TEACHING SCHEME
OF
B.TECH. IN
METALLURGICAL AND MATERIALS ENGINEERING

(1st – 8th SEMESTER)

UNIVERSITY OF STEEL TECHNOLOGY
AND MANAGEMENT

DEPARTMENT OF METALLURICAL ENGINEERING
SCHOOL OF ENGINEERING,
OP JINDAL UNIVERSITY
RAIGARH, CHHATTISGARH

2023-2027

Academic Semester I and II

PROGRAM OUTCOMES

PO-1: Knowledge and Problem Solving: Acquire in-depth scientific knowledge of their discipline both in theory and practical, demonstrate basic skills, investigate, apply, and solve the problems in a variety of contexts related to science and technology.

PO-2: 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-3: 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 valid conclusion with clear understanding of limitations.

PO-4: Logical Thinking: Develop logical thinking and expertise with precision, analytical mind, innovative thinking, clarity of thought, and systematic approach for proving or disproving the facts after mathematical formulation. with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach

PO-5: Skill Development and Employability: Develop elementary computing and soft skills to prepare students for industry, entrepreneurship and higher education with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

PO-6: Ethics and Citizenship: Able to recognize different value systems and ethical principles; and commit to professional ethics, norms, and responsibilities of the science practice and act with informed awareness to participate in civic life activities.

PO-7: 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.

PO-8: 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.

ACADEMIC SEMESTER III to VIII
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 GRADUATES:

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 OUTCOMES (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 analyse 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 II

S. No.	Subject Code	SUBJECT	Periods per Week			Credit L+(T+P) /2
			L	T	P	
1	SOE-B-MATH-23-201	Engineering Mathematics- II	3	0	0	3
2	SOE-B-MME-23-201	Engineering Chemistry	3	0	0	3
3	SOE-B-MME-23-202	Introduction to Material Science	4	0	0	4
4	SOE-B-MME-23-203	Introduction to Computational Material Science	3	0	0	3
5	SOE-B-MME-23-204	Indian Knowledge System (Ancient Metallurgy)	3	0	0	3
6	SOE-B-MME-23-205	Workshop Practice	0	0	4	2
7	SOE-B-MME-23-206	Engineering Chemistry Lab	0	0	2	1
8	SOE-B-MME-23-207	Introduction to Computational Material Science Lab	0	0	2	1
TOTAL			**16**	**0**	**8**	**20**

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Academic Semester III

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-B-MME301	MME	Introduction to Physical Metallurgy	3	2	0	30	20	50	100	4
2	SOE-B-MME302	MME	Mineral Dressing	3	0	0	30	20	50	100	3
3	SOE-B-MME303	MME	Metallurgical Thermodynamics and Kinetics	3	2	0	30	20	50	100	4
4	SOE-B-MME304	MME	Mathematical Analysis in Metallurgical Processes	4	0	0	30	20	50	100	4
5	SOE-B-MME305	MME	Physical Metallurgy Lab	0	0	4	0	30	20	50	2
6	SOE-B-MME306	MME	Mineral Dressing Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME307	MME	Materials Science Lab	0	0	4	0	30	20	50	2
TOTAL				**13**	**4**	**12**	**120**	**170**	**260**	**550**	**21**

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.	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-B-MME401	MME	Iron Making	3	0	0	30	20	50	100	3
2	SOE-B-MME402	MME	Fuels, Furnaces and Refractories	3	0	0	30	20	50	100	3
3	SOE-B-MME403	MME	Deformation Behaviour & Testing of Materials	3	2	0	30	20	50	100	4
4	SOE-B-MME404	MME	Composite Materials	3	0	0	30	20	50	100	3
5	SOE-B-MME405	MME	Heat Treatment of Materials	3	0	0	30	20	50	100	3
6	SOE-B-MME406	MME	Fuels, Furnaces and Refractories Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME407	MME	Deformation Behaviour & Testing of Materials Lab	0	0	4	0	30	20	50	2
8	SOE-B-MME408	MME	Heat Treatment of Materials Lab	0	0	4	0	30	20	50	2
9			NPTEL (Transferred Course)	0	0	0	0	0	0	0	0
TOTAL				**15**	**2**	**12**	**150**	**190**	**310**	**650**	**22**

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

* End Semester Examination
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Academic Semester V

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-B-MME501	MME	Melting and Casting Technology	3	2	0	30	20	50	100	4
2	SOE-B-MME502	MME	Steel Making	3	2	0	30	20	50	100	4
3	SOE-B-MME503	MME	Principles of Extractive Metallurgy	3	2	0	30	20	50	100	4
4	SOE-B-MME504	MME	Phase Transformation	3	0	0	30	20	50	100	3
5	SOE-B-MME505	MME	Melting and Casting Technology Lab	0	0	4	0	30	20	50	2
6	SOE-B-MME506	MME	Process Metallurgy Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME507	MME	Industrial Training and Seminar	0	0	2	0	25	25	50	1
TOTAL				**12**	**6**	**10**	**120**	**165**	**265**	**550**	**20**

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

* End Semester Examination

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Academic Semester VI

S. No.	Subject Code	Board of Study	SUBJECT	Periods per week			Scheme of Examination and Marks				Credit L+(T+P)/ 2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1	SOE-B-MME601	MME	Metal Forming Processes	3	0	0	30	20	50	100	3
2	SOE-B-MME602	MME	Materials Characterization	3	0	0	30	20	50	100	3
3	SOE-B-MME603	MME	Transport Phenomena in Metallurgical Processes	3	0	0	30	20	50	100	3
4	SOE-B-MME604	MME	Metal Joining Processes	3	0	0	30	20	50	100	3
5	SOE-B-MME605	MME	**Professional Elective-I (MME Annexure-I)**	3	0	0	30	20	50	100	3
6	SOE-B-MME606	MME	Materials Characterization Lab	0	0	4	0	30	20	50	2
7	SOE-B-MME607	MME	Welding Metallurgy Lab	0	0	4	0	30	20	50	2
8	SOE-B-MME608	MME	Transport Phenomena in Metallurgical Processes Lab	0	0	4	0	30	20	50	2
9	SOE-B-MME609	MME	Professional Development	0	0	2	0	25	25	50	1
10	SOE-B-MME610	MME	NPTEL (Transferred Course)	0	0	0	0	0	0	0	0
TOTAL				**15**	**0**	**14**	**150**	**215**	**335**	**700**	**22**

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

* End Semester Examination
** Progress Review Examination

Professional Elective-I (MME Annexure-I)

S. No	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

Scheme of Teaching and Examination
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Academic Semester VII

S. No.	Subject Code	Board of Study	Subjects	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-B-MME701	MME	Long Term Internship	0	0	44	0	250	250	500	22
TOTAL				**0**	**0**	**44**	**0**	**250**	**250**	**500**	**22**

OR

S. No.	Subject Code	Board of Study	Subjects	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-B-MME801	MME	Alloys their Properties and Selection	4	0	0	30	20	50	100	4
2	SOE-B-MME802	MME	Corrosion Engineering	4	0	0	30	20	50	100	4
3	SOE-B-MME-OPE803 (1-39)	MME	**Open Elective – I (OE Annexure – I)**	3	0	0	30	20	50	100	3
4	SOE-B-MME804 (1-4)	MME	**Professional Elective-II (MME Annexure-II)**	3	0	0	30	20	50	100	3
5	SOE-B-MME805	MME	Corrosion Engineering Lab.	0	0	4	0	30	20	50	2
TOTAL				**14**	**0**	**4**	**120**	**110**	**220**	**450**	**16**

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

* End Semester Examination
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Option A: The Student who has not opted for an Internship in the 7th Semester will have to choose Subjects in the 8th semester.

Option B: The Student who opted for Subjects in the 7th semester will have to opt internship in the 8th semester.

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Open Elective-I (OE Annexure - I)

S. No	Subject Code	Board of Study	Name of the Courses
1	OPE4201	CIE	Disaster Management
2	OPE4202	CIE	Construction Management
3	OPE4203	CIE	Ecology and Sustainable Development
4	OPE4204	CSE	Bio Informatics
5	OPE4205	CSE	Software Technology
6	OPE4206	CSE	Internet & Web Technology
7	OPE4207	CSE	Business Analysis and Optimization
8	OPE4208	CSE	IT Industry Management
9	OPE4209	CSE	IT Industry Entrepreneurship
10	OPE4210	CSE	Evolutionary Computations
11	OPE4211	CSE	E-Commerce & Strategic IT
12	OPE4212	CSE	Decision Support & Executive Information
13	OPE4213	CSE	Information Theory & Control
14	OPE4214	EEE	Distributed Generation
15	OPE4215	EEE	Non-Conventional Energy Sources
16	OPE4216	EEE	Energy Auditing and Management
17	OPE4217	HSS	Innovation, Entrepreneurship and Leadership
18	OPE4218	HSS	Technology Management
19	OPE4219	HSS	Knowledge Entrepreneurship
20	OPE4220	HSS	Finance Management
21	OPE4221	HSS	Project Planning, Management & Evaluation
22	OPE4222	HSS	Intellectual Property Rights
23	OPE4223	HSS	Engineering Economics
24	OPE4224	HSS	Human Relations Management
25	OPE4225	HSS	Entrepreneurship Development
26	OPE4226	HSS	Personnel Management and Industrial Engineering
27	OPE4227	MEE	Safety Engineering
28	OPE4228	MEE	Value Engineering
29	OPE4229	MEE	Energy Conservation & Management
30	OPE4230	MEE	Thermal Treatment of Metal and alloys
31	OPE4231	MEE	Simulation of Physical Processes
32	OPE4232	MEE	TQM and Reliability Engineering
33	OPE4233	MEE	Non Traditional Machining Techniques
34	OPE4234	MME	Nanotechnology
35	OPE4235	MME	Introduction to Nano-Technology applications
36	OPE4236	MME	Material Characterization
37	OPE4237	MME	Materials Management
38	OPE4238	MME	Manufacturing Strategies
39	OPE803	MME	Entrepreneurship Development

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

Professional Elective-II (MME Annexure - II)

S. No.	Subject Code	Board of Study	Subjects	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-B-MME804 (1)	MME	Introduction to Stainless Steel	3	0	0	30	20	50	100	3
2.	SOE-B-MME804 (2)	MME	Introduction to Nano-Science and Nano-Technology	3	0	0	30	20	50	100	3
3.	SOE-B-MME804 (3)	MME	Ceramic and Powder Metallurgy	3	0	0	30	20	50	100	3
4.	SOE-B-MME804 (4)	MME	Lightweight Materials	3	0	0	30	20	50	100	3

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

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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)/ 2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1	SOE-B-MME801	MME	Alloys their Properties and Selection	4	0	0	30	20	50	100	4
2	SOE-B-MME802	MME	Corrosion Engineering	4	0	0	30	20	50	100	4
3	SOE-B-MME-OPE-803 (1-39)	MME	Open Elective – I **(OE Annexure – I)**	3	0	0	30	20	50	100	3
4	SOE-B-MME804 (1-4)	MME	Professional Elective-II **(MME Annexure-II)**	3	0	0	30	20	50	100	3
5	SOE-B-MME805	MME	Corrosion Engineering Lab	0	0	4	0	30	20	50	2
6	SOE-B-MME806	MME	Major Project	0	0	16	0	50	50	100	8
TOTAL				**14**	**0**	**20**	**120**	**160**	**270**	**550**	**24**

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

* End Semester Examination
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OPEN Elective-I (OE Annexure - I)

S. No	Subject code	Board of Study	Name of the Courses
1	OPE4201	CIE	Disaster Management
2	OPE4202	CIE	Construction Management
3	OPE4203	CIE	Ecology and Sustainable Development
4	OPE4204	CSE	Bio Informatics
5	OPE4205	CSE	Software Technology
6	OPE4206	CSE	Internet & Web Technology
7	OPE4207	CSE	Business Analysis and Optimization
8	OPE4208	CSE	IT Industry Management
9	OPE4209	CSE	IT Industry Entrepreneurship
10	OPE4210	CSE	Evolutionary Computations
11	OPE4211	CSE	E-Commerce & Strategic IT
12	OPE4212	CSE	Decision Support & Executive Information
13	OPE4213	CSE	Information Theory & Control
14	OPE4214	EEE	Distributed Generation
15	OPE4215	EEE	Non-Conventional Energy Sources
16	OPE4216	EEE	Energy Auditing and Management
17	OPE4217	HSS	Innovation, Entrepreneurship and Leadership
18	OPE4218	HSS	Technology Management
19	OPE4219	HSS	Knowledge Entrepreneurship
20	OPE4220	HSS	Finance Management
21	OPE4221	HSS	Project Planning, Management & Evaluation
22	OPE4222	HSS	Intellectual Property Rights
23	OPE4223	HSS	Engineering Economics
24	OPE4224	HSS	Human Relations Management
25	OPE4225	HSS	Entrepreneurship Development
26	OPE4226	HSS	Personnel Management and Industrial Engineering
27	OPE4227	MEE	Safety Engineering
28	OPE4228	MEE	Value Engineering
29	OPE4229	MEE	Energy Conservation & Management
30	OPE4230	MEE	Thermal Treatment of Metal and alloys
31	OPE4231	MEE	Simulation of Physical Processes
32	OPE4232	MEE	TQM and Reliability Engineering
33	OPE4233	MEE	Non Traditional Machining Techniques
34	OPE4234	MME	Nanotechnology
35	OPE4235	MME	Introduction to Nano-Technology applications
36	OPE4236	MME	Material Characterization
37	OPE4237	MME	Materials Management
38	OPE4238	MME	Manufacturing Strategies
39	OPE803	MME	Entrepreneurship Development

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Academic Semester VIII

Professional Elective-II (MME Annexure - II)

S. No.	Subject Code	Board of Study	Subjects	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-B-MME804 (1)	MME	Introduction to Stainless Steel	3	0	0	30	20	50	100	3
2.	SOE-B-MME804 (2)	MME	Introduction to Nano-Science and Nano-Technology	3	0	0	30	20	50	100	3
3.	SOE-B-MME804 (3)	MME	Ceramic and Powder Metallurgy	3	0	0	30	20	50	100	3
4.	SOE-B-MME804 (4)	MME	Light Weight Materials	3	0	0	30	20	50	100	3

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

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B. Tech (Metallurgical and Materials Engineering)

(2nd SEMESTERS SYLLABUS)

OP JINDAL UNIVERSITY

OP Jindal Knowledge Park, Raigarh-496109

Department of Metallurgical Engineering

Programme:	**B. Tech**	**Semester:**	**II Sem**
Name of the Course:	**Engineering Mathematics-II**	**Course Code:**	**SOE-B-MATH-23-201**
			3 hours/week
Credits:	**3**	**No of Hours**	**50**
Max Marks:	**100**		

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Course Description:

Learning Objective 1. Evaluate first order differential equations including separable, homogeneous, exact, and linear. 2. Show existence and uniqueness of solutions. 3. Solve second order and higher order linear differential equations. 4. Create and analyze mathematical models using higher order differential equations to solve application problems such as harmonic oscillator and circuits. 5. Solve differential equations using variation of parameters 6. Solve linear systems of ordinary differential equations**.**

Course Outcomes:

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

CO Number	Course Outcomes
CO1	Understand ordinary differential equation.
CO2	Understand applications in Engineering Problems
CO3	Understand higher order differential equation with constant coefficient.
CO4	Understand simultaneous linear equations with constant coefficients.
CO5	Understand Linear partial differential equation of first order.
CO6	Understand Non-homogeneous linear partial differential equations
CO7	Understand Euler's Formula, Functions having points of discontinuity Understand Fourier series, Linear and quasi linear equations
CO8	Understand Harmonic analysis.
CO9	Understand Method of separation of variables; Solution of heat equation;
CO10	Understand Wave equation; Laplace equation & Poisson's equation

Syllabus:

UNIT 1: Ordinary Differential Equation of First order

Review of ordinary differential equation of first order; non linear differential equation of first order and their applications to engineering problems (viz. Simple electrical circuits, Heat conduction problem, Rate of decay of radio-active material, Chemical reactions and solutions, etc.).

UNIT 2: Differential Equation of Higher order

Linear differential equations of higher order with constant coefficients; Method of variation of parameters; Cauchy's & Legendre's linear equations; simultaneous linear equations with constant coefficients; Applications to engineering problems.

UNIT 3: Partial Differential Equation

Formation of partial differential equation; Linear partial differential equation of first order; Standard forms; Charpit's method; Homogeneous linear partial differential equations with constant coefficients; Non-homogeneous linear partial differential equations.

UNIT 4: Fourier series

Euler's Formula; Functions having points of discontinuity; Change of interval; Even and odd functions; Half range series; Harmonic analysis.

UNIT 5: Application of Partial Differential Equation

Method of separation of variables; Solution of heat equation; Wave equation; Laplace equation & Poisson's equation

Text Books:

1. Advanced Engineering. Mathematics by Erwin Kreyszig (8th edition) – John Wiley & Sons.
2. Higher Engineering. Mathematics by B. S. Grewal (38th edition)-Khanna Publishers.
3. Higher Engineering Mathematics by B. V. Rammana-Tata Mc Graw Hill.
4. Advance Engineering Mathematics by R. R. Greenberg- Pearson Publication.
5. Ordinary and Partial Differential Equations by MD Rai Singhania-S. Chand & Sons.

Reference Books:

1. Peter V. O'Neil, Advance Engineering Mathematics, Thomson (Cengage) Learning, 2007.
2. Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas, Calculus, Eleventh Edition, Pearson.
3. D. Poole, Linear Algebra : A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
4. Veerarajan T., Engineering Mathematics for first year, Tata Mc Graw-Hill, New Delhi, 2008.
5. P. Sivaramakrishna Das and C. Vijayakumari, Engineering Mathematics, 1st Edition, Pearson India Education Services Pvt. Ltd

CO- PO & PSO Correlation

Course Name: ENGINEERING MATHEMATICS- II								
Program Outcomes								
Course Outcomes	1	2	3	4	5	6	7	8
CO1:	2	1		2	1		1	1
CO2:	1					1		1
CO3:	1		1		1		1	
CO4:	2				2			
CO5:	2	2	2	2			1	1
CO6:	1				2	1		
CO7:	2	1						1
CO8:	1		1			1	2	
CO9:	2			1	1			1
CO10:	1		1		1		1	

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

Programme :	**B.Tech.**	**Semester :**	**II**
Name of the Course:	**Engineering Chemistry**	**Course Code :**	**SOE-B-MME-23-201**
Credits :	**3**	**No of Hours :**	**3 hours/week**
Max Marks :	**100**		

Course Description:

This course provides fundamentals knowledge of chemistry and able to apply such knowledge in domains corrosion and metal extraction or surface hardening. Prerequisite to study this subject requires the fundamental knowledge of chemistry, and some metallurgy fundamentals. This subject includes underpinning corrosion processes and respective approaches to control through techniques ranging from material selection to protection. Moreover, leaching and electro refining surface hardening and electro refining and nano-materials added values for knowledge of metallurgical chemistry.

Course Objectives:

1. To learn the concept of corrosion emphasizing on basic fundamentals;
2. To learn about the various types of corrosion and selection of appropriate corrosion protection approaches for engineering applications;
3. To understand the basic fundamentals of leaching process related to metals;
4. To gather knowledge about surface hardening and electro-refining process;
5. To understand the basic fundamentals of nano-materials.

Syllabus:

UNIT 1: Electro Chemistry and Reactions

Principles of Electrochemistry, Electro-chemical nature of corrosion, Definition of corrosion, Corrosion Principles: Electrochemical reactions, thermodynamics of corrosion, cell potential, EMF and galvanic series, representation of cell/cell diagram, Cost of Corrosion, corrosion damage, environments, electrode kinetics, Pilling Bed Worth ratio, Pourbaix diagram, Evans diagram, Passivation, Polarization and types of polarization, mixed potential theory.

UNIT 2: Leaching behaviour related to extraction of metals

Microbial leaching, dezincification characteristics, mechanism, prevention, selective leaching by aqueous environments like acids, leaching for other alloy systems, high temperatures leaching behaviour.

UNIT 3: Corrosion Chemistry

Galvanic or two metal corrosion, pitting, crevice corrosion, intergranular corrosion, erosion, stress corrosion cracking, nature of the metal & corroding environment, methods of testing in corrosion like Potentiodynamic polarization, linear polarization, electrochemical impedance, spectroscopy, Corrosion Control.

UNIT 4: Chemical Reactions in surface hardening

Surface hardening of steel and non-ferrous components: Nitriding, carbonitriding; Surface modification using a liquid, gaseous. Principles of electroless and electroplating, setup for electroplating, baths for electroless plating, baths for electroplating, plating practices for electroplating of ferrous and non-ferrous metals and alloys, alloy plating, etc. wear surface properties; types of wear, roles of friction, fretting wear, adhesive wear.

UNIT 5: Electro-refining reaction

Electrorefining reaction, Electrorefining of metals, General principles and practice of Electrorefining, Fused salt electrolysis of aluminium and magnesium, Electro refining of copper-nickel silver and gold. Rare Earth Metal Production by Molten Salt Electrolysis.

Recommended Books:

1. Corrosion Engineering, Fontana, 3rd Edition, McGraw Hill, 1986.
2. An Introduction to Electrometallurgy, Satya Narain and Rajendra Sharan, Standard Publishers Distributors, New Delhi.
3. Sudarshan T.S, Surface Modification Technologies-An Engineers guide, Marcel Dekker, Newyork, 1989.
4. Surface Engineering & Heat Treatment Past, present and Future, edited by P. H. Morton, Published by the Institute of Metals, London, 1991.
5. Electroplating and other surface treatments, A Practical Guide, CD Varghese, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2003.
6. Introduction to Chemical Metallurgy, R.A. Parker, Pergamon press, NY, 1978.
7. Chemical Metallurgy, J J Moore, Heinemann Ltd., 1990.

Reference Books:

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

e-learning Resources

1. http://nptel.ac.in/courses.php
2. http://jntuk-coeerd.in

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C201-01	To make the students understand the principles the corrosion and corrosion control.
C201-02	To impart knowledge about the leaching behavior of materials in various environments; To impart knowledge of electrochemical cells, EMF and applications of EMF measurements;
C201-03	To impart knowledge of types of corrosion and related polarization techniques.
C201-04	To apprehend the knowledge about the surface hardening and wear behaviors of materials;
C201-05	To understand the knowledge of electro-refining process including nano- materials.

CO- PO & PSO Correlation

Course Name: ENGINEERING CHEMISTRY												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1					2		1	1			1
CO2:	2	1	1		1			1	1	1		1
CO3:	2	1	1		1			1	1	1		1
CO4:	1					2		1	1			1
CO5:	1					2		1	1			1

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

Programme :	**B.Tech.**	**Semester :**	**II**
Name of the Course:	**Introduction to Materials Science**	**Course Code :**	**SOE-B-MME-23-202**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks :	**100**		

Course Description:

This course provides an introduction to the fundamental principles of materials science. Topics include the structure of materials, their properties, and the relationship between structure and properties. Emphasis is placed on understanding the behavior of different types of materials such as metals, ceramics, polymers, and composites.

Course Objectives:

The objectives of this course are to introduce fundamental concepts in materials science, explore diverse material properties, establish structure-property relationships, and understand material performance. By the end, students will be able to describe material structures, analyze properties, interpret phase diagrams, evaluate material performance, and communicate technical information effectively.

Syllabus:

UNIT 1: Crystallography

Lattice, Crystals, Unit Cell, Lattice parameters, Crystal systems, Bravais lattice, crystallographic directions, crystallographic planes, Single crystals, polycrystalline materials.

UNIT 2: Stress and strain

Stress, Stress-strain curve for ferrous metals, Stress strain curve for non-ferrous metals., Young modulus, Yield strength, Ultimate tensile strength, Resilience, Toughness, Relation between true stress and Engineering stress, Relation between true strain and Engineering strain.

UNIT 3: Basic equilibrium diagram, lever rule

Types of phase diagram, Binary Phase diagram, Isomorphous phase diagram, Gibb's Phase rule, Iron Carbon phase diagram, Al-Cu Phase diagram, lever rule, Derivation of lever rule, Applications of phase diagram.

UNIT 4: Electronic Materials
Electronic and ionic conduction, Energy band structure in Solids, Electron mobility, Electrical resistivity, Semiconductors, Intrinsic and extrinsic semiconductor, Semiconductor devices, Energy storage materials.

UNIT 5: Advanced Materials
Composites, application of composites, ceramic, application of ceramics, shape memory alloys, biomaterials, sensor materials, Applications of advanced materials.

Text Books:

1. Callister, WD. Materials Science and Engineering: An Introduction, ISBN: 978-1-119-40549-8.
2. Raghavan, Materials Science and Engineering (5th Edition),Prentice-Hall of India Pvt. Ltd., 2004.
3. Introduction to Materials Science for Engineers; Author James F. Shackelford; Publisher Prentice Hall, 2009; ISBN 0136012604, 9780136012603

Reference Books:

1. Essentials of Materials Science and Engineering; Authors: Donald R. Askeland and Wendelin J. Wright, Edition: 4th, ISBN: 978-1337385497
2. NOC: Introduction to Materials Science and Engineering https://archive.nptel.ac.in/courses/113/102/113102080/

Course Outcomes:

CO	Students will be able to:
1	Understand the basic concepts of materials science.
2	Be able to describe the different types of materials and their properties.
3	Understand the relationship between the structure of materials and their properties.
4	Be able to explain the mechanisms behind various material properties and behaviors.
5	Gain insight into the applications of different materials in engineering and technology.

CO-PO & PSO Correlation

Course Name: Introduction to Materials Science												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
1	**3**		**2**		**2**		**2**	**3**	**3**	**2**	**1**	**3**
2	**3**		**2**		**2**		**2**	**3**	**3**	**2**	**1**	**3**
3	**3**		**2**		**2**		**2**	**3**	**3**	**2**	**1**	**3**
4	**3**		**2**		**2**		**2**	**3**	**3**	**2**	**1**	**3**
5	**3**		**2**		**2**		**2**	**3**	**3**	**2**	**1**	**3**

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

Programme :	**B.Tech.**	**Semester :**	**II**
Name of the Course:	**Introduction to Computational Material Science**	**Course Code :**	**SOE-B-MME-23-203**
Credits :	**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:

Course Objectives are as follows:

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 1: INTRODUCTION

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 2: MATERIALS AT DIFFERENT LENGTH SCALES

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 3: DATA ANALYTICS

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 4: DATA MINING AND VISUALIZATION

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 5: ARTIFICIAL INTELLIGENCE AND APPLICATIONS IN METALLURGY

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 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	Students will be able to:
1	Apply knowledge of data science to problems in materials engineering.
2	Get a multidisciplinary exposure.
3	Employability significantly improved after studying.
4	Apply technical skills (experimental, computational) and efficiently use data analysis tools for industrial problems in metallurgical engineering.
5	Enhanced commitment towards environment and responsibility to the society.

CO-PO & PSO Correlation

Course Name: Introduction to Computational Materials Science												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
1	3		1						3			1
2	1		1			1			1	1		
3		2	1	1					1		1	2
4	3		1			1			2			1
5		2	1			1			1		1	

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

Programme:	**B.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Indian Knowledge System (Ancient Metallurgy)**	**Course Code:**	**SOE-B-MME-23-204**
Credits:	**3**	**No of Hours :**	**3 hours/week**
Max Marks:	**50**		

Course description:

This course is designed for 1st year B. Tech student so that they can appreciate the contributions made by ancient Indian people in the field of metallurgy. The course covers all aspects of Metallurgy right from ores, mines to the extraction of ferrous and non-ferrous metals and subsequently processing of metals/alloys in ancient India. Students can understand the advances made by ancient Indian in the field of Metallurgy and Materials with limited resources and understanding of the subject.

Syllabus:

UNIT 1: Ores and mines in Ancient India

Copper Ores and its mines, Tin Ores and mines, Gold Ores and mines, Silver Ores and mines, Iron Ores and mines, Zinc Ores and mines, Diamond mines. Literary evidence of ores and mines. Archeological evidence of ores and mines.

UNIT 2: Metallurgy of iron and steel

Literary Evidence of Iron, Archaeological Evidence of Iron, Evidence of Iron-Mining of Ancient India, Ethnological Evidence of Iron, Metallurgy of Iron and steel, Famous iron pillar, Manufacturing of steels, The famous Damascus sword (Wootz steel).

UNIT 3: **Metallurgy of Non-ferrous metals and alloys**

Literary Evidence of Copper, Bronze and Brass, Archaeological Evidence of Copper and Bronze, Metallurgy of Copper and Bronze, Literary Evidence of Gold and Silver, Metallurgy of Gold, Silver and Lead, Literary Evidence of Zinc, Archaeological Evidence of Zinc, Metallurgy of Zinc and Brass.

UNIT 4: Metallurgical Processes in ancient India

Manufacturing of different tools like arrows, chisels, Manufacturing of utensils; Heat treatment of tools, Castings of copper and brass and idols, Forging of metals, Different furnaces used, Literary Evidence and archeological evidence of metallurgical processes in ancient India.

UNIT 5: Ceramics technology, glass technology and bead making technology in ancient India

Ceramics Bricks for construction works, ceramics in pottery, literary Evidence, Glass and it's uses in ancient India, literary evidence of glass in ancient India. Beads used in ancient technology, literary evidence and archeological evidence.

Reference Books:

1. Minerals and Metals in Pre-modern India, A. K. Biswas, D.K. Printworld, 2001
2. Ancient India Metallurgy (Theory and Practice), A. K. Mishra, Agam Kala Prakashan Delhi, 2009
3. Ancient Metallurgy, R. C. Gupta

Course Outcomes:

CO	Students will be able to:
CO1	Students will be able to appreciate and understand the rich heritage of our ancestors in the field of Metallurgy in India
CO2	Students will be motivated to enhance the quality of life in the current civilization by enhancing their knowledge of Metallurgy and contribute to innovations which is ever evolving process.
CO3	Students will understand the importance of preserving the nature for sustainable development of society

CO-PO & PSO Correlation

Course Name: INDIAN KNOWLEDGE SYSTEM (ANCIENT METALLURGY)												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1	2	1	1	2	2	2	3	1				
CO2	1	2	1	2	2	1	2	2				
CO3	1	2	2	1	1	3	3	2				

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

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Department of Metallurgical Engineering

Programme:	**B.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Workshop Practice**	**Course Code:**	**SOE-B-MME-23-205**
Credits:	**2**	**No of Hours :**	**20**
Max Marks:	**50**		

Course Description:

It allows to study the basic workshop practices which enables the students to carry out/understand the day to day work easily with the application of Engineering knowledge through machine tools and equipment.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcomes
CO1	Graduates will gain a strong foundation in machine tool engineering.
CO2	Acquire knowledge and hands-on competence in applying the concepts of manufacturing science in the development of mechanical systems.
CO3	Demonstrate creativeness in designing new systems components and processes in the field of engineering in general and mechanical engineering in particular.
CO4	Work effectively with engineering and science teams as well as with multidisciplinary designs.
CO5	Skill fully use modern engineering tools and techniques for mechanical engineering design, analysis and application.

Syllabus:

Week	Content	Practical (Hrs)
1 & 2	**Furnace Design** 1. Introduction. 2. Various types of furnaces and refractories. 3. Furnace coil design. 4. Temperature measurement and controller.	4
3 & 4	**WELDING SHOP** 1. Introduction 2. Types of welding 3. Soldering 4. Brazing 5. Butt and Lap welding	4

	6. Safety precautions in welding safety equipment's and its use in welding processes.	
5 & 6	**MACHINE SHOP** 1. Introduction about various machine tools 2. Principal parts of a lathe 3. Measuring instruments 4. EDM wire cutting 5. Tool materials 6. Lathe operations (CNC) 7. Safety precautions	4
7	Test and quiz	

Text Books:

1. Manufacturing Technology (Vol. – I & II) – P.N. Rao – Tata McGraw Hill Pub. Company, New Delhi.
2. A Text Book of Production Technology (Manufacturing Processes) – P.C. Sharma – S. Chand and Company Ltd., New Delhi.
3. Machine Tool Engineering – G.R. Nagpal – Khanna Publishers, New Delhi.
4. A course in workshop Technology (Vol- I & II) – B.S. Raghuvanshi – Dhanpat Rai & Sons, New Delhi.

Reference Books:

1. Kent's Mechanical Engineering Hand book, John Wiley and Sons, New York.
2. Workshop Technology by H.S.Bawa,Tata McGraw Hill Publishers.
3. Workshop Technology by S.K. Hajara Chaudhary, Media Promotors and Publishers.
4. Chapman, W.A.J. and Arnold E., "Workshop Technology" Vol. I & III, Viva Low price student Edition, 1998.
5. Chaudhary, Hajra, "Elements of Workshop Technology" Media Promoters & Publishers, 1997.
6. Raghuwanshi, B.S., "Workshop Technology" Vol I 7 II, Dhanpat Rai and Sons 1998.

CO-PO & PSO Correlation

Course Name: WORKSHOP PRACTICE										
Course Outcomes	**Program Outcome**								**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**
CO1	3	-	2	3	-	1	1	-		
CO2	3	2	2	2	2	1	2	2		
CO3	3	2	-	2	2	1	-	2		
CO4	2	3	2	2	3	2	-	3		
CO5	2	3	1	-	-	1	-	2		

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

Program: B. Tech **Semester: II**
Name of the Course: Engineering Chemistry Lab **Code: SOE-B-MME-23-206**
Credit: 2 **No of Hours: 4 hours/week**
Max. Marks: 50

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Course Objectives:

The course will provide the students with an insight into the importance and solid foundation of engineering chemistry involved in the application of engineering materials. There are several key objectives, as follows:

1. To learn the concept regarding the preparation of electrolyte.
2. To understand the behavior of corrosive environment on materials.
3. To learn the handling of equipment used for electrochemistry.

List of Experiments:

1 Determination of corrosion rate by weight loss method
2 Corrosion rate measurement by using Potentiostat/ Galvanostat.
3 Perform and observe the corrosion Phenomenon of crevice corrosion of steel in chloride solution.
4 Study the effect of inhibitors on the rate of corrosion.
5 Determine the polarization resistance of weld sample.
6 Perform electro-plating of Copper and Nickel and study the effect of parameters.
7 Electrochemical behavior of Galvanic corrosion in 3.5% NaCl Medium.
8 Detection of heavy metals from waste water.
9 To increase the surface hardness by using pack carburizing method.
10 Refining of copper produce by electrolysis.

Reference Books:

1 An introduction to electrochemistry. Read Books Ltd. Glasstone, S.
2 Corrosion engineering. McGraw-Hill, Fontana, Mars Guy, and Norbert D. Greene.
3 Principles of corrosion processes." Corrosion Processes: Sensing, Monitoring, Data Analytics, Prevention/Protection, Diagnosis/Prognosis and Maintenance Strategies, Natarajan, K. A.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C206-01	Conduct and analysis on metals and alloys in various corrosive environments.
C206-02	Able to know the concept of inhibitors on the corrosion.
C206-03	Solve the problems through experiments and reach a solution related to metals and alloy.

CO-PO & PSO Correlation

Course Name: Engineering Chemistry Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	1								1		
CO2:		2	1	3		1			2			1
CO3:	1	2	3	3						2		2

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

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Department of Metallurgical Engineering

Programme :	**B.Tech.**	**Semester :**	**II**
Name of the Course:	**Introduction to Computational Material Science Lab**	**Course Code:**	**SOE-B-MME-23-207**
Credits :	**1**	**No of Hours :**	**2 hours/week**
Max Marks :	**50**		

Course Description:

This lab will provide with hands on learning experience on various computational tools, software and algorithms based on concepts of statistics, and artificial intelligence. Students will utilize these computational tools in solving problems within the domain of metallurgical and materials engineering. Consequently, students will be introduced to basic industrial problems and guided in a manner that they can develop an understanding of these problems and make an attempt to solve it. Students will be provided with few data sheets and they will use several software on the same data sheet. This way, they will be able to determine which computational tool suits them best. Additionally, the students will be also introduced to visualization of various organic and inorganic matter including basic crystals, drugs, refrigerants etc.

List of Experiments:

1. Data analysis in MS Excel: Curve fitting, and Plotting.
2. Determination of statistical measures: Mean, R^2, Correlation (Pearson, Spearman), in MS Excel.
3. Calculation of Carbon equivalent (CE, CEN, PCM) of steel in MS Excel.
4. Determination of coefficients of Hall-Petch equation in MS Excel for steel specimen.
5. Calculation of composition of top gas of an iron making blast furnace.
6. Introduction to Python: Data analysis and statistics in Python
7. Introduction to MATLAB: Data analysis and statistics in MATLAB.
8. Introduction to ORIGIN: Data analysis and statistics in ORIGIN.
9. Introduction to WEKA: Data analysis and statistics in WEKA.
10. Computational chemistry: Representation of FCC, BCC, HCP, SMILES.

Reference Books:

1. Callister, WD. Materials Science and Engineering: An Introduction, ISBN: 978-1-119-40549-8
2. 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
3. Datta, S. (2016). Materials Design Using Computational Intelligence Techniques (1st ed.). CRC Press. https://doi.org/10.1201/9781315373003
4. MATLAB, https://in.mathworks.com/products/matlab.html

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C207-01	Learn to utilize data mining in MS Excel, ORIGIN, and WEKA.
C207-02	Learn programming in Python: Google COLAB, Jupyter notebook.
C207-03	Learn programming in MATLAB.
C207-04	Learn visualization of crystals in VESTA.
C207-05	Learn visualization of SMILES using computational tools.

CO-PO & PSO Correlation

Course Name: Introduction to Computational Material Science Lab												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	3		3			3			3	3		3
CO2:	2		2			1			3	2	3	
CO3:		2	1	1					3		1	2
CO4:	3		2						2			1
CO5:		1	1			1			1		1	

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

B. Tech (Metallurgical and Materials Engineering)

(3RD SEMESTER SYLLABUS)

Program: B. Tech | **Semester: III**

Name of the Course: Introduction to Physical Metallurgy | **Code: SOE-B-MME301**

Credit: 4 | **No of Hours: 4 hours/week**

Max. Marks: 100

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 1:

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 2:

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 3:
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 4:
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 5:
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:**
C301-01	Understand the crystal structure and behavior of materials.
C301-02	Understand the kinetics of phase transformation.
C301-03	Understand the properties of materials and their applications.
C301-04	Understand the concept of relationships between physical metallurgy, materials science and solid state physics.

Assessment:

Assessment can vary from course to course and can include a combination of class work, tutorials, assignments, laboratory work, quizzes, project work and exams.

CO-PO & PSO Correlation

Course Name: Introduction to Physical Metallurgy												
	Program Outcomes								PSOs			
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2								3			
CO2:	2	1	1						2			
CO3:	1								1			1
CO4:	1			1		1				1		

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

Program: B. Tech
Name of the Course: Mineral Dressing
Credit: 3
Max. Marks: 100

Semester: III
Code: SOE-B-MME302
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 1:

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 2:

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 3:
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 4:
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 5:
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:**
C302-01	Understand the characteristics of different ores and minerals
C302-02	Familiar with the different ore dressing processes utilized in industrial practices
C302-03	Use the techniques, skills, and modern engineering tools necessary for industrial practices.

Assessment:
Assessment can vary from course to course and can include a combination of class work, tutorials, assignments, laboratory work, quizzes, project work and exams.

CO-PO & PSO Correlation

Course Name: Mineral Dressing												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**1**							**1**	**1**			**1**
CO2:	**2**	**1**			**1**			**1**		**1**		**1**
CO3:		**2**		**1**		**2**				**1**		**1**

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

Program: B. Tech | **Semester: III**

Name of the Course: Metallurgical Thermodynamics and Kinetics | **Code: SOE-B-MME303**

Credit: 4 | **No of Hours: 5 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 1:

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 2:

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 3:

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 4:

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 5:
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:
C303-01	Understand concepts and laws of thermodynamics.
C303-02	Derive different thermodynamic relations and solve problems.
C303-03	Comprehend the concept and applications of energy and entropy.
C303-04	Interpret Ellingham Diagram for oxides.

CO-PO & PSO Correlation

Course Name: Metallurgical Thermodynamics and Kinetics												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**								**1**			
CO2:		**2**	**1**			**1**			**1**	**1**		
CO3:	**1**								**1**			
CO4:	**2**								**1**	**1**		

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

Program: B. Tech **Semester: III**

Name of the Course: Mathematical Analysis in Metallurgical Processes **Code: SOE-B-MME304**

Credit: 4 **No of Hours: 4 hours/week**

Max. Marks: 100

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Course Description:

Each and every aspect of metallurgical engineering can be explained and quantified through mathematical modelling. Any given problem associated with metallurgical engineering can be solved at multiple length and time scales. A given problem can be formulated through basic concepts of physics, chemistry and statistics. These concepts are the basis of simulations base on ab-initio: density functional theory (DFT) /Molecular Dynamics (MD), finite element analysis (FEA), computational fluid dynamics (CFD), calculation of phase diagram (CALPHAD) etc. Mathematics is the binding force which helps in formulating the problem as per the user requirement. Data-driven models based on concepts of artificial intelligence requires understanding of various mathematical and statistical concepts. Metallurgical processes are associated with a certain degree of uncertainty. From an industrial point of view, it is important to quantify these uncertainties associated with the metallurgical process. This course is aimed at providing a mathematical understanding of various processes associated with metallurgical and materials engineering.

Course Objectives:

6. To expose students to concepts based on mathematics and statistics and their importance to various phenomenon of metallurgical engineering.
7. To help students develop the understanding of various metallurgical processes and quantify their understanding in mathematical form.
8. To help students attempt real case studies from the iron and steel industry.
9. To help students understand the importance of various mathematical functions in common and advanced diagnostic tools.
10. To help students familiarize themselves with new initiatives in the industry.

Syllabus:

UNIT 1: INTRODUCTION TO CALCULUS

Introduction to differential and integral calculus; Application of calculus in metallurgical engineering; Mathematical model; Physical models; Data-driven model.

UNIT 2: STATISTICS
Scaling of data; Correlation coefficient: Pearson and Spearman; Curve fitting; Error metrics: Root mean square error (RMSE), Mean Absolute Error (MAE), Relative Absolute Error (RAE); Matrices and determinants and its application in solving equations like Gibb's phase rule; Phase diagram.

UNIT 3: NUMERICAL METHODS IN METALLURGICAL ENGINEERING
Numerical methods: Solving algebraic equations through Newton-Raphson method; Differential equations and it's solution through Runge-Kutta method; Numerical Integration by Trapezoidal and Simpson's rule and its application in solution thermodynamics;

UNIT 4: CASE STUDIES
Heat and mass balance: Calculations for various ironmaking (blast furnace/DRI) and steel making (LD/EAF) furnaces; Roll force and torque calculation through mathematical modelling; Indexing a diffraction pattern.

UNIT 5: ADDITIONAL APPLICATIONS IN METALLURGY
Taylor's series and its application in extractive metallurgy; Introduction to Schrodinger's equation and Fourier transform and its application in electron microscopy; Introduction of artificial intelligence (AI); Artificial neural network (ANN); Industry 4.0; Internet of Things (IoT).

Text Books:

1. Peck et al (2008); Introduction to Statistics and Data Analysis, Duxbury, an imprint of Thomson Brooks/Cole
2. Chapra, Steven C. (2015) Numerical methods for engineers, Seventh Edition, McGraw-Hill Education
3. Pal, S. et al. Process Modeling for Steel Industry April 2018 Edition: Publisher: I.K. International Publishing House ISBN: 9789385 909399
4. 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	Metallurgical and Materials Engineering Graduates will be able to:
C304-01	Apply knowledge of mathematics to problems in metallurgical engineering.
C304-02	Correlate operation parameters with final product quality/quantity.
C304-03	Potential for employability significantly improved after studying.
C304-04	Develop an understanding of various mathematical and statistical concepts utilized in common equipment's in the lab.

C304-05	Apply technical skills (experimental, computational) for solving industrial problems through concepts of mathematics and statistics.

CO-PO & PSO Correlation

Course Name: Mathematical Analysis in Metallurgical												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**3**		**3**						**3**			**1**
CO2:	**1**		**1**			**1**			**1**	**3**		
CO3:		**2**	**3**	**2**					**1**		**1**	**2**
CO4:	**3**		**1**			**3**			**2**			**1**
CO5:		**2**	**3**			**1**			**1**		**3**	

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

Program: B. Tech | **Semester: III**
Name of the Course: Physical Metallurgy Lab | **Code: SOE-B-MME305**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

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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

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.

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:
C305-01	Conduct and analyze internal characteristics of metals and alloys.
C305-02	Able to know the concept of grain size and related mechanical properties correlation.
C305-03	Solve the problems through experiments and reach a solution related to a specified metal or alloy.

CO-PO & PSO Correlation

Course Name: Physical Metallurgy Lab												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**	**1**								**2**		
CO2:		**2**	**1**			**1**			**2**			**1**
CO3:	**1**			**1**	**1**					**1**		**1**

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

Program: B. Tech | **Semester: III**
Name of the Course: Mineral Dressing Lab | **Code: SOE-B-MME306**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

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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.

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:
C306-01	Perform the experiments related to a specified mineral or ore.
C306-02	Conduct and analyze minerals' size reduction processes.
C306-03	Select and redesign a problem in extraction of minerals.

CO-PO & PSO Correlation

Course Name: Mineral Dressing Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	1				1			1	2		
CO2:	1							1	1	2		1
CO3:	1				1		1	1	2			2

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

Program: B. Tech | **Semester: III**
Name of the Course: Material Science Lab | **Code: SOE-B-MME307**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

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Course Objectives:

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.

List of Experiments:

1. Electrical conductivity measurement of Non ferrous metals.
2. To measure the magnetic hysteresis, retentivity, coercivity and saturation magnetization of a material by tracing a B-H curves.
3. To find out the wear rate of different materials using wear testing machine.
4. To prepare the models and identify the imperfection in crystal.
5. Determination of heat transfer through composite walls.
6. Preparation of composite material.
7. Porosity measurement of materials.
8. Determination the crystal structure of materials.
9. Study the various types of microscope.
10. To measure the mechanical properties of Metal Matrix Composites.

Equipment Required:

1. Disc Wear Testing Machine
2. Hall Effect apparatus
3. Four probe apparatus.
4. Thermal Conductometer for composite material analysis.

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:
C307-01	Select and redesign the problem of material science.
C307-02	Solve the materials problem through experiments to reach the sustainable solution.
C307-03	Explain and demonstrate the solution related to materials.

CO-PO & PSO Correlation

Course Name: Material Science Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1		1						1			2
CO2:	2		1	1				1	1			2
CO3:	1		1	2					1	1		1

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

B. Tech (Metallurgical and Materials Engineering)

(4TH SEMESTER SYLLABUS)

Program: B. Tech | **Semester: IV**
Name of the Course: Iron Making | **Code: SOE-B-MME 401**
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 1:
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 2:
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 3:
Modern concept of Blast Furnace process; Temperature profile in Blast furnace; Aerodynamics; Blast Furnace reactions; Injection of Coal, Oil and Gas; Numericals.

UNIT 4:
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 5:

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:
C401-01	Understand various concepts related to Iron Making processes.
C402-02	Learn to perform BF charge calculations.
C402-03	Understand the various alternate routes of iron making.

CO-PO & PSO Correlation

Course Name: Iron Making												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2					1			3			1
CO2:	2	1				1			2	1		
CO3:	1					1			2			1

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

Program: B. Tech | **Semester: IV**
Name of the Course: Fuels, Furnaces and Refractories | **Code: SOE-B-MME402**
Credit: 3 | **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:
Fuels are basic necessities of metallurgical furnaces for extraction of metals and this subject deals with the optimum utilization of fuels, in-situ fundamentals of furnaces and above all, refractories, the important material for construction of furnaces and its utilization related to metallurgical process. Thus study of this subject has a consequence of its own.

Course Objectives:
1. To familiarize the students with solid, liquid and gaseous fuels for industrial practices;
2. To understand the basic concept of manufacture and testing of metallurgical coke;
3. To understand the principles, working processes and applications of various furnaces including various parts and their applications;
4. To study various types of refractories, their properties, manufacturing process, and their industrial practises;
5. To implement the knowledge as effective engineers/scientists in the related fields.

Syllabus:

UNIT 1:
Classification of fuels and their importance, conventional and newer sources of energy, concept of the terms like flash point, fire point, compression ratio, cetane no and octane no, rank of coals, beneficiation of coal, coal characterizations, coal to coke formation process, testing and properties of coke, principle of coal washing, washability curve, various indexing process and application of coke.

UNIT 2:
Proximate and ultimate analysis of fuels, various carbonization processes and their importance, principle and determination of calorific value and related equipment, fuel combustion mechanism and related factors, principles production of liquid from crude and their utilizations; manufacture, properties and uses of producer gas. water gas and their properties, uses of blast furnace gas and coke oven gas, natural gas and LPG; combustion calculations and numerical,

UNIT 3:
Classification of furnace following selective parameters, difference between furnace and kiln, various heat losses in furnace and minimization, concept of flame, various drafting systems and their significances, concept of waste heat recovery, chimney height, construction and working principles of cupola, induction furnace, arc furnace, resistance furnace, pit furnace, rotary furnace, muffle furnace and plasma heating furnace, uses of Laser.

UNIT 4:
Definition, properties and testing of refractories, production of different types of refractories, selection of refractories for metallurgical applications, special refractories, selection of refractory for coke oven, iron blast furnace, copper convertor, electric arc furnace, concept of castable refractories and their types and significances.

UNIT 5:
Basic concept of temperature measurement and control, optical and radiation pyrometers - principle, construction, working process and advantages, field study on industrial furnace related software.

Text / Reference Books:

1. Elements of Fuels, Furnaces and Refractories, O. P. Gupta, Khanna publication.
2. Marion L. Smith and Karl W., Fuels and Combustion, McGraw-Hill Book Company,Inc. New York.
3. Fuels, Furnaces and Refractories, J. D. Gilchrist, Pergamon Press.
4. Fuels, Furnaces, Refractories and Pyrometry, -A.V.K. Suryanarayana, B. S.Publication
5. Refractories, M. L. Mishra, BHU Publication, 1961.
6. Industrial Furnaces - Vol. I & II, W. Trinks and M. H. Mawhiney, Wiley
7. Refractories, F. H. Norton, CBLs Publication.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C402-01	Implement the acquired skills for selecting appropriate fuels for selective metallurgical operation.
C402-02	Implement the acquired skills to select the proper type of furnace with relevant refractory materials.
C402-03	Implement the acquired skills to control the furnace.

CO-PO & PSO Correlation

Course Name: Fuels, Furnaces and Refractories												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**			**1**		**1**			**2**	**1**		
CO2:			**2**		**1**	**1**			**1**		**1**	
CO3:				**1**		**1**		**1**	**1**		**2**	

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

Program: B. Tech **Semester: IV**

Name of the Course: Deformation Behavior & Testing of Materials **Code: SOE-B-MME403**

Credit: 4 **No of Hours: 3 hours/week**

Max. Marks: 100

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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 1:

Mechanical properties of materils; Stress and strain; Elastic, Anelastic 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 2:

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 3:

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 4:

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 5:

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. CalisterJr. 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:
C403-01	Know about elastic and plastic deformation of metallic materials .
C403-02	Understand effect of deformation behavior of ductile & brittle material.
C403-03	Understand various strengthening methods of metals & alloys.
C403-04	Understand various concepts of fracture, creep, fatigue behaviors in metals.
C403-05	Have understanding on various destructive and non-destructive tests.

CO-PO & PSO Correlation

Course Name: Deformation behaviour and testing of materials												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1	1				1			2	2		
CO2:	1	1							2			1
CO3:	1					1			3			1
CO4:	2	1	1			1			2	2		1
CO5:	1		1			1			1	3		1

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

Program: B. Tech | **Semester: IV**
Name of the Course: Composite Materials | **Code: SOE-B-MME404**
Credit: 3 | **No of Hours: 3 hours/week**
Max. Marks: 100

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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 1:
Introduction: Definitions, Classifications, limitations and advantages of composites, concept of reinforcements and matrices, type of reinforcements, types of matrix, rule of mixture, properties of composite in comparison with standard materials, applications of metal, ceramic and polymer matrix composites.

UNIT 2:
Fabrication of composites, hand and spray layup, injection molding, resin injection, filament winding, pultrusion, centrifugal casting and prepress, fibre/matrix interface, mechanical measurement of interface strength, characterization of composite materials.

UNIT 3:
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 4:
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 5:

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. IM Daniel and O Ishai, Engineering Mechanics of Composite Materials, Oxford University Press India

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C605(4)-01	Gain fundamental knowledge of composite materials.
C605(4)-02	Apply the theory to practical problems.
C605(4)-03	Implement the concept for practical aspects.

CO-PO & PSO Correlation

Course Name: Composite Materials												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2					1			2			1
CO2:	1	1			1	1			1			2
CO3:					2				1	1		2

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

Program: B. Tech **Semester: IV**
Name of the Course: Heat Treatment of Materials **Code: SOE-B-MME405**
Credit: 3 **No of Hours: 3 hours/week**
Max. Marks: 100

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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 1:

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 2:

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 3:

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, thermo mechanical treatment, intercritical heat treatment, polymer quenching, sub-zero treatment – cryogenic quenching, patenting.

UNIT 4:
Surface Hardening methods, Thermal – flame hardening, induction hardening, and advanced techniques like plasma, electron beam etc. Thermo-chemical processes – carburizing, nitriding, carbonitriding.

UNIT 5:
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:
C405-01	Understand the different types of phases present in the materials.
C405-02	Know about various steels and their heat treatment methods.
C405-03	Understand the role of heat treatment in enhancing the material properties.

CO-PO & PSO Correlation

Course Name: Heat Treatment of Materials												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**								**3**			
CO2:	**1**	**1**	**1**						**2**	**1**		
CO3:	**2**		**1**			**1**			**2**			**1**

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

Program: B. Tech | **Semester: IV**
Name of the Course: Fuels, Furnaces and Refractories Lab | **Code: SOE-B-MME406**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

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Course Objectives:

1. To understand a knowledge over practical phenomenon of solid, liquid and gaseous fuels.
2. To acquire practical fundamental ideas about Refractories and metallurgical furnaces.
3. Able to operate as effective engineers/scientists in metallurgical and materials domain.

List of Experiments:

1. Determination of flash and fire point of given oil by Pensky Marten open cup method.
2. Determination of flash and fire point of given oil by Pensky Marten close Cup apparatus.
3. Determination of flash and fire Point of given oil by Able apparatus.
4. Determination of viscosity using redwood viscometer.
5. Determination of calorific value of coal using bomb calorimeter.
6. Melting of metal using induction furnace.
7. Proximate analysis of coal sample.
8. Determination of refractoriness (P.C.E.).
9. Determine the apparent porosity of a refractory sample.
10. Determination of resistance to thermal shock (Spalling).

Equipment Required:

1. Pensky Martin Apparatus.
2. Able's Apparatus.
3. Redwood Viscometer.
4. Bomb Calorimeter.
5. Sieve Analyzer.
6. Muffle Furnace.

Reference Books:

1. Elements of Fuels, Furnaces and Refractories, O. P. Gupta, Khanna publication.
2. Marion L. Smith and Karl W., Fuels and Combustion, McGraw-Hill Book Company, Inc. New York.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C406-01	Conduct and analyze and selection of various fuels for specific application.
C406-02	Have overall understanding about the different types of furnaces and refractories.
C406-03	Overall understanding about the various furnaces and refractories.

CO-PO & PSO Correlation

Course Name: Fuels, Furnaces and Refractories Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1		1							2		
CO2:	2	1	1			1			3			1
CO3:	1				1	1		1	1		1	

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

Program: B. Tech **Semester: IV**

Name of the Course: Deformation Behaviour & Testing of Materials Lab **Code: SOE-B-MME407**

Credit: 2 **No of Hours: 4 hours/week**

Max. Marks: 50

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Course Objectives:

1. To understand mechanical behavior of materials under different loading conditions
2. To provide basic understanding of different hardness testing.
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.

List of Experiments:

1. To determine the tensile properties of ductile and brittle materials.
2. To determine hardness of materials by Brinell, Rockwell and Vickers test.
3. To determine the impact strength of materials by Izod and Charpy impact test.
4. To determine the twisting properties of materials by torsion test.
5. To determine the fatigue limit of material by Fatigue test.
6. To study of Creep and creep failure of material.
7. To perform visual inspection of materials.
8. To perform magnetic particle test of materials.
9. To perform ultrasonic test of materials.
10. To perform the Radiography test.

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:
C407-01	Conduct and analyze various mechanical properties of materials.
C407-02	Understand the need of non-destructive testing for different types of materials.
C407-03	Understand various destructive testing of materials.

CO-PO & PSO Correlation

Course Name: Deformation behaviour and testing of materials Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	1				1			3	2		1
CO2:	1		1	1					2			1
CO3:	2	1				1			3			

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

Program: B. Tech | **Semester: IV**
Name of the Course: Heat Treatment of Materials Lab | **Code: SOE-B-MME408**
Credit: 2 | **No of Hours: 4 hours/week**
Max. Marks: 50

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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

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C408-01	Gain hands on experience to different heat treatment cycles of ferrous and non-ferrous alloys.
C408-02	Understand different heat treatment process variables.

CO-PO & PSO Correlation

Course Name: Heat treatment of materials Lab												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	2	1						2			2
CO2:	1	2	1			1			2	1		1

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

B. Tech (Metallurgical and Materials Engineering)

(5th SEMESTER SYLLABUS)

Program: B.Tech | **Semester: V**
Name of the Course: Melting and Casting Technology | **Code: SOE-B-MME501**
Credit: 4 | **No of Hours:5 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 1:
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 2:
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 3:
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 4:

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 5:

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:
C501-01	Distinguish between various methods of foundry practice.
C501-02	Compare various types of patterns based on their uses.
C501-03	Develop skills to conceptualize to design the process and solve the practical problems encountered while metal processing.
C501-04	Recognize the casting defects, their causes, and remedies.
C501-05	Know the inspection techniques to detect casting defects.

CO-PO & PSO Correlation

Course Name: Melting and Casting Technology												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	1							3	3		2
CO2:	2		3			3	2	3	1	2		
CO3:	3	1	2	2	3	3		2	3	3		2
CO4:	3	1	2	3	3		2	2	3	3		3
CO5:	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 1:
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 2:
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 3:
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 4:

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 5:

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:
C502-01	Have fundamental knowledge on basic principles of steel making.
C502-02	Understand the working process of open hearth, Bessemer, LD and Q-BOP steel making processes.
C502-03	Describe the secondary refining techniques of steel making.
C502-04	Understand the principle of continuous casting of steel.

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
CO1:	2					1		1	2	1		
CO2:	3	1	1			1			3			1
CO3:	2	1						1	1			1
CO4:	2	1							2			2

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:5 hours/week**
Max. Marks: 100

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Course Description:

This course introduces the various extraction processes which include pyrometallurgy, 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 1:

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 2:

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 of order and rate constant of a reaction and its numerical.

UNIT 3:

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 4:

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

UNIT 5:

Refining of zinc by distillation in refluxing units, refining of lead bullion by Parks process. electro refining of copper, nickel, lead, tin and 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:
C503-01	Know about various ferrous and non-ferrous metals and their processing.
C503-02	Understand the techniques related to extraction of metals.
C503-03	Have fundamental knowledge on applications of ferrous and non-ferrous metals.

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
C503-01	3							1	2			
C503-02	1	2	1						1	2		1
C503-03	1		1	1	1				1	1		1

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

Program: B.Tech | **Semester: V**
Name of the Course: Phase Transformation | **Code: SOE-B-MME504**
Credit: 3 | **No of Hours:3 hours/week**
Max. Marks: 100

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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 1:

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 2:

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 3:

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 4:
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 5:
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:
C504-01	Understand the different types of phases present in the materials.
C504-02	Have fundamental knowledge on phase diagrams.
C504-03	Understand the kinetics of phase transformation.
C504-04	Have idea about the surface treatments of the materials.

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
CO1:	2					1			1			1
CO2:	2	1			1				1	1		
CO3:	2				1	1			2			1
CO4:	1		1			1		1	1			1

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

Program: B.Tech | **Semester: V**
Name of the Course: Melting and Casting Technology Lab | **Code: SOE-B-MME505**
Credit: 2 | **No of Hours:4 hours/week**
Max. Marks: 50

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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:
C506-01	Have knowledge of moulding sand.
C506-02	Hands on Experience on different foundry equipment, their use and different type casting processes.

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
CO1:	2	1	1			1			1			1
CO2:	2	1	1						1	2		

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

Program: B.Tech | **Semester: V**
Name of the Course: Process Metallurgy Lab | **Code: SOE-B-MME506**
Credit:2 | **No of Hours:4 hours/week**
Max. Marks: 50

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:
C507-01	Have practical knowledge about various testing processes related to iron and steel making.
C507-02	Analyse the BF charge calculations.

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**
CO1:	**2**	**1**	**1**			**1**		**1**	**1**	**2**		
CO2:	**2**		**1**			**2**			**3**			**1**

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

OP JINDAL UNIVERSITY

OP Jindal Knowledge Park, Raigarh-496109

Department of Metallurgical Engineering

Program: B.Tech **Semester: V**
Name of the Course: Industrial Training and Seminar **Code: SOE-B-MME507**
Credit:1 **No of Hours: 2 hours/week**
Max. Marks: 50

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Course Description:

Industrial Training and Seminar gives the students an exposure towards current industrial practices related to the theoretical knowledge being taught at the classes. Industrial visits provide an excellent opportunity to interact with industries and know more about industrial environment. Industrial visits are arranged for the students for Industrial realities and related professionalism related to Industry. With an objective of providing students functional opportunity in different sectors. Industrial visit helps to combine theoretical knowledge with industrial knowledge. Industrial realities are opened to the students through industrial visits

Course Objectives:

1. To prepare industry-oriented 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 Industrial areas.
3. Able to operate as effective engineers or scientists in metallurgical and materials Industries academia. equipment/machine or related fields with respect to advanced level.

Syllabus:

The student has to give a review presentation of comprehensive design/experimental project on a selected topic and industrial Report preparation and submission.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C509-01	Know how the basic principles of the industrial equipment/ machines.
C509-02	Solve and analyse a problem from an industry/institute.
C509-03	Select and redesign a problem.
C509-04	Solve the problem through experiments to reach the sustainable solution.
C509-05	Explain and demonstrate the solution developed.

CO-PO & PSO Correlation

Course Name: Industrial Training and Seminar												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**					**2**		**1**	**2**	**2**		**3**
CO2:	**1**	**1**	**1**		**1**	**1**			**1**	**1**		**2**
CO3:			**1**		**2**	**1**			**1**			**2**
CO4:			**1**	**1**	**1**	**2**			**2**			**2**
CO5:			**1**		**1**		**1**				**2**	**2**

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

B. Tech (Metallurgical and Materials Engineering)

(6TH SEMESTER SYLLABUS)

Program: B.Tech | **Semester: VI**
Name of the Course: Metal Forming Processes | **Code: SOE-B-MME601**
Credit:3 | **No of Hours: 3 hours/week**
Max. Marks: 100

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Course Description:
This course is designed to introduce the students about the force required to deform materials in desired shape with proper quality and minimum defect. This course comprises the concept of load requirements, response of materials to external loads, temperature requirement for material deformation, production of finished products with minimal defects. This course explains various forming processes such as rolling, forging, extrusion and possible defects and their remedies.

Course Objectives:

1. A basic understanding of all the metal forming processes.
2. Knowledge about the principles and science of all the plastic deformation processes.
3. An idea about converting the raw material into finished product.
4. An overview of the defects caused during the various processes and how to rectify it.

Syllabus:

UNIT 1:
Introduction: Introduction to metal working, classification of primary forming processes, classification of processes based on temperature, advantages and limitations of metal forming. Mechanical behaviour of materials: elastic and plastic behaviour, stress and strain, flow curve, flow stress. yield criteria: Tresca yield criteria, Von- mises yield criteria. variables in metal forming: temperature, strain rate or deformation velocity, grain size and microstructure, friction, lubrication, deformation zone, residual stresses.

UNIT 2:
Forging: Introduction, forgeability, metals and alloys suitable for forging, forging temperature, forging operations, forging processes, forging equipment, grain flow in forging, forging pressure and loads, forging die design parameters, defects in forgings, residual stresses in forgings.

UNIT 3:

Rolling: Introduction, rolling products, types of rolling mills, hot rolling, cold rolling, ring rolling, rolling of steel ingots, microstructural changes in hot and 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 4:

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 5:

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:
C601-01	Understand the deformation behaviour of materials to external loads
C601-02	Understand the importance and use of various rolling mills
C601-03	Understand the use of various metal forming processes
C601-04	Solve numerical problems encountered in various 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
CO1:	2	1				3			2	1		1
CO2:	2	1	1			3			1	1		1
CO3:						3			2	2		
CO4:	3					3			2			3

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

Program: B.Tech | **Semester: VI**
Name of the Course: Materials Characterization | **Code: SOE-B-MME602**
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 learn relation between material structure and its properties.
2. To understand the concept to find the different properties of materials with the help of characterization techniques.
3. To understand the way to find the crystal structure of material.
4. To learn the processes of materials synthesis.
5. To solve the different problems related to physical and chemical property related parameters.

Syllabus:

UNIT 1:

Periodic patterns, lattices, unit cells, crystal structure, Stereography techniques, primitive and non-primitive cells, crystal systems and Bravais lattices, crystallographic directions and planes, Miller indices, bonding in materials and atomic packing, concept of co-ordination number.

UNIT 2:
Fundamentals of optics, optical microscope and its instrumental details, variants in the optical microscopes and image formation and phase contrast, polarised light, differential interference contrast, concept of fluorescence microscopy, sample preparation and applications of optical microscopes.

UNIT 3:
Principle of SEM, instrumentation details and related parameters and applications. SEM resolution, image formation, electron-specimen interaction, ancillary techniques available in the SEM. Principle of TEM, instrumentation details and related parameters and applications. TEM image formation, diffraction contrast, ancillary techniques available in the SEM and specimen preparation.

UNIT 4:
Fundamental basis of Spectroscopic analysis of UV-Visual (UV-VIS), IR & Raman spectroscopy, X-ray Fluoroscopy (XRF), Atomic absorption spectrometer (AAS), XPS (ESCA), Auger Electron Spectroscopy, EDS and WDS, EPMA and NMR.

UNIT 5:
Thermal analysis: DTA, TGA and DSC, TMA and dilatometer, working principle and applications. Principles of EBSD, X-ray diffraction: powder diffraction, phase identification, determination of crystal structure, lattice parameter, crystallite size by diffraction techniques.

Text/Reference Books:

1. F. Weinberg, Editor, Tools & Techniques in Physical Metallurgy, Vol. I & Vol. II, Marcel Dekker, 1970.
2. J. P. Sibilia, A guide to Material Characterization & Chemical Analysis, VCH Publishers, 1988.
3. J. M. Walls, Editor, Methods of Surface Analysis: Techniques & Applications, Cambridge University. Press, 1990.
4. B. D. Cullity, Elements of X-ray diffraction, Addison-Wesley Publishing Company, INC, 1978.
5. B. Wounderlich, Thermal Analysis, Academic Press, INC, 1990.
6. B. L. Gabriel, SEM: A user's manual for materials Science, American Society for Metals, 1985.
7. P. R. Khangaonkar, An Introduction to Materials Characterization, Penram International Publishing (India) Pvt. Ltd.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C602-01	Understand and describe the fundamental principles behind the methods of characterization.
C602-02	Analyze, interpret the different characterization methods.
C602-03	Assess which methods of characterization are appropriate for different material problems.

CO-PO & PSO Correlation

Course Name: Materials Characterization												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2	1	1						2			1
CO2:	1	1			1					2		1
CO3:	1	1		1	1	1			2	1		2

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:3 | **No of Hours: 3 hours/week**

Max. Marks: 100

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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 1:

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 2:

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 3:

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 4:
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, radiation exchange between black bodies separated by a non-absorbing medium, shape factor and its salient features, Heat exchange between two infinitely long and wide parallel plates, radiation shields, radiation from gases, vapours and flames, coefficient of radiant heat transfer and radiation combined with convection.

UNIT 5:
Mass Transfer: Fick's Law, general mass diffusion equation in stationary media, diffusion in solids, liquid and gases, diffusion in substitutional solid solution, diffusion of gases through porous solids, gas-solid reactions, mass transfer with vaporization.

Text Books:

1. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, Wiley, 1994.
2. G. H. Geiger and D. R. Poirier, Transport Phenomena in Materials Processing, Addison Wesley, Mass, 1994.

Reference Books:

1. N. J. Themelis, Transport and Chemical Rate Phenomena, Gordon Breach, New York, 1995.
2. Rate Processes in Metallurgy. – A.K. Mohanty.
3. R. I. L. Guthrie, Engineering in Process Metallurgy, Oxford Science, 1992.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
CCO603-01	Know the significance of fluid dynamics, heat and mass transfer concept and its application in Metallurgical processes.
CCO603-02	Explain the concept with a practical example related to the metallurgical process.
CCO603-03	Solve numerical problems encountered in various metallurgical processes.

CO-PO & PSO Correlation

Course Name: Transport Phenomena in Metallurgical Processes												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**					**1**			**1**	**1**		**2**
CO2:		**1**	**1**		**1**	**1**			**2**			**2**
CO3:	**1**	**1**	**1**		**1**	**1**			**2**	**2**		**1**

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

Program: B.Tech | **Semester: VI**
Name of the Course: Metal Joining Processes | **Code: SOE-B-MME604**
Credit:3 | **No of Hours: 3 hours/week**
Max. Marks: 100

Course Description:

The major aspect of this course is to introduce to various metal joining processes such as oxy-acetylene welding, resistance welding and also their advancements. The students would also learn how to find welding flaws and also how to remedy them in the industry.

Course Objectives:

1. To provide with the knowledge on basics of joining processes.
2. To gain the knowledge on the Gas and Arc welding and Resistance and Pressure welding processes.
3. To gain the knowledge on the special welding processes and soldering and brazing techniques.
4. To gain hands on experience on inspection and testing of weldments.

Syllabus:

UNIT 1:

Basic Science of welding processes, sources of heat energy, the flame, the electric arc. chemical reactions during welding, oxidation reaction, protection of weld pool with fluxes or gases, microstructural changes during welding, the effect of heat on metals. pre-treatment and post-treatment of welds.

UNIT 2:

Gas and arc welding processes: Classification of welding processes- heat sources and shielding methods- fusion welding processes, oxy-acetylene welding, arc welding- manual, submerged arc welding, gas tungsten arc and gas metal arc welding; their advantages and disadvantages. Resistance and pressure welding processes, cold and hot pressure welding, friction stir welding, and diffusion welding, resistance welding- spot and projection welding, advantages and disadvantages.

UNIT 3:

Special welding processes emphasizing principle, equipment, process variables, merits, limitations and applications of electron beam, plasma arc, laser beam and Thermit welding processes, soldering and brazing. Practice of soldering, types of joints and fabrications. Role of fluxes, filler materials heat sources and heat transfer and heat sources, Different types of brazing and braze welding.

UNIT 4:
Welding of structural steels, cast iron, stainless steels, and other high-alloyed steels. Welding of non-ferrous alloys like aluminum, titanium, and copper, welding of dissimilar metals.

UNIT 5:
Inspection and testing of welds and joints like mechanical testing, non-destructive testing. Welding metallurgy- heat affected zone, phase transformation in HAZ, Weld defects and their causes and remedies.

Text / Reference Books:

1. Parmar, R.S., Welding Processes and Technology, 2nd edn. Khanna Pub., New Delhi, 2001.
2. ASM Metals Handbook. Vol.6. Welding Brazing & Soldering, ASM International, Metals Park, Ohio, USA, 1993.
3. AWS Welding Handbooks, AWS, New York, 1995
4. Davies-A C. Welding, 10th edition, Cambridge University Press, UK, 1996.
5. Howard B Cary., Modern Welding Technology, 4th edn., Prentice Hall, New Jersey, USA, 1997.
6. Lancaster. J.F., Metallurgy of Welding, George Allen Co, Boston, 1980.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C604-01	Understand the overview of joining processes.
C604-02	Understand the welding process and related physics of welding.
C604-03	Understand the practical applications of welding for ferrous and non-ferrous metals.

CO-PO & PSO Correlation

Course Name: Metal Joining Processes												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2								2			1
CO2:	2	1					1	1	1			1
CO3:	1		1		1	1			1			1

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

Program: B.Tech **Semester: VI**

Name of the Course: Advanced Materials and Processes (Professional Elective-I) **Code: SOE-B-MME605 (1)**

Credit:3 **No of Hours: 3 hours/week**

Max. Marks: 100

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Course Description:

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

Course Objectives:

To develop an understanding of the principles, capabilities, limitations and applications of advanced materials and processing technologies along with an in- depth knowledge.

Syllabus:

UNIT 1:

Atomic structure and bonding, crystal structures lattices, indices etc. with examples of atomic structures and bonding types, order and disorder, diffusion mechanisms, deformation mechanisms, defects in crystals, strengthening mechanisms, introduction to metastable and functional alloys.

UNIT 2:

Metallic foams, processing of Ni- base super alloys for turbine engine discs, mechanically alloyed oxide dispersion strengthened super alloys, Gamma-Titanium aluminides, stainless steels for high temperature applications, various stages of creep, design of transient creep, Monkman-Grant relationship.

UNIT 3:

Low dielectric constant materials, optoelectronic materials. Introduction to bulk metallic glasses, soft and hard magnetic materials and their applications. Shape memory alloys and its concepts, band model of semiconductors, basic concepts of Hall effect and Hall sensor devices.

UNIT 4:

Concept of nano materials, advantages and limitations at the nano level, thermodynamic aspects at the nano level, size effect of structural and functional properties, processing methods of nanomaterials, nano tubes, nano wires, applications of nanomaterials. Advanced Processes like PVD, CVD, single crystal growth, rapid solidification etc.

UNIT 5:

Solid state sintering, composite interfaces, bonding mechanisms, other interfacial properties, types of polymer matrix composites, metal matrix composites, ceramic matrix composites, high strength and ductile bulk quasi crystalline alloys and their composites, introduction to additive manufacturing.

Text Books:

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

Reference Books:

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

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C605(1)-01	Understand the various processing and manufacturing techniques.
C605(1)-02	Learn the various processing of advanced materials.
C605(1)-03	Understand the basic properties of materials and apply these properties to a specific related outcome.
C605(1)-04	Understand the advanced mechanical manufacturing processes e.g. microscale and nano-scale technologies.

CO-PO & PSO Correlation

Course Name: Advanced Materials and Processes												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1					1			2			1
CO2:	1	2			1	1			2	1		2
CO3:			1		1	1			1	1		1
CO4:		2	1			1	1	1	1	2		1

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

Program: B.Tech **Semester: VI**

Name of the Course: Solar Energy Materials (Professional Elective-I) **Code: SOE-B-MME605 (2)**

Credit:3 **No of Hours: 3 hours/week**

Max. Marks: 100

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Course Description:

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

Course Objectives:

1. To learn the fundamentals of solar energy conversion systems, available solar energy and the local and national needs, photovoltaic and photothermal engineering applications, emerging technologies;
2. To understand the interdisciplinary approach for designing stand-alone PV systems, predicting performance with different systems, implementing design with cost analysis;
3. To learn photovoltaic energy conversion: generation, storage, and grid connection processes for residential and industrial applications;
4. To be familiar with current technology of the solar energy systems for making the process economical, environmentally safe and sustainable.

Syllabus:

UNIT 1:

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

UNIT 2:

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

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

UNIT 4:
PV materials: silicon - single crystalline, polycrystalline, ribbon, amorphous; CdS, CuInSe2, CdTe, GaAs, InP. AR coatings, Ohmic contacts, inter-connection and sealing; energy and cost considerations for terrestrial applications.

UNIT 5:
Photo-electrochemical hydrogen production, photo-electrochemical cells, solar-to- hydrogen efficiency; hydrogen storage, hydrogen economy, electrochemical storage of energy, current developments in energy storage.

Text Books:

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

Reference Books:

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

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C605(2)-01	Understand the concept of solar energy, its conversion and utilization processes.
C605(2)-02	Learn various solar technologies and materials related.
C605(2)-03	Understand the challenges in sustainable energy processes.
C605(2)-04	Understand the manufacturing processes involved environmental challenges that need to be solved, economic aspects, and future potentials of solar energy utilization.

CO-PO & PSO Correlation

Course Name: Solar Energy Materials												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**2**					**1**			**2**			**1**
CO2:		**2**	**1**		**1**				**1**			**1**
CO3:	**2**						**2**	**1**			**1**	**2**
CO4:	**1**		**1**		**1**	**1**		**2**	**1**		**2**	

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

Program: B.Tech **Semester: VI**

Name of the Course: Surface Engineering (Professional Elective-I) **Code: SOE-B-MME605 (3)**

Credit:3 **No of Hours: 3 hours/week**

Max. Marks: 100

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Course Description:

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

Course Objectives:

1. To be familiar with basics of surface cleaning process.
2. To know the relationship between metal and atmosphere.
3. To know the basic setup of electroplating and related to equipment for coating.
4. To know the various application arears in industry.

Syllabus:

UNIT 1:

Scope and application of surface engineering, classifications of surface engineering methods, typical thickness related to various surface engineering methods, substrate and pretreatment processing, role of surface cleanliness and surface finish, criteria for selection of cleaning process.

UNIT 2:

Principles of electroless and electroplating, setup for electroplating, baths for electroless plating, baths for electroplating, role of bath constituents, structure of coating, plating practices for electroplating of non-ferrous metals and alloys, multilayer, alloy plating etc. Electroless plating of non-ferrous metals and alloys, electroless plating of industrial alloys.

UNIT 3:

Principle of hot-dip method, structure of hot-dip coating, batch process and continuous process, its scope and limitations, coating Zn, Zn-Al and Sn by hot-dip method, pre and post surface treatment, interfacial reactions and evolution of phases during galvanizing.

UNIT 4:

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

UNIT 5:

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

Text Books:

1. Surface Engineering & Heat Treatment Past, present and Future, Edited by P. H. Morton, Published by the Institute of Metals, London, 1991.
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:
C605(3)-01	Have fundamental knowledge on surface technologies.
C605(3)-02	Learn to analyze the surface engineering issues.

CO-PO & PSO Correlation

Course Name: Surface Engineering												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2					1		1	2			1
CO2:	1	1				1	1			2		1

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

Program: B.Tech | **Semester: VI**
Name of the Course: Fracture Mechanics and Failure Analysis (Professional Elective-I) | **Code: SOE-B-MME605 (4)**
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, 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:

UNIT1:

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 2:

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

UNIT 3:

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 4:

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 5:

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:
C4235(2)-01	Predict material failure for any combination of applied stresses.
C4235(2)-02	Estimate failure conditions of a structure.
C4235(2)-03	Determine the stress intensity factor for simple components of simple geometry.
C4235(2)-04	Predict the likelihood of failure of a structure containing a defect.

CO-PO & PSO Correlation

Course Name: Fracture Mechanics and Failure Analysis												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2					1			2	1		1
CO2:		1	1		1				1	1		2
CO3:	2		1			1			1	1		
CO4:				1	2	1			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

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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:
C606-01	Have knowledge on basic principles of the advanced equipment.
C606-02	Solve and analyze a problem from an industry/Institute.
C606-03	Select and redesign the material problem.
C606-04	Solve the problems through experiments to reach the sustainable solution.

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
CO1:	2	2				2			2			1
CO2:	1	1			1	1			2	2		1
CO3:	1	1	2		1	1			2	2		1
CO4:		1		1	1	1			2	2		1

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

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

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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. 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:
C607-01	Have practical exposure of various welding processes.
C607-02	Understand the various parameters used in Welding.

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
CO1:	2		1			1	1		2			1
CO2:	1	1				1			1	1		1

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

Program: B.Tech
Name of the Course: Transport Phenomena in Metallurgical Processes Lab
Credit:2
Max. Marks: 50

Semester: VI
Code: SOE-B-MME608

No of Hours: 4 hours/week

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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:
C608-01	Understand the significance of Transport phenomena concept in various metallurgical processes.
C608-02	Analyze the various principles in heat and mass transfer in metallurgical process.

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
CO1:	2					1			2			1
CO2:	1	1			1	1				2		1

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

Program: B.Tech | **Semester: VI**
Name of the Course: Professional Development | **Code: SOE-B-MME609**
Credit:1 | **No of Hours: 2 hours/week**
Max. Marks: 50

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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 1: 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 2: 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 3: Problem Solving Skills
Problem-solving, Concept of Problem-solving, Process of Problem-Solving, Technique for Problem Solving. Challenges in Generating Creative Ideas.

UNIT 4: 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 5: 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:
C609-01	Distinguish between leadership and management.
C609-02	Recognize their own leadership style.
C609-03	Identify and understand various approaches in leading others.
C609-04	Employ key competencies of visioning, aligning, delegation, motivating and inspiring others.
C609-05	Recognize the need for collective problem solving and apply appropriate techniques.
C609-06	Understand time pressures and the need for time management.
C609-07	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
CO1:				2	2	1					2	2
CO2:				2	1	1					2	1
CO3:	1	1		1	1	1			1		1	1
CO4:				1	1	1	1				1	2
CO5:		1			1	1					1	1
CO6:					2	2					2	2
CO7:				1	3	1					2	1

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

B. Tech (Metallurgical and Materials Engineering)

(7th SEMESTER SYLLABUS)

Program: B.Tech | **Semester: VII**
Name of the Course: Long Term Internship | **Code: SOE-B-MME701**
Credit:22 | **No of Hours: 44 hours/week**
Max. Marks: 500

Course Description:

Every student of 7th semester has to undergo six-month Long-Term 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 (study load of 24) 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:
C701-01	Gain knowledge of a specific company/industry about various job functions.
C701-02	Acquire specific skills, confidence, competency towards carrier front.
C701-03	Work independently with sensitivity for the organization.
C701-04	Practice communication and teamwork skills.
C701-05	Understand effective management of personal behaviour, ethics and attitudes.

CO-PO & PSO Correlation

Course Name: Long Term Internship												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1	2							1	2		2
CO2:	1	1				2				2		2
CO3:		1					1	1		1		1
CO4:				2			1	1				2
CO5:							2	2				2

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

B. Tech (Metallurgical and Materials Engineering)

(8TH SEMESTER SYLLABUS)

Program: B.Tech | **Semester: VIII**
Name of the Course: Alloys their Properties and Selection | **Code: SOE-B-MME801**
Credit:4 | **No of Hours: 4 hours/week**
Max. Marks: 100

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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 1:

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 2:

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

UNIT 3:

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 4:
Introduction to Non-ferrous alloys, structure and properties of brasses, bronzes, babbits, structure and properties of titanium alloys, aluminum alloys, monels.

UNIT 5:
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:
C801-01	Attain an ability to distinguish between various alloying effects.
C801-02	Have an increased level of awareness towards alloys and their applications.
C801-03	Have knowledge on production of alloy steel, cast iron and nonferrous alloys as per their need.
C801-04	Apply their basic understanding in development of alloys with better properties.

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**
CO1:	**2**					**1**			**2**			**1**
CO2:				**1**	**1**	**1**			**1**			**1**
CO3:		**1**	**1**		**1**	**1**			**1**			**1**
CO4:	**1**				**1**				**1**			**2**

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

Program: B.Tech
Name of the Course: Corrosion Engineering
Credit:4
Max. Marks: 100

Semester: VIII
Code: SOE-B-MME802
No of Hours: 4 hours/week

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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 1:

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 2:

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 3:

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 4:

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

UNIT 5:

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:
C802-01	Learn the applications of cathodic and anodic protection to engineering systems.
C802-02	Have fundamental knowledge on of electrochemical reaction of alloys and cathodic and anodic relations.
C802-03	Analyze the Tafel curve in acid, gases and mixture of both.
C802-04	Construct a system for protection of materials through various coating.

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
CO1:	2	1				1			1	1		1
CO2:	2	1	1			1		1	1	1		1
CO3:	1	2	1			1			1	2		2
CO4:			1		1				1	1		1

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

Program: B.Tech
Name of the Course: Open Elective – I
Credit:3
Max. Marks: 100

Semester: VIII
Code: SOE-B- OPE-803 (1-39)
No of Hours: 3 hours/week

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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. This course is also having PRE and ESE which contains 50+50 = 100 marks. PRE segment is as Teaching Assessment (TA) 20 marks and Mid Semester Examination of 30 Marks. Minimum pass marks for PRE is 15 and for ESE is 15. But overall marks of these two must be of 35 marks.

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:

As per the department recommends.

Course Outcomes:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C803-01	Accomplish a prior idea of building efficiency beside own core area.
C803-02	Get a multidisciplinary expose.
C803-03	Achieve a potential for employability significantly improved after studying.
C803-04	Gain a good entrepreneurship idea with the knowledge.
C803-05	Commitment towards environment and responsibility to the society will be considerably improved.

CO-PO & PSO Correlation

Course Name: Open Elective - I												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	1			1		1			1			1
CO2:	1		1			1			1			1
CO3:		1			1	1			1			2
CO4:				1	2		1					2
CO5:					1	1		2			1	1

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

Program: B.Tech
Name of the Course: Introduction to Stainless Steel
Credit:3
Max. Marks: 100

Semester: VIII
Code: SOE-B-MME804 (1)
No of Hours: 3 hours/week

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 1:

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 2:

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 3:
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 4:
Testing of Stainless Steel: PMI technique, other NDT methods, handling and storage of stainless steel, recommended procedures for storage.

UNIT 5:
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:
C804(1)-01	Distinguish between various stainless steels.
C804(1)-02	Have an increased level of awareness towards stainless steel and their applications.
C804(1)-03	Have fundamental understanding of the phase transformations in ferrous alloys.
C804(1)-04	Apply their basic understanding in development of alloys with better properties.

CO-PO & PSO Correlation

Course Name: Introduction to Stainless Steel												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:		**2**	**1**			**2**			**2**			**1**
CO2:	**1**	**3**	**2**			**2**			**2**	**2**		**1**
CO3:	**1**	**3**	**2**			**2**			**2**	**2**		**1**
CO4:	**1**	**3**	**2**			**2**			**2**	**2**		**1**

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

Program: B.Tech | **Semester: VIII**

Name of the Course: Introduction to Nano-Science and Nano-Technology | **Code: SOE-B-MME804 (2)**

Credit:3 | **No of Hours: 3 hours/week**

Max. Marks: 100

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Course Descriptions:

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. Knowhow the potential impact of nano-science in applications.
5. Adopt current challenges of nano-technology.

Syllabus:

UNIT 1:

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 2:

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 3:

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

UNIT 4:

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 5:
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:
C4804(2)-01	Understand the need to increase nanotechnology awareness.
C4804(2)-02	Explain the fundamental principles for the different synthesis techniques.
C4804(2)-03	Understand the nanomaterials and physical and chemical properties at the nanoscale.
C4804(2)-04	Explain general concepts and physical phenomena of relevance within the field of nano-science.
C4804(2)-05	Know the processing and characterization tools/equipment to synthesize nano- particles.
C4804(2)-06	Know the application areas of the nano-particles.

CO-PO & PSO Correlation

Course Name: Introduction to Nanoscience and Technology												
Course Outcomes	**Program Outcomes**								**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**
CO1:	**1**		**1**						**1**			
CO2:	**2**	**1**				**1**			**1**			**1**
CO3:	**1**		**1**						**1**			**1**
CO4:				**1**	**1**	**1**			**1**		**1**	**1**
CO5:	**1**	**2**	**1**			**1**			**2**	**1**		**1**
CO6:	**1**		**1**			**1**			**1**			**1**

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

Program: B.Tech | **Semester: VIII**
Name of the Course: Ceramic and Powder Metallurgy (Professional Elective-II) | **Code: SOE-B-MME804 (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 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:

This course aims to build the necessary background of emergence and importance of:

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 1:

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 2:

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 3:

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 4:

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 5:

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 Outcome:

CO	Metallurgical and Materials Engineering Graduates will be able to:
C804(3)-01	Understand the fundamental principles and properties of ceramics such as structure, physical and chemical properties.
C804(3)-02	Have fundamental knowledge on principles of the powder metallurgy part production.
C804(3)-03	Have knowledge of particular powders preparation, their properties, compaction techniques.
C804(3)-04	Conceptualize the blend between theory and practical knowledge especially understanding the key parameters of powder metal processing.
C804(3)-05	Work effectively as an individual member of a multidisciplinary team in any scientific team/industry.

CO-PO & PSO Correlation

Course Name: Ceramics and Powder Metallurgy												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2					1			2			
CO2:		1	1			1			1	2		1
CO3:		2	1			1			1	1		1
CO4:						2			1			1
CO5:				2	1							2

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

Program: B.Tech
Name of the Course: Light Weight Materials
Credit:3
Max. Marks: 100

Semester: VIII
Code: SOE-B-MME804 (4)
No of Hours: 3 hours/week

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 1:

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 2:

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

UNIT 3:

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

UNIT 4:

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

UNIT 5:

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:
C804(4)-01	Attain sound knowledge on microstructures, properties, and applications of several nonferrous alloys such as Al, Be, Mg, Ti alloys.
C804(4)-02	Design light alloys for specific metallurgical applications.

CO-PO & PSO Correlation

Course Name: Light Metals												
Course Outcomes	Program Outcomes								PSOs			
	1	2	3	4	5	6	7	8	1	2	3	4
CO1:	2		1			1			1			1
CO2:	1	1	1			1			1	1		1

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

Program: B.Tech | **Semester: VIII**
Name of the Course: Corrosion Engineering Lab | **Code: SOE-B-MME805**
Credit:2 | **No of Hours: 2 hours/week**
Max. Marks: 50

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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. Disc Wear Testing Machine
2. Potentiostat.
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:
C805–01	Have the knowledge of different corrosion and surface engineering laboratory related equipment.
C805–02	Hands on experience on various surface medication techniques related to corrosion and wear methods.

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
CO1:	2	2	1	1				1	1	1		1
CO2:	2	2	1	1				1	1	1		1

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