DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –I TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	SH0101	Differential Calculus and Matrix Algebra	04	02	00	05	06	30	10	60	00	00	100
2	SH0001	Engineering Physics	03	00	02	04	05	30	10	60	40	60	200
3	EL0001	Electrical Workshop	00	00	02	01	02	00	00	00	40	60	100
4	EL0002	Elements of Electrical Engineering	03	00	02	04	05	30	10	60	40	60	200
5	ME0001	Engineering Graphics	01	06	00	04	07	30	10	60	00	00	100
6	EC0001	Basic Electronics	02	00	02	03	04	30	10	60	40	60	200
7	MT0001	Materials Science	03	00	00	03	03	30	10	60	00	00	100
8	SH0102	Technical English	01	02	00	02	03	30	10	60	00	00	100
TOTAL			**17**	**10**	**08**	**26**	**35**	**210**	**70**	**420**	**160**	**240**	**1100**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –II TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017

SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	SH0201	Integral Calculus and Linear Algebra	04	02	00	05	06	30	10	60	00	00	100
2	SH0002	Engineering Chemistry	03	00	02	04	05	30	10	60	40	60	200
3	ME0004	Mechanical Workshop	00	00	02	01	02	00	00	00	40	60	100
4	ME0002	Elements of Mechanical Engineering	03	00	02	04	05	30	10	60	40	60	200
5	CE0001	Computer Programming	03	00	02	04	05	30	10	60	40	60	200
6	CV0002	Engineering Mechanics	03	02	00	04	05	30	10	60	00	00	100
7	CV0001	Environmental Science	01	00	02	02	03	30	10	60	40	60	200
8	SH0202	Business Communication and Presentation Skill	01	02	00	02	03	30	10	60	00	00	100
TOTAL			**18**	**06**	**10**	**26**	**34**	**210**	**70**	**420**	**200**	**300**	**1200**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –III TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
			L	T	P			CIE		ESE	CIE	ESE	
								MID	IE				
1	SH0301	Differential Equations and Integral Transforms	03	02	00	04	05	30	10	60	00	00	100
2	MT0301	Mineral Processing	03	00	02	04	05	30	10	60	40	60	200
3	MT0302	Structural Metallurgy and Physics of Materials	03	02	00	04	05	30	10	60	00	00	100
4	MT0303	Fuels Furnaces and Refractories	03	02	00	04	05	30	10	60	00	00	100
5	MT0304	Physical Metallurgy of Ferrous Alloys	03	02	02	05	07	30	10	60	40	60	200
6	MT0305	Environmental Pollution and Control in Metallurgical Industries	03	00	00	03	03	30	10	60	00	00	100
7	SH0307	Human Values and Professional Ethics	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**19**	**08**	**04**	**24**	**31**	**180**	**60**	**360**	**80**	**120**	**800**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –IV TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017

SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	SH0401	Complex Analysis and Numerical Methods	03	02	00	04	05	30	10	60	00	00	100
2	MT0401	Physical Metallurgy of Non-Ferrous Alloys	03	00	02	04	05	30	10	60	40	60	200
3	MT0402	Introduction to Process Metallurgy	03	02	00	04	05	30	10	60	00	00	100
4	MT0403	Transport Phenomena	03	02	02	05	07	30	10	60	40	60	200
5	MT0404	Metallurgical Thermodynamics	03	02	00	04	05	30	10	60	00	00	100
6	MT0405	Energy Economy and Waste Management	03	00	00	03	03	30	10	60	00	00	100
7	CE0407	Cyber Security and Intellectual Property Right	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**19**	**08**	**04**	**24**	**31**	**180**	**60**	**360**	**80**	**120**	**800**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –V TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017

SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0501	Heat Treatment Principles and Practices	03	00	02	04	05	30	10	60	40	60	200
2	MT0502	Iron Making	04	00	02	05	06	30	10	60	40	60	200
3	MT0503	Foundry Technology	04	00	02	05	06	30	10	60	40	60	200
4	MT0504	Non Ferrous Extractive Metallurgy	03	02	00	04	05	30	10	60	00	00	100
5	MT0505	Plastic Deformation of Metals	03	02	00	04	05	30	10	60	00	00	100
6	MT0506	Surface Engineering	04	00	00	04	04	30	10	60	00	00	100
7	SH0507	Technical Communication and Soft Skills	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**22**	**04**	**06**	**26**	**32**	**180**	**60**	**360**	**120**	**180**	**900**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –VI TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017

SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0601	Steel Making	04	02	00	05	06	30	10	60	00	00	100
2	MT0602	Electrometallurgy and Corrosion	04	00	02	05	06	30	10	60	40	60	200
3	MT0603	Powder Metallurgy	04	00	02	05	06	30	10	60	40	60	200
4	MT0604	Metal Forming	03	02	00	04	05	30	10	60	00	00	100
5	MT0605	Material Characterization (EL – 1)	03	02	00	04	05	30	10	60	00	00	100
	MT0611	Computational Materials Science (EL – 1)											
	MT0612	MOOC Course – 1 (EL – 1)											
6	MT0606	Industrial Ceramics and Polymers (EL – 2)	04	00	00	04	04	30	10	60	00	00	100
	MT0607	Nano Technology (EL – 2)											
	MT0608	Composite Materials (EL – 2)											
	MT0609	Nuclear Metallurgy (EL – 2)											
	MT0610	Modelling of Metallurgical (EL – 2)											
7	SH0607	Advanced Technical Communication and Soft Skills	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**23**	**06**	**04**	**27**	**33**	**180**	**60**	**360**	**80**	**120**	**800**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –VII TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017

SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0701	Metal Joining Processes	03	00	02	04	05	30	10	60	40	60	200
2	MT0702	Non-Destructive Testing	04	00	00	04	04	30	10	60	00	00	100
3	MT0703	Alloy Design	03	02	00	04	05	30	10	60	00	00	100
4	MT0704	Material Testing and Standards	03	00	02	04	05	30	10	60	40	60	200
5	MT0705	Selection of Materials and Failure Analysis	03	02	00	04	05	30	10	60	00	00	100
6	MT0706	Advanced Ferrous Metallurgy (EL – 3)	04	00	00	04	04	30	10	60	00	00	100
	MT0707	Advanced Materials and Applications (EL – 3)											
	MT0708	Advanced Foundry Technology (EL – 3)											
	MT0709	Phase Transformations (EL – 3)											
	MT0710	Advances in Thin Film Technology (EL – 3)											
	MT0711	Industrial Welding Codes and Standards (EL – 3)											
	MT0712	MOOC Course – 2 (EL – 3)											
7	CV0712	Disaster Management	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**21**	**04**	**04**	**24**	**29**	**180**	**60**	**360**	**80**	**120**	**800**

DEPARTMENT OF METALLURGICAL ENGIEERING
INDUS INSTITUTE OF TECHNOLOGY & ENGINEERING
INDUS UNIVERSITY

B-TECH METALLURGICAL ENGINEERING, SEMESTER –VIII TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0801	Project	00	00	40	20	40	00	00	00	120	180	300
TOTAL			**00**	**00**	**40**	**20**	**40**	**00**	**00**	**00**	**120**	**180**	**300**

1ST SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –I TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017													
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	SH0101	Differential Calculus and Matrix Algebra	04	02	00	05	06	30	10	60	00	00	100
2	SH0001	Engineering Physics	03	00	02	04	05	30	10	60	40	60	200
3	EL0001	Electrical Workshop	00	00	02	01	02	00	00	00	40	60	100
4	EL0002	Elements of Electrical Engineering	03	00	02	04	05	30	10	60	40	60	200
5	ME0001	Engineering Graphics	01	06	00	04	07	30	10	60	00	00	100
6	EC0001	Basic Electronics	02	00	02	03	04	30	10	60	40	60	200
7	MT0001	Materials Science	03	00	00	03	03	30	10	60	00	00	100
8	SH0102	Technical English	01	02	00	02	03	30	10	60	00	00	100
TOTAL			**17**	**10**	**08**	**26**	**35**	**210**	**70**	**420**	**160**	**240**	**1100**

Subject: **Differential Calculus and Matrix algebra**								
Program: **B.Tech. All**				Subject Code: **SH0101**			Semester**: I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	2	0	5	24/60	-	16/40	-	100

Course Objectives

1. To analyze mathematical knowledge and skills needed to support their concurrent and subsequent engineering studies.
2. To analyze knowledge of basic science and engineering fundamentals.
3. To describe an ability to undertake problem identification, formulation and solution.
4. To analyze different mathematical models within science and technology and work creatively, systematically and critically.
5. To describe the solution of different types of mathematical models using knowledge about the possibilities and limitations of the different methods and tools.
6. To analyze an ability to develop abstract, logical and critical thinking and the ability to reflect critically upon their work and work of others.
7. To analyze their strengths and weakness as learners and to appreciate the value of errors or mistakes as powerful motivators to enhance learning and understanding.

CONTENTS

UNIT-I

[10 hours]

Differential Calculus

Derivatives of nth Derivative of some Elementary Functions
Leibnitz's Theorem
Taylor's Series and Maclaurin's Series Expansions
Indeterminate Forms.
Functions of Several Variables: Limit and Continuity

UNIT-II

[13 hours]

Partial Differentiation and its Applications

Partial Differentiation
Variable Treated as Constant, Total Derivative
Partial Differentiation of Composite Functions: Change of Variable-Differentiation of an Implicit

Function -Euler's Theorem
Jacobian, Error and Approximations
Taylor's Theorem for Function of two Variables
Maxima and Minima of Functions of two Variables: with and without constraints
Lagrange's Method of Undetermined Multipliers.

UNIT-III

[13 hours]

Basic of Matrix algebra
Concepts of Determinants and Matrices, Types of Matrices
Row Echelon and Reduced Row Echelon form
Inverse of a Matrix, Rank of a Matrix, Normal Form
System of Linear Homogeneous Equations
System of Non-Homogeneous Equations, Gaussian Elimination Method

UNIT-IV

[12 hours]

Vector Differential Calculus
Curvilinear coordinate system, Cartesian, Spherical and Cylindrical coordinate system
Vector Differentiation, Directional Derivative, Gradient of a Scalar Function and Conservative Field
Directional Derivative, Gradient of a Scalar Function and Conservative Field
Divergence and Curl, Related Properties of Gradient, Sums of Divergence and Curl

Course Outcomes

1. Apply the knowledge of multivariable calculus for solving various practical & engineering problems.
2. Apply the concept of power series expansion of one and two variable functions in Taylor's and Maclaurin's series.
3. Apply the basic concept of partial derivatives and their applications.
4. Apply the knowledge of Lagrange's method of undetermined multipliers.

Text Books

1. B.V.RAMANA: "HIGHER ENGINEERING MATHAMATICS", TATA McGraw Hill**.** 6th Edition", 2006, ISBN: 007063419X
2. R K Jain, S R K Iyengar: " Advanced Engineering Mathematics. Narosa Publishing House, 3rd Edition", 2002, ISBN: 817319730X

Reference Books

1. Erwin Kreyszig: "Advanced Engineering Mathematics (8th Edition) ",Wiley Eastern Ltd., New Delhi. 8th Edition , 2004, ISBN: 9971512831
2. Dr. B.S. Grewal : "Higher Engineering Mathematics", Khanna Publishers, New Delhi ,

44th Edition, 2010, ISBN:8174091955
3. Murray Spiegel : "Advanced Mathematics for Engineering & Science: Schaum's Outline Series" ,Tata - McGraw Hill Publication 3rd Edition, 2010, ISBN: 9780071623667
4. Merel C Potter, J L Goldberg: "Advanced Engineering Mathematics (3rd Edition)"Oxford India Publication. . 3rd Edition, 2005, ISBN: 0195681428

Web Resources

1. Calculus by IIT Kanpur (https://www.youtube.com/watch?v=0lzOAW8yMTc)
2. Linear Algebra by Prof. K. C. Shivakumar (http://nptel.ac.in/courses/111106051/)

Subject: **Engineering Physics**								
Program: **B.Tech. All**				Subject Code: **SH0001**			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	24/60	16/40	16/40	200

Course Objectives

1. To describe the basic laws of Physics, mathematical foundations and Engineering theory and to apply the knowledge in modeling and designing a real-world problem (fundamental engineering analysis skills).
2. To analyze a problem, identify and formulate using the concept of physics and to solve engineering problem (engineering problem solving skills).
3. To analyze and interpret experimental data using concepts of Physics (information retrieval skills).
4. To analyze and use current techniques, skills and tools necessary for Physics and engineering practice (practical engineering analysis skills).

CONTENT

UNIT-I

[12 hours]

Wave motion and Sound

Propagation of waves, longitudinal and transverse waves, mechanical and non-mechanical waves
Introduction to sound waves, Characteristics and Properties of Sound, Absorption co-efficient, Reverberation time, Sabine's formula (without derivation), Factors affecting architectural acoustics,
Introduction of Ultrasonic waves, Generation of ultrasonic waves, Detection of ultrasonic waves, Applications of Ultrasonic waves: NDT, SONAR & others.

Optics

Introduction to Reflection, Refraction and Total Internal Reflection;
Wavefront and Huygen's principle; Interference: Types of interferences, Thin film interference, Newton's rings and its applications
Diffraction of light waves: Types of Diffraction, Single-slit Fraunhoffer diffraction, Plane diffraction grating, Resolving power of grating, Rayleigh Criterion, Optical polarization (Introduction)

UNIT-II

[11 hours]

Quantum Mechanics

Black body radiation: Planck's law (without derivation), Wien's displacement law and Rayleigh – Jeans' law from Planck's theory; Compton effect (Theory and experimental verification), De-Broglie theorem, Uncertainty principle; Schrodinger's wave equation – Time independent and time dependent equations – Physical significance of wave function, Particle in one dimensional rigid box.

Laser

Energy levels in atoms, Absorption, Spontaneous Emission and Stimulated Emission of light, Relation between Einstein's Coefficients, Population Inversion, Metastable State, Pumping Mechanism, Optical Resonators, Fundamentals of LASER, Characteristics of Laser radiation
Types of Laser: Solid State Laser (Nd-YAG laser), Gas laser (He-Ne laser), Applications of Laser: Medical, Industrial, Holography (introduction).

UNIT-III

[12 hours]

Electromagnetism & Dielectrics

Coulomb's law for distribution of charges, Gauss's law and applications, Electric current and Equation of continuity, Electric field intensity, Electric flux, Electric dipole moment, Electric field due to dipole, Introduction to dielectrics, Polarizability, Types of polarization – electronic, ionic, orientational, Polarization of dielectrics, Gauss's law in presence of dielectric, Dielectric constant, Electric susceptibility and Permittivity, Internal (Local) field in dielectric, Clausius Mossotti equation (with derivation)
Magnetic field, Steady current, Biot-Savart law, Ampere's law and applications, Faradays law of Induction, Lenz's Law; Effect of magnetic field on current carrying conductor, Lorentz force

Magnetism

Basic important terms and units in Magnetism, Concept and origin of magnetic moment, magnetic susceptibility, Total angular momentum, Diamagnetism, Paramagnetism, Ferromangnetism, Ferrimagnetism, Antiferromagnetism, Domain theory of Ferromagnetism, Curie temperature and hysteresis loss

UNIT-IV

[10 hours]

Superconductivity

Superconductivity: Zero resistance, Critical temperature, Meissner effect, Critical field, General properties of superconductors**,** Type-I and Type-II superconductors, BCS theory of Superconductor, High temperature superconductors
Applications of Superconductors: SQUID, Maglev

Nanophysics

Nanoscale, Surface to volume ratio, Surface effects on nanomaterials, Quantum size effect, Electron confinement, Nanoparticles and Nanomaterials, Properties of Nanomaterials
Advantages & Disadvantages of Nanomaterials**,**
Synthesis of nanomaterials: Laser ablation, ball milling, chemical vapor deposition, sol gel, Carbon nanotubes: structure, synthesis, properties and applications, Applications of Nanomaterials.

Course Outcomes

1. To apply the concepts of Physics in various branches of Engineering.
2. To apply the knowledge of Physics to formulate and solve Engineering problems through numerical analysis & laboratory methods.
3. To apply the techniques, skills and modern tools of Physics necessary for Engineering applications.
4. To apply the basic idea of Physics to design and conduct experiments, analyze and interpret data.
5. To apply the concepts of Physics to design a system, a component, a process or a measurement technique to meet specific criteria
6. To apply the knowledge of contemporary issues and to function on multidisciplinary teams

Text Books

1. Engineering Physics by Rajendran ,Tata Mc Graw-Hill Education Pvt. Ltd., First edition, 2010, ISBN: 0071070141/9780071010140.
2. Engineering Physics by D.K. Bhattacharya, Poonam Tandon ,Oxford University Press, First published, 2015, ISBN-13:978-0-19-945281-1

Reference Books

1. Engineering Physics;Fundamentals and Modern applications by P. Khare & A. Swarup ,Jones & Bartlett Learning, 2009, ISBN-13: 978-0763773748
2. A textbook of Engineering Physics by S.O. Pillai and Sivakami,New Age International, Third edition, 2011, ISBN:978-81-224-3162-9
3. An introduction to Electrodynamics by David Griffiths,Pearson Education, 3th edition, 1999,ISBN:9780138053260
4. Optics by A. Ghatak , McGraw-Hill Education India Private Limited, 6th edition, 2017, ISBN-13:978-9339220907
5. Engineering Electromagnetics by W H Hayt & J A Buck, McGraw-Hill Education, 8th edition, 2017, ISBN-13:978-9339203276
6. Engineering Physics by K. Rajagopal ,Prentice Hall of India Pvt. Ltd., 2007, ISBN: 9788120332867
7. A Textbook of Engineering Physics by M. N. Avadhanulu, P. G. Khirsagar , S.Chand Pub., Revised edition, 1992, ISBN: 9788121908177
8. University Physics, Sears and Zemansky, Pearson Education India, 13th edition, 2013, ISBN-13:978-8131790274

Web resources

1. Topics: Acoustics & Optics (http://www.nptel.iitm.ac.in/courses/Webcourse-contents/ IIT%20Guwahati/engg_physics/index_cont.htm)
2. Course: Engineering Physics (http://www.nptelvideos.in/search?q=engineering+physics)
3. Topic: Laser(http://science.howstuffworks.com/laser1.htm)
4. Topic: Optics(http://www.pitt.edu/~poole/physics.html#light)
5. Topic: Magnetism (https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields)
6. Topic: Interference(https://www.khanacademy.org/science/physics/light-waves)
7. Topic: Quantum Mechanics(https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/index.htm

MOOCs:

1. https://www.edx.org/course/subject/physics

LIST OF EXPERIMENTS

Experiment no.	Title	Learning Outcomes
1	Photocell: To verify the inverse square law using photocell.	a) To understand the relation between current and the distance between photocell and source b) To understand the inverse square law and photoelectric effect
2	Ultrasonic Interferometer: To determine the wavelength and velocity of ultrasonic wave through ultrasonic interferometer.	a) To calculate wavelength and velocity of ultrasound in liquid medium b) To understand the properties of Ultrasonic wave
3	Determination of Refractive index: To determine the refractive index of a given material (prism) using spectrometer.	a) To familiarize with spectrometer b) To understand the phenomenon of polychromatic light source c) To calculate refractive index of prism
4	Resolving power of grating: To determine resolving power of a diffraction grating.	a) To understand the diffraction phenomena of light b) To understand the use of diffraction grating
5	Newton's Ring: To determine the wavelength of monochromatic light	a) To familiarize with travelling microscope b) To understand the phenomena of monochromatic light & calculating wavelength of it c) To understand the use of optical lenses
6	Planck's Constant: To determine the Planck's Constant using LED	a) To study V-I characteristics of different LED b) To find the variation of current with temperature c) To see the relation between band gap and Planck's constant & calculating the value of it

7	Determination of Wavelength of Laser: To determine the wavelength of LASER using diffraction grating.	a) To understand the properties of Laser b) To understand the diffraction phenomena of light c) To study the use of diffraction grating
8	Determination of wavelength of laser using single slit	d) To calculate the wavelength of laser e) To study the use of single slit
9	Dielectric constant: To determine the dielectric constant of a dielectric substance.	a) To understand the properties of dielectric material b) To study the dielectric constant with respect to capacitance of variable and test capacitor c) To understand the difference between variable and test capacitor
10	Hysteresis loss: To determine the Hysteresis loss in a Ferromagnetic material.	a) To study hysteresis loss for ferromagnetic material b) To understand the hysteresis curve for ferromagnetic material c) To understand the use of CRO
11	To determine the magnetic field at the center of a coil and its variation with distance and radius of the coil.	a) To see the effect of magnetic field with different radius of coil b) To verify Biot-Savart law c) To study the use of tangent galvanometer
12	To verify the Faraday's law of electromagnetic induction.	a) To study the Faraday's law b) To understand the variation of magnetic field

Subject: **Electrical Workshop**								
Program: **B.Tech. All**				Subject Code: **EL0001**			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
0	0	2	1	-	24/60	-	16/40	100

Course Objectives

1. Describe and apply basic symbols and abbreviations and IE rules used in electrical engineering.
2. Describe, apply and analyze different types of cables/wires, switches, fuses, and circuit breaker.
3. Describe and analyze Measuring instruments like Ammeter, Voltmeter, Wattmeter, Watt-hour Meter, and Megger.
4. To analyze and apply domestic wiring.

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcome
1	Introduction to symbols and abbreviations used in electrical engineering.	a) Basic knowledge of symbols and abbreviations that are used in electrical engineering
2	Introduction to IE rules.	a) Understanding of safety rules b) Safety precautions to be taken in the laboratory
3	Identify different types of cables/wires, switches, fuses, MCB, ELCB, MCCB with their ratings and usage.	a) To understand basic working principle of different protective devices b) To recognize the practical applications of these protective devices by their demonstration
4	Performance of Electric shock phenomena, precautions, preventions, earthing.	a) To identify the importance of earthing in electric network. b) To understand, how earthing works
5	Measuring instruments like Ammeter, Voltmeter, Wattmeter, Watt-hour Meter, and Megger with their description and usage.	a) To get familiar with different measuring devices b) To understand the working principle on which these devices work

6	To measure earthing resistance using insulation tester (Megger).	a) Basic knowledge of earthing resistance b) Working principle of insulation tester (megger)
7	Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, Main switch and Energy meter.	a) To identify different components used in wiring scheme b) Basic knowledge of designing a simple wiring scheme c) To identify the principle and working of energy meter
8	Wiring of light/fan circuit using Two way switches (Staircase wiring), Wiring of fluorescent lamps and light sockets (6 A)	a) Basic knowledge of staircase wiring b) Wiring of fluorescent lamps c) Identification of sockets
9	Wiring of backup power supply including inverter, battery and load for domestic installations.	a) To have the basic idea of inverter and battery b) Basic knowledge of back-up power supply
10	Demonstration and measurement of power consumption of Electric Iron, Mixer Grinder, Single phase pump, exhaust fan or other home appliance.	a) To have the knowledge of working of electric iron, mixer grinder and pump b) To demonstrate the power consumption by these devices
11	Preparing the drawing for wiring a newly built room, without any electrical wiring along with a bill of materials with specifications; the room may be a class-room, an office, a shop, a clinic, a small workshop etc.	a) Exercise for students to make a wiring scheme for any of the given example b) To estimate the total cost of appliances, materials and wiring

Course Outcomes

1. To apply electrical symbol and IE rules for safety.
2. To apply power distribution arrangement for house hold application.
3. To apply power consumption calculation for house hold appliances.
4. To apply power back up using inverter for domestic purpose.

Subject: **Elements of Electrical Engineering**								
Program: **B.Tech. All**				Subject Code: **EL0002**			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	24/60	16/40	16/40	200

Course Objectives

1. Describe, apply and analyze basic network concepts emphasizing series and parallel combination of passive components.
2. Describe, apply and analyze laws of electrostatics, charging and discharging of capacitor and magnetic circuit.
3. To analyze and apply single phase and three phase AC circuit with RL, RC and RLC.
4. To analyze and apply construction and working of transformer, DC machine and Induction Motor.

CONTENTS

UNIT-I

[07 hours]

Elementary Concepts:
Ohm's Law and Kirchhoff's Laws, Analysis of series, parallel and series-parallel circuits; Star–Delta conversion; Nodal analysis, Mesh analysis, voltage sources and current sources, Super position theorem, Thevenin's theorem, Norton's theorem, Equvalence of thevenin's and norton's theorem, Maximum power transfer theorem.

UNIT-II

[12 hours]

Electrostatics:
Electric charge and Laws of electrostatic, Capacitor; Capacitor in series and parallel, variable capacitor, Instantaneous voltage and current in capacitor, charging and discharging of capacitor, Energy stored in a capacitor, types of capacitor.

Magnetic Circuit:
Magneto motive force, magnetic field strength, reluctance, Relation between magnetic circuit parameter, Laws of magnetic circuit, composite magnetic circuit: series magnetic circuit, parallel magnetic circuit, comparison of Electric and magnetic circuit, Effect of magnetic field on current carrying conductor; Statically and dynamically induced EMF; Concepts of self

inductance, mutual inductance, energy stored in inductor, coefficient of coupling; Inductance in series and parallel; Hysteresis and Eddy current losses.

UNIT-III

[16 hours]

Single Phase A.C. Circuits:
Generation of sinusoidal voltage, Definition of average value, root mean square value, form factor and peak factor; Phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, R-L, R-C and R-L-C circuits; Concepts of Real power, Reactive power, Apparent power and Power factor, methods to improve power factor, Series, Parallel and Series - Parallel circuits; Power in AC circuit, Resonance in series and parallel circuits

Three Phase A.C. Circuits:
Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method; Work, Power, Energy, Problems

UNIT-IV

[13 hours]

Transformers:
Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency.

DC Machines:
Working principle of DC machine as a generator and a motor; DC series motor, DC shunt motor, DC compound motor constructional features.

Induction Motor:
Concept of rotating magnetic field; Principle of operation, types and constructional features, slip and its significance.

Course Outcomes

1. To apply various circuit theorem like Thevenin, Norton, Super position.
2. To apply electrostatic and electromagnetic laws.
3. To apply RL, RC and RLC relationship in single phase and 3 phase circuit
4. To apply machine principle for transformer, DC machines and Induction Motor.

Text Books

1. A. Chakrabarti, “Basic Electrical Engineering”, 1st Edition Tata McGraw Hill, 2009, ISBN: 9780070669307.

Reference Books

1. A.E Fitzgerald, David E. Higginbotham, Arvin Grabel, “Basic Electrical Engineering”, 5th Edition, Tata McGraw Hill- 2009, ISBN 9780070682566
2. Vincent Del. Toro “Principles of Electrical Engineering”, 2nd Edition Prentice Hall, India- 2012, ISBN 812030599X

3. J.N. Swamy, "Elements of Electrical Engineering" 3rd Edition, Mahajan Publishing House, 2009, ISBN: 9788189050986
4. Nagrath I.J. and D. P. Kothari "Basic Electrical Engineering", 3rd Edition Tata McGraw Hill, 2009, ISBN: 9780070146112

Web Resources

1. KCL, KVL and Network Analysis (https://www.youtube.com/watch?v=QYE6uZlPqZY)
2. Single phase AC circuit (https://www.youtube.com/watch?v=VMBEOfjgn0A)
3. Magnetic Circuit (https://www.youtube.com/watch?v=RxbJo2kDRxE)
4. DC machine construction (https://www.youtube.com/watch?v=IC-PWxtcirI)
5. Induction motor construction (https://www.youtube.com/watch?v=CL2YEx4ul80)

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes
1	To determine V-I characteristics of lamp	Understanding of voltage current relationship
2	To verify Kirchhoff's current law and Kirchhoff's voltage law.	Understanding of basic circuit law.
3	To verify Super position theorem.	Understanding of circuit analysis for multiple sources.
4	To verify Thevenin's and Norton's theorem.	Understanding of circuit analysis for multiple sources.
5	To measure current, power, voltage and power factor of series RL circuit.	Understanding of voltage and current relationship and power factor for R-L circuit.
6	To measure current, power, voltage and power factor of series RLC circuit.	Understanding of voltage and current relationship and power factor for R-L-C circuit.
7	To measure the resonance frequency in series R-L-C circuit.	Understanding of series resonance circuit.
8	To verify voltage and current relationship of star connection of 3-phase AC	Understanding of voltage and current relationship for star connected system.

9	To verify voltage and current relationship of delta connection of 3-phase AC.	Understanding of voltage and current relationship for delta connected system.
10	To measure 3-phase power by two wattmeter method.	Understanding of 3 phases measurement.
11	To perform ratio test of single phase transformer.	Understanding of transformer.
12	To study construction of D.C. machine.	Understanding of DC machine.

Subject: **Engineering Graphics**								
Program: **B.Tech. All**				Subject Code: **ME0001**			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	6	0	4	24/60	-	16/40	-	100

Course Objectives

1. Analyze the conventions and the methods of engineering drawing.
2. Describe the technical communication skill in the form of communicative drawings.
3. Analyze engineering drawings using fundamental technical mathematics.
4. Describe to construct basic and intermediate geometry.
5. Analyze the visualization skills so that they can apply these skills in developing new products.

CONTENTS

UNIT – I

[06 hours]

Introduction to engineering graphics

Principles of Engineering Graphics and their Significance – Drawing Instruments and their Use – Conventions in Drawing – Lettering – BIS Conventions- Dimensioning systems – polygons- types of lines.

Engineering curves

Classification and application of Engineering Curves, Construction of different methods of Ellipse, parabola and Hyperbola, construction of Conics, Cycloid Curves – Cycloid, Hypocycloid, Epicycloids, Involutes and Spirals.

UNIT – II

[08hours]

Projections of Points and Lines

Introduction to principal planes of projections, Projections of the points located in same quadrant and different quadrants, Projections of line with its inclination to one reference plane and with two reference planes. True length and inclination with the reference planes.

Projections of Planes

Projections of planes (polygons, circle, and ellipse) with its inclination to one reference plane and with two reference planes, Concept of auxiliary plane method for projections of the plane.

UNIT – III

[05hours]

Projections of Solids
Classification of solids. Projections of solids (Cylinder, Cone, Pyramid, Prism) along with frustum of cone and pyramid with their inclinations to one reference plane and with two reference planes.

UNIT – IV

[15hours]

Orthographic And Sectional Orthographic Projections
Fundamental of projection along with classification, Projections from the pictorial view of the object on the principal planes for view from front, top and sides using first angle projection method and third angle projection method, introduction of section of objects, full sectional view.

Isometric Projections
Isometric Scale, Conversion of orthographic views into isometric projection, isometric view or drawing.

Course Outcome

1. Apply the theory of projection.
2. Apply vision to view different views of the object like front, top, side views from isometric drawing.
3. Apply methods of construct an isometric view from given orthographic views.
4. Apply work on different sheet metal job.

Text Books

1. P.J. Shah, "A Text Book of Engineering Graphics" Publication: S.Chand, ISBN: 9788121929677, edition 2015.

Reference Books

1. N.D.Bhatt , "Elementary Engineering Drawing", Charotar Publishing House, Anand ISBN: 9789380358963, 53rd edition -2014.
2. P.D.Patel, " Engineering Graphics" Publication: Mahajan, ISBN:9789381256756 , 5th edition -2017.
3. A text book of Engineering Drawing by P.S.Gill, S.K.Kataria & sons, Delhi, ISBN: 9788185749624, 13th Edition- 2016.

Web Resources

1. Types of Projections, Basics of orthographic projection (http://nptel.ac.in/courses /112103019 /14)

Subject: **Basic Electronics**								
Program: **B.Tech. All**				Subject Code: **EC0001**			Semester: **I**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
2	0	2	3	24/60	24/60	16/40	16/40	200

Course Objectives

1. To describe the concepts of semiconductor physics.
2. To analyze and recognize basic electronic components and devices used for different electronic functions.
3. To analyze the design and test basic electronic circuits using active components.
4. To describe problem solving techniques in simple electronic circuits

CONTENTS

UNIT-I

[10 hours]

Energy Bands in Solids

Charged Particles, Field Intensity, Potential Energy, The eV Unit of Energy, Nature of Atom, Atomic Energy Levels, Electronic Structure of the Elements, Energy distribution of electrons, Fermi-Dirac function, Energy Band Theory of Crystals, Insulators, Semiconductors and Metals

Transport Phenomena in Semiconductors

Mobility and Conductivity, Electrons and Holes in an Intrinsic Semiconductor, Donor and Acceptor Impurities, Charge Densities in a Semiconductor, Electrical properties of Ge and Si, Hall Effect, Conductivity Modulation, Generation and Recombination of Charges, Diffusion, The Continuity Equation, Injected Minority–Carrier Charge, Potential variation within a Graded Semiconductor.

UNIT-II

[10 hours]

Junction –Diode Characteristics

Open circuit p-n Junction, p-n Junction as a Rectifier, Current Components in a p-n diode, Volt-Ampere Characteristic, Temperature Dependence of the V/I Characteristic, Diode Resistance, Space Charge, Transition Capacitance, Charge-Control Description of a Diode, Diffusion Capacitance, Junction Diode Switching Times, Breakdown Diodes, Tunnel Diode, Semiconductor Photodiode, Photovoltaic Effect, Light –Emitting Diodes, Schottky diode, varactor diode, GUNN diode, SCR

Diode Circuits:
Diode as a Circuit Element, Load-Line Concept, Piecewise Linear Diode Model, Clipping Circuits, Clipping at Two Independent Levels, Comparators, Sampling Gate, Rectifiers, Other Full-Wave Circuits, Capacitor Filters, Additional Diode Circuits

UNIT-III

[07 hours]

Transistor Characteristics
Junction Transistor, Transistor Current Components, Transistor as an Amplifier, CB Configuration, CE Configuration, CC Configuration, Analytical Expressions for Transistor Characteristics Maximum Voltage Rating, Phototransistor, Transistor biasing.

UNIT-IV

[05 hours]

Field Effect Transistors:
Junction FET, JFET Volt-Ampere Characteristics, MOSFET
Operational Amplifiers:
Introduction to Op Amps, Inverting Amplifier, Non-inverting amplifier, Op Amp applications
Introduction to Data converters:
ADC & DAC
Introduction to Microprocessors and Microcontrollers:
Basic digital ICs, Architecture of processors and controllers

Course Outcomes

1. Able to recognize various electronics components and understand their applications for various applications.
2. Able to analyze and test basic electronics circuits.
3. Able to solve basic design problem related to basic electronic circuit.

Text Books

1. Integrated Electronics' By J. Millman and C. C. Halkias, Chetan Parikh, 2nd Ed., Tata McGraw Hill Publication.

Reference Books

1. 'Electronic Principles' by Albert Malvino and David Bates, 7th Ed., Tata McGraw Hill Publication
2. 'Electronic Devices and Circuit Theory' by Robert Boylestad and Louis Nashelsky, 9th Ed., Prentice Hall India
3. "Digital Electronics" by Morris Mano, 2006, Pearson Education Asia.

Web Resources

1. NPTEL MOOC course on the Basic Electronics (https://onlinecourses.nptel.ac.in/noc17_ee02/preview)
2. NPTEL MOOC course on the Solid State Physics (https://onlinecourses.nptel.ac.in/noc17_ph08/preview)

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes
1	To plot VI characteristics of PN junction diode	Basic knowledge about the semiconductor PN junction diode and its behavior.
2	To plot VI characteristics of Zener diode	Basic knowledge about the zener diode, its characteristics and its use as a voltage regulator.
3	To plot VI characteristics of Tunnel diode	Basic knowledge about the tunnel diode and and its behavior.
4	To measure ