolytes, Cost of Corrosion, potentiostatic polarization curves, Types of Corrosion-atmospheric corrosion, galvanic corrosion, Intergranular corrosion, crevice corrosion, pitting corrosion, dealloying corrosion, erosion corrosion, Corrosion prevention methods, and applications.

UNIT-V

Thermal analysis: Thermal events in materials, enthalpy changes, working principle, instrumentation and applications of differential thermal analysis (DTA), differential scanning calorimetry (DSC), thermogravimetry (TG), factors affecting the results of DTA/DSC/TG and their interpretations.

Text/Reference Books:

1. B. D. Cullity and S. R. Stock, Elements of X – Ray Diffraction, Prentice-Hall, New Jersy, 2001.
2. C. Suryanarayana and M. Grant Norton, X-ray Diffraction A Practical Approach, Springer
3. Corrosion Engineering, M. G. Fontana, McGraw-Hill Book Company, 3rd Edition.
4. Corrosion and Corrosion Control, H. H. Uhlig and R. W. Revie, Wiley (NY) (1985).

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Understand and describe the fundamental principles behind the methods of characterization.
CO-02	Analyze, interpret the different characterization methods.
CO-03	Assess which methods of characterization are appropriate for different material problems.

CO-04	Know principle of corrosion engineering and it's applications
CO-05	Know about various thermal analysis techniques

Program: M. Tech **Semester: II**
Name of the Course: Advances in Iron & Steel Making **Code: MME25-M-MMT109**
Credit: 3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:

The course provides fundamental knowledge about the history of Iron and steel making, the raw materials required for Iron & steel making process. Also, it gives knowledge about the construction and design of BF, LD converter, EAF, and Tundish along with various reactions inside these metallurgical reactors. Apart from these, this course will give information about the charge calculations & post-processing of various continuous casting products.

Course Objectives:

1. Students will become familiar with iron making and steel making.
2. To become conversant with charge calculations and other numerical in Iron & Steel Making.
3. To get the idea of producing Iron & Steel through different route.

Syllabus:

UNIT-I
Raw materials & its manufacturing process, blast furnace and its overview, chemical reactions at different parts of blast furnace, blast furnace gas cleaning systems, blast furnace products and its application, blast furnace irregularities

UNIT-II
Numericals: Dead-man cleanliness index, Calculation of Fe from FeO in slag, Density of BF top gas calculation, BF-Co volume calculation in top gas, BF top gas volume calculation, BF CO/THM calculation, BF exit gas calorific value, Depth of blast penetration calculation, BF fuel rate/THM calculation, Slag volume & its % calculation, calculation of % carbon burnt in front of tuyers, Calculation of BF oxygen enrichment, Hearth drainage rate calculation, BF minimum tapping open/day calculation, BF top gas velocity calculation, Exit gas volume calculation, BF permeability calculation, RAFT calculation.

UNIT-III
Alternate Routes of Iron Making: Various coal-based and gas-based DRI processes; Numericals: Filling degree calculation, calculation of refractory quantity required in rotary kiln, calculation of anchors required in kiln,

Calculation of angle of cone, Calculation of angle of rotary kiln, Theoretical calculation of sponge iron yield in iron ore, Calculation of O_2 remove in sponge iron, Carbon balance in DRI process, Fe(T) balance in DRI process, Calculation of coal required for DRI process, Iron ore required for DRI making, Calculate DRI kiln inlet, outlet C/Fe and carbon.

UNIT-IV

Introduction to Basic oxygen furnace and its design, Raw materials and various Reactions in LD converter, Modern trends in BOF Technology; Novel steel making technologies- EOF, CONARC. Steel making in Electric Arc Furnace- Raw materials for EAF process, design and construction futures of EAF process, Steel Making in Induction Furnace.

UNIT-V

Ladle Metallurgy-Deoxidation and desulphurization of liquid steel, degassing techniques; Clean steel-source of inclusions, types of inclusions, inclusion engineering. Tundish Metallurgy-Role of Tundish in the Continuous Casting Process, Details of Continuous casting process and its Products, Casting defects and its remedies.

Text/ References Books:

1. Iron Making and Steel Making Theory and Practice - Ahindra Ghosh, Amit Chatterjee.
2. Principles of Blast Furnace Ironmaking - A.K. Biswas.
3. A First Course in Iron and Steel Making - Dipak Mazumdar.
4. Basic Concepts of Iron and Steel Making – Sujay Kumar Dutta and Yakshil B. Chokshi

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Understand Raw material preparation and BF iron-making process
CO-02	Learn to perform BF by-products calculation
CO-03	Learn the various alternate routes of iron making and charge calculation
CO-04	Learn the various routes of Steel making process
CO-05	Learn the secondary steel making process and its products, defects.

Program: M. Tech
Name of the Course: Nanomaterials and Technology
Credit: 3
Max. Marks: 100

Semester: II
Code: MME25-M- MST111 (1)
No of Hours: 3 hours/week

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Course Description:
This course introduces the conceptual and analytical challenges for developing nano-materials and the respective scientific role.

Course Objectives:
This course aims to provide a comprehensive overview of nano-materials in terms of the synthesis, characterization, properties, and applications. It will cover the fundamental scientific principles for the different synthesis techniques, assembly of nano-structured materials and, new physical and chemical properties at the nano-scale. Existing and emerging applications will also be discussed through case studies.

Syllabus:

UNIT-I
Definition of Nano, Atomic Structure and atomic size, scale/dimensional aspects, properties of nano materials, carbon age-new form of carbon (CNT to Graphene), advantages and limitations at the nano level, Nano-Physics, health and environmental issues.

UNIT-II
Long range and short-range order forces, Van der Waal forces, solvation forces, electrostatic forces, hydrophobic forces, electric double layer forces, steric forces; Relevant theories, advantages and limitations.

UNIT-III
Top down and bottom-up approaches for preparing nano materials, Sol Gel processing, high energy ball milling, plasma assisted deposition, CVD, Langmuir-Blodgett (LB) films, Spin coating.

UNIT-IV
X-ray diffraction technique -Nano Particle size analyses, peaks of nano-particles, Electron Microscope and surface analysis techniques.

UNIT-V
Various applications of Nano Materials: Electronic Devices, Solar Cells, Drug delivery, coating.

Text/Reference Books:

1. T. Pradeep, Nano: The essentials, McGraw Hill.
2. M. Wilson, Nano Technology, Overseas Press.
3. C. P. Poole and J. F. Owens, Introduction to Nano Technology, Wiley.
4. G. Schmid, Nano Particles: from Theory to Applications, Wiley VCH Verlag GmBH and Co.

Course Outcomes:

CO	Material Science and Technology Post Graduates will be able to:
CO-01	Acquire the knowledge of theoretical prerequisites of nano-materials and related chemical and physical approaches.
CO-02	Understand the important properties, techniques, and applications of nano-materials.
CO-03	Apply the knowledge for future generations' product development and the ability to demonstrate continuous upgrading knowledge for technological upgradation.
CO-04	Know about various characterization techniques used in nano technology
CO-05	Know various applications of nano technology.

Program: M. Tech **Semester: II**
Name of the Course: Non-Destructive Evaluation **Code: MME25-M-MMT110(2)**
Credit: 3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:

This course provides an in-depth understanding of non-destructive evaluation (NDE) techniques used in materials testing, quality control, failure analysis, and in-service inspection. It covers the fundamental principles, equipment, standards, and practical applications of key NDE methods such as radiographic testing, ultrasonic testing, magnetic particle testing, eddy current testing, acoustic emission, thermography, and advanced techniques including digital radiography and phased array ultrasonics. Emphasis is laid on the selection of appropriate techniques based on materials and defect types, interpretation of results, and understanding of codes and standards.

Course Objectives:

1. To understand the principles and physics behind various NDE techniques.
2. To familiarize students with the applications, advantages, and limitations of NDE methods.
3. To develop competency in selecting suitable NDE techniques for different engineering materials and components.
4. To interpret NDE data and results for defect characterization and life assessment.
5. To understand national and international standards and certifications related to NDE.

Syllabus:

UNIT-I

Definition, historical development, and scope of NDE, Importance and need for NDE in design, manufacturing, and service life assessment, Comparison between destructive and non-destructive testing methods, Classification of NDE methods, Overview of commonly used NDE techniques, Standards, codes, and certification.

UNIT-II

Fundamentals of visual testing, Direct and indirect visual inspection techniques, Tools used, lighting requirements and inspection environments, Defect types detectable and limitations of visual inspection, Principles of capillary action and surface-breaking defects, Types of penetrants, Process steps, Types of developers and their applications, Applications and limitations of LPT.

UNIT-III
Magnetic principles, Magnetization techniques, Types of magnetic particles, Demagnetization, Indication types and interpretation, Defects detectable, Safety considerations, advantages, and limitations of MPT.

UNIT-IV
Wave types in solids, Ultrasonic transducers, UT techniques, Calibration blocks, Phased Array Ultrasonic Testing (PAUT), Time-of-Flight Diffraction (TOFD) Applications in weld inspection, castings, forgings, and composites.

UNIT-V
Radiation sources, Interaction of radiation with matter, Radiographic films, Digital radiography, Advantages, limitations, and applications of radiographic methods.

Text Books:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, Narosa Publishing House.
2. Peter J. Shull, Nondestructive Evaluation: Theory, Techniques, and Applications, CRC Press.

Reference Books:

1. Don E. Bray, R. K. Stanley, Nondestructive Evaluation: A Tool in Design, Manufacturing and Service, CRC Press.
2. Paul E. Mix, Introduction to Nondestructive Testing: A Training Guide, Wiley.
3. ASNT Handbooks (Vol. I–VII), American Society for Nondestructive Testing.
4. Relevant ASTM & ISO standards for NDT methods (e.g., ASTM E165, E1444, E213, E273).

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Describe the principles of various NDE methods and select suitable techniques based on material type and application requirements.
CO-02	Analyze and interpret results from Visual Inspection and Liquid Penetrant Testing to detect surface flaws and discontinuities.
CO-03	Assess the applicability, advantages, and limitations of Magnetic Particle Testing for inspecting different materials and weldments.
CO-04	Apply Ultrasonic Testing techniques for internal defect detection and material evaluation.
CO-05	Interpret radiographic test images and utilize radiographic testing knowledge for defect detection in industrial applications.

Program: M. Tech **Semester: II**
Name of the Course: Materials for Bio-implants **Code: MME25-M-MMT110(3)**
Credit: 3 **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:
The Materials for Bio-implants course provide an in-depth exploration of the various materials used in the development and application of bio-implants. This course gives comprehensive knowledge of different types of biomaterials, including metals, ceramics, polymers, and composites, and their specific roles in bio-implant applications.

Course Objectives:

1. Understand common use of biomaterials as metals, ceramics and polymers and its chemical structure, properties, and morphology.
2. Understand the methods for categorization of biomaterials.
3. Properties, behaviour and applications of bioimplants materials for different applications.

Syllabus:

UNIT-I
Introduction to basic concepts of biomaterials, property requirement of biomaterials; Concept of biocompatibility. Types of biomaterials: Metallic, ceramic, polymeric and composite biomaterials. Classification according to physiological response of biomaterials: bioinert, bioactive and bioresorbable biomaterials.

UNIT-II
Structure and properties of biological cells & tissues. Cell-material interactions and foreign body response. Assessment of biocompatibility of biomaterials. In vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation using ALP assay; Biomnuneralisation using Osteocalcin assay) In vivo testing and histocompatibility assessment.

UNIT-III
Important biometallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys, Bioinert, Bioactive and bioresorbable ceramics. Processing and properties of different bioceramic materials with emphasize on hydroxyapatite.

UNIT-IV
Nanostructured biomaterials, criteria for selection of biomaterials for specific medical applications, concepts of biocompatibility, evaluation of biocompatibility, mechanical properties of biomaterials, corrosion and

biodegradation, simulated body fluids and their effect on biodegradation. Orthopaedic implants, dental materials, vascular grafts, ocular materials, drug delivery carriers, introduction to tissue regeneration scaffolds.

UNIT-V

Synthesis of biocompatible coatings on structural implant materials; plasma spraying of carbon nanotube reinforced hydroxyapatite on Ti-6Al-4V substrate; Microstructure and properties of glass-ceramics; biodegradable polymers; Design concept of developing new materials for bio-implant applications.

Text/Refereance Books:

1. Biomaterials Science: An introduction to Materials in Medicine, Edited by Ratner, Hoffman, Schoet and Lemons, Second Edition: Elsevier Academic Press, 2004.
2. Comprehensive structural interity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, Elsevier Academic Press, 2003.
3. T.S. Hin (Ed.) Engineering Materials for Biomedical Applications. World Scientific. 2004. ISBN 981-256-061-0

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Understand structure properties relationship of biomaterials.
CO-02	Understand synthesis routes of biomaterials for a particular application.
CO-03	Analyse the properties and behaviour of biomaterials for implants applications.
CO-04	Understand biocompatibility of the materials for the intended application.
CO-05	Know about various coatings used in biomaterials

Program: M. Tech
Name of the Course: Composite Materials
Credit: 3
Max. Marks: 100

Semester: II
Code: MME25-M-MMT110(4)
No of Hours: 3 hours/week

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Course Description:

Composites are widely used in modern engineering applications. This course will provide fundamental knowledge of constituents of various composites and their structures-properties relationship commonly used in manufacturing process. This course will help student the concepts better, and gain deeper insights to composites.

Course Objectives:

1. Basics of composite materials.
2. Manufacturing of composite materials.
3. Effect of different parameters on properties of composite materials.
4. Properties and performance study through mechanical analysis.

Syllabus:

UNIT-I
Introduction: definitions, composites, reinforcements and matrices, types of reinforcements, types of matrices, types of composites, carbon fibre composites, properties of composites in comparison with standard materials. Limitations and advantages of composites, rule of mixture, applications of metal, ceramic and polymer matrix composites.

UNIT-II
Fabrication of composites, Metal Matrix Composites: Processing: Liquid state processes, solid state processes and in situ processes. Polymer Matrix Composites Processing: Hand lay-up and spray technique, filament winding, pultrusion, resin transfer moulding, bag and injection moulding, sheet moulding compound. Ceramic Matrix Composites Processing: Cold pressing & sintering, hot pressing reaction bonding processes, infiltration, in-situ chemical reaction, Sol-Gel and polymer pyrolysis, self-propagating high temperature synthesis. Carbon- carbon composites and Interfaces.

UNIT-III
Transverse modulus, stress-strain diagram of composites, concept of discontinuous and aligned fiber composites, related numerical, mechanical behavior of composites materials related numerical, application of composites.

UNIT-IV

Types of Laminates, Symmetric Laminates, Antisymmetric Laminate, Balanced Laminate, concept of particulate reinforced composites, fiber reinforced composites, polymer matrix composites, ceramic matrix composites and metal matrix composites, strengthening mechanism.

UNIT-V

Joining Methods and Failure Theories: Advantages and disadvantages, Mechanical behavior of composites materials related numerical, application of Composites, nano- composites materials.

Text Books:

1. K.K. Chawla, Composite Materials, Science & Engineering, Springer-Verlag
2. F.L. Matthews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman & Hall.
3. Martin Baeker, Mechanical Behavior of Engineering Materials: Metals, Ceramics, Polymers, and Composites.

Reference Books:

1. Navin Chand, Tribology of Natural fiber Composites, Wood Head Publishing Limited
2. I. M Daniel and O. Ishai, Engineering Mechanics of Composite Materials, Oxford University Press India

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Gain fundamental knowledge of composite materials.
CO-02	Apply the theory to practical problems.
CO-03	Implement the concept for practical aspects.
CO-04	Know about various metal matrix composites.
CO-05	Know about different methods of joining of composites.

Program: M. Tech **Semester: II**
Name of the Course: Artificial Intelligence in Material Industries
Code: MME25-M-MMT110(5) **Credit: 3**
Max. Marks: 100 **No of Hours: 3 hours/week**

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Course Description:

The Artificial Intelligence in Material Industries course focuses on integrating advanced AI techniques with materials science to enhance manufacturing processes and product quality.

Course Objectives:

1. Gain a foundational understanding of artificial intelligence concepts, including machine learning, deep learning, and data analytics for material industries.
2. Apply AI methodologies to solve complex problems in materials discovery, design, and optimization.
3. Implement AI and ML driven tools for predictive maintenance and fault detection in materials manufacturing routes and their equipment.

Syllabus:

UNIT-I

Introduction to Modelling and simulation; Mathematical and Physical models: Advantages and Limitations; Data-driven model; Predictive model based on statistics: Advantages and Limitations; Data-driven model based on concepts of artificial intelligence; Modelling applications in metallurgical and materials engineering.

UNIT-II

Artificial Intelligence; Machine Learning: Supervised and Unsupervised Machine Learning; Supervised Machine Learning: Artificial Neural Network, Deep Learning; Unsupervised Machine Learning: Clustering analysis; Theory of Pareto-optimality; Modelling at different length and time scales.

UNIT-III

Iron making: Blast furnace and alternate routes; Blast furnace iron making: Mathematical Modelling and Data-driven modelling; Application of AI-algorithm in blast furnace and alternate routes.

UNIT-IV

Steel making: Electric arc furnace (EAF), LD/BOF, Induction furnace; Steel Refining: Ladle furnace; Heat and mass balance; Application of AI-algorithm in EAF, LD/BOF, Induction furnace.

UNIT-V

Casting of steel: Ingot and Continuous casting route; Rolling mill: Plate and Coils; Mathematical and Data driven model for estimation of rolling force and torque; Introduction/overview of Industry 4.0, Internet of Things (IoT).

Text/Referance Books:

1. Datta, S. (2016). Materials Design Using Computational Intelligence Techniques (1st ed.). CRC Press. https://doi.org/10.1201/9781315373003
2. Chen, Y., Wang, T., Zhang, G.: Artificial Intelligence for Materials Science. Springer International Publishing, Cham (2021).
3. Tayal, S., Singla, P., Nandi, A., & Davim, J.P. (Eds.). (2021). Computational Technologies in Materials Science (1st ed.). CRC Press. https://doi.org/10.1201/9781003121954
4. Pal, S. et al. Process Modeling for Steel Industry April 2018 Edition: Publisher: I.K. International Publishing House ISBN: 9789385 909399
5. Jha, R., & Jha, B.K. (2022). Artificial Intelligence-Aided Materials Design: AI-Algorithms and Case Studies on Alloys and Metallurgical Processes (1st ed.). CRC Press. https://doi.org/10.1201/9781003167372

Course Outcomes:

CO	**Metallurgy and Material Technology Post Graduates will be able to:**
CO-01	Develop a deep understanding of artificial intelligence algorithms.
CO-02	Learn application of AI-algorithms from industrial point of view.
CO-03	Employability opportunity will be significantly improved.
CO-04	Will learn to frame and solve industrial problems through AI- based algorithms.
CO-05	Enhanced commitment towards environment and responsibility to the society.

Program: M. Tech **Semester: II**
Name of the Course: Metal Casting Laboratory **Code: MME25-M-MMT111**
Credit: 2 **No of Hours: 4 hours/week**
Max. Marks: 50

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Course Description:

This course aims to provide students with a comprehensive understanding of the principles, processes, and practices involved in metal melting and casting. The various foundry methods, theories and parameters and the new insights in metal casting will be discussed in detail.

Course Objectives:

1. To understand the basic principles of melting and casting processes, including the transformation of solid metals into liquid forms.
2. Familiarize with different melting practices for casting of ferrous and non-ferrous alloys.
3. Analyze the design considerations for molds and cores to optimize the casting process.
4. Knowledge about the different casting methods.

List of Experiments:

1. To find the grain fineness number of the silica sand.
2. To test the permeability of the silica sand.
3. To test the moisture content in the silica sand.
4. To find the hardness of the silica sand mold.
5. To find the dry compressive strength and dry shear strength of the silica sand mold.
6. To design the silica sand mold for the casting process.
7. To melt the aluminum/ copper or medium carbon steel in an induction furnace and cast it in a silica sand mold.
8. To melt the aluminum/ copper or medium carbon steel in an induction furnace and cast it in a permanent mold.
9. To compare the mechanical properties of the aluminum/ copper or medium carbon steel cast in silica sand mold and permanent mold.
10. To observe the casting defects, and identify their causes occurred in aluminum/ copper or medium carbon steel.

Equipment Required:

1. Casting sand
2. Wooden pattern
3. Induction furnace
4. Aluminum and medium carbon steel
5. Permeability tester

6. Rapid moisture meter
7. Sieve shaker.

Text/Reference Books:

1. Principles of Foundry Technology- P L Jain, Tata McGraw-Hill, New Delhi.

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Have knowledge of moulding sand.
CO-02	Hands on Experience on different foundry equipment, their use and different type casting processes.
CO-03	Know about various casting defects

Program: M. Tech **Semester: II**
Name of the Course: Material Characterization Lab
Code: MME25-M-MST106
Credit: 2
No of Hours: 4 hours/week **Max. Marks: 50**

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Course Description

This lab course introduces students to essential techniques for analyzing the structure, composition, and properties of materials. Experiments may include X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and hardness testing. The course emphasizes hands-on experience, data interpretation, and understanding the relationship between material structure and performance.

Course Objectives:

1. Fully qualified as entry-level materials engineers, with an ability to adapt and progress in a rapidly changing field.
2. Well-rounded individuals who both understand the principles and can undertake the practice of the engineering materials.
3. Able to operate as effective engineers or scientists in materials industries, academia, or related fields with respect to advanced level equipment.
4. Able to an understanding of both theoretical as well as experimental aspects of corrosion principles through advanced techniques.

List of Experiments:

1. To determine the impact strength of materials by Izod and Charpy Impact test.
2. To determine the hardness of materials by Vickers and Rockwell Test.
3. Electrochemical impedance, cyclic potentiodynamic polarization and polarization resistance test of metallic specimen in seawater.
4. Corrosion rate measurement by immersion test.
5. To determine the internal surface defects by Ultrasonic Test.
6. Obtain x-ray scattering patterns for all materials and perform peak fitting.
7. To determine percent crystallinity and crystallite size.
8. To study the constructional arrangement of SEM.
9. To study the constructional arrangement of DTA, TGA and DSC.
10. To calculate thermal expansion and volume changes associated with phase transformations, using a dilatometer.

Equipment required

1. Image analyzer.
2. Electron microscope like SEM.
3. XRD Machine.

4. Vicker's Hardness Machine
5. Rockwell Hardness Machine
6. Potentiometer

Reference Books:

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

Course Outcomes:

CO	Metallurgy and Material Technology Post Graduates will be able to:
CO-01	Acquire knowledge on the basic principles of functioning of the advanced equipment.
CO-02	Perform experiments and identify the Material Characteristics.
CO-03	Select and redesign the problem related to corrosion and protection practices.

OPJU

Dr Makkuva Kalyan Phani <kalyan.makkuva@opju.ac.in>

Board of Studies - BOS Meeting Invitation Department of Metallurgical Engineering, O.P. Jindal University

4 messages

Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 7:01 PM
To: manoj.chopkar@gmail.com, mchopkar.mme@nitrr.ac.in

Dear Sir,

Greetings from O.P. Jindal University!!

You are cordially invited to attend the Board of Studies (BOS) meeting of the Department of Metallurgical Engineering, scheduled as follows:

Topic: BOS meeting of Metallurgical Engineering
🗓 **Date:** April 25, 2025
⏰ **Time:** 03:00 PM IST
📍 **Mode:** Online (Zoom)

Join Zoom Meeting
https://us06web.zoom.us/j/83339140068?pwd=vv5NGDzWUVjNFvE1bwbMQnIBr7eVu8.1

Meeting ID: 833 3914 0068
Passcode: 428255

Your presence and valuable inputs will be highly appreciated as we deliberate on key academic matters and curriculum advancements in the field of Metallurgical Engineering. I will be sending you the presentation along with Scheme and Syllabus shortly for your kind perusal.

Looking forward to your participation.

Thanks,

With Regards,
Kalyan Phani

Dr. M. Kalyan Phani
Head - Metallurgical and Mining Engineering
Director - R&D Cell II IQAC
O. P. Jindal University
Raigarh - 496 109, Chhattisgarh, India

Email: kalyan.makkuva@opju.ac.in
Mobile: +91 9445884028
Website: www.opju.ac.in

Professional Memberships: LM-IIM | LM-EMSI | LM-PMAI | LM-CAERD | PM-IEEE

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Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 10:37 PM
To: manoj.chopkar@gmail.com, mchopkar.mme@nitrr.ac.in

Dear Sir,

Please find attached the BOS presentation scheduled for discussion tomorrow. Submitted for your kind perusal and feedback.

Thanks,

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BOS-Metallurgical-OPJU.pdf
1449K

Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Fri, May 16, 2025 at 10:39 PM
To: manoj.chopkar@gmail.com, mchopkar.mme@nitrr.ac.in

Dear Sir,

Please find attached the Minutes of the Meeting (MoM) of the Board of Studies, along with the revised teaching scheme and syllabus, updated in line with your suggestions.

Kindly review the documents and provide your approval at your earliest convenience.

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2 attachments

Dip-B.Tech-M.Tech Teaching Scheme - 2025-26.pdf
4252K

MoM Meta - BOS-16052025.pdf
566K

Dr. Manoj Chopkar, Metallurgical & Materials Engg, NIT Raipur <mchopkar.mme@nitrr.ac.in> Thu, May 22, 2025 at 3:00 PM
To: "Dr. M. Kalyan Phani" <kalyan.makkuva@opju.ac.in>

Dear Sir
It ok from my side. Plz proceed with this.

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Dr Makkuva Kalyan Phani <kalyan.makkuva@opju.ac.in>

Board of Studies - BOS Meeting Invitation Department of Metallurgical Engineering, O.P. Jindal University

4 messages

Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 7:03 PM
To: hod-mm@nitrkl.ac.in
Cc: chaira.debasis@gmail.com

Dear Sir,

Greetings from O.P. Jindal University!!

You are cordially invited to attend the Board of Studies (BOS) meeting of the Department of Metallurgical Engineering, scheduled as follows:

Topic: BOS meeting of Metallurgical Engineering
Date: April 25, 2025
Time: 03:00 PM IST
Mode: Online (Zoom)

Join Zoom Meeting
https://us06web.zoom.us/j/83339140068?pwd=vv5NGDzWUVjNFvE1bwbMQnIBr7eVu8.1

Meeting ID: 833 3914 0068
Passcode: 428255

Your presence and valuable inputs will be highly appreciated as we deliberate on key academic matters and curriculum advancements in the field of Metallurgical Engineering. I will be sending you the presentation along with Scheme and Syllabus shortly for your kind perusal.

Looking forward to your participation.

Thanks,

With Regards,
Kalyan Phani

Dr. M. Kalyan Phani
Head - Metallurgical and Mining Engineering
Director - R&D Cell ll IQAC
O. P. Jindal University
Raigarh - 496 109, Chhattisgarh, India

Email: kalyan.makkuva@opju.ac.in
Mobile: +91 9445884028
Website: www.opju.ac.in

Professional Memberships: LM-IIM | LM-EMSI | LM-PMAI | LM-CAERD | PM-IEEE

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Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 10:36 PM
To: hod-mm@nitrkl.ac.in
Cc: chaira.debasis@gmail.com

Dear Sir,

Please find attached the BOS presentation scheduled for discussion tomorrow. Submitted for your kind perusal and feedback.
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BOS-Metallurgical-OPJU.pdf
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Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Fri, May 16, 2025 at 10:38 PM
To: hod-mm@nitrkl.ac.in
Cc: chaira.debasis@gmail.com

Dear Sir,

Please find attached the Minutes of the Meeting (MoM) of the Board of Studies, along with the revised teaching scheme and syllabus, updated in line with your suggestions.

Kindly review the documents and provide your approval at your earliest convenience.

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2 attachments

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566K

Dip-B.Tech-M.Tech Teaching Scheme - 2025-26.pdf
4252K

HOD MM, Head of Dept. - MM <hod-mm@nitrkl.ac.in> Sat, May 17, 2025 at 9:50 AM
To: "Dr. M. Kalyan Phani" <kalyan.makkuva@opju.ac.in>
Cc: chaira debasis <chaira.debasis@gmail.com>

Dear Prof. Kalyan Phani,

I have reviewed the Minutes of the Meeting (MoM) of the Board of Studies, the revised teaching scheme, syllabus and approved the same.

Thanks and regards
Debasis Chaira

������***
Prof. D. Chaira
Head, Department of Metallurgical and Materials Engineering
National Institute of Technology Rourkela
Rourkela - 769 008, Odisha, India
Phone: +91 661 246 2551
https://website.nitrkl.ac.in/MM/

From: "Dr. M. Kalyan Phani" <kalyan.makkuva@opju.ac.in>
To: "hod-mm" <hod-mm@nitrkl.ac.in>
Cc: "chaira debasis" <chaira.debasis@gmail.com>
Sent: Friday, 16 May, 2025 22:38:12
Subject: Re: Board of Studies - BOS Meeting Invitation Department of Metallurgical Engineering, O.P. Jindal University

OPJU

Dr Makkuva Kalyan Phani <kalyan.makkuva@opju.ac.in>

Board of Studies - BOS Meeting Invitation Department of Metallurgical Engineering, O.P. Jindal University

4 messages

Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 6:58 PM
To: "Director, SMM" <director.smm@knu.ac.in>

Dear Sir,

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Meeting ID: 833 3914 0068
Passcode: 428255

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With Regards,
Kalyan Phani

Dr. M. Kalyan Phani
Head – Metallurgical and Mining Engineering
Director – R&D Cell II IQAC
O. P. Jindal University
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Email: kalyan.makkuva@opju.ac.in
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Professional Memberships: LM-IIM | LM-EMSI | LM-PMAI | LM-CAERD | PM-IEEE

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Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 10:37 PM
To: "Director, SMM" <director.smm@knu.ac.in>

Dear Sir,

Please find attached the BOS presentation scheduled for discussion tomorrow. Submitted for your kind perusal and feedback.

Thanks,

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BOS-Metallurgical-OPJU.pdf
1449K

Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Fri, May 16, 2025 at 10:37 PM
To: "Director, SMM" <director.smm@knu.ac.in>

Dear Sir,

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Kindly review the documents and provide your approval at your earliest convenience.

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2 attachments

Dip-B.Tech-M.Tech Teaching Scheme - 2025-26.pdf
4252K

MoM Meta - BOS-16052025.pdf
566K

Director, SMM <director.smm@knu.ac.in> Fri, May 16, 2025 at 10:43 PM
To: "Dr. M. Kalyan Phani" <kalyan.makkuva@opju.ac.in>

Approved from my side. Please go ahead.

Dr. Arghya Majumder
Director
School of Mines & Metallurgy
Kazi Nazrul University, Asansol
Hello:9440977597,7893024057

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[Quoted text hidden]

OPJU

Dr Makkuva Kalyan Phani <kalyan.makkuva@opju.ac.in>

Board of Studies - BOS Meeting Invitation Department of Metallurgical Engineering, O.P. Jindal University

5 messages

Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 6:59 PM
To: Sharad Srivastava <sharad.srivastava@nalwa.com>

Dear Sir,

Greetings from O.P. Jindal University!!

You are cordially invited to attend the Board of Studies (BOS) meeting of the Department of Metallurgical Engineering, scheduled as follows:

Topic: BOS meeting of Metallurgical Engineering
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⏰ **Time:** 03:00 PM IST
📍 **Mode:** Online (Zoom)

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Looking forward to your participation.

Thanks,

With Regards,
Kalyan Phani

Dr. M. Kalyan Phani
Head - Metallurgical and Mining Engineering
Director - R&D Cell II IQAC
O. P. Jindal University
Raigarh - 496 109, Chhattisgarh, India

📧 **Email:** kalyan.makkuva@opju.ac.in
📞 **Mobile:** +91 9445884028
🌐 **Website:** www.opju.ac.in

Professional Memberships: LM-IIM | LM-EMSI | LM-PMAI | LM-CAERD | PM-IEEE

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Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Thu, Apr 24, 2025 at 10:37 PM
To: Sharad Srivastava <sharad.srivastava@nalwa.com>

Dear Sir,

Please find attached the BOS presentation scheduled for discussion tomorrow. Submitted for your kind perusal and feedback.

Thanks,

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BOS-Metallurgical-OPJU.pdf
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Dr. M. Kalyan Phani <kalyan.makkuva@opju.ac.in> Fri, May 16, 2025 at 10:39 PM
To: Sharad Srivastava <sharad.srivastava@nalwa.com>

Dear Sir,

Please find attached the Minutes of the Meeting (MoM) of the Board of Studies, along with the revised teaching scheme and syllabus, updated in line with your suggestions.

Kindly review the documents and provide your approval at your earliest convenience.

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2 attachments

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4252K

MoM Meta - BOS-16052025.pdf
566K

Sharad Srivastava <sharad.srivastava@nalwa.com> Sat, May 17, 2025 at 11:09 AM
To: "Dr. M. Kalyan Phani" <kalyan.makkuva@opju.ac.in>

Please specify page no on which I have to sign

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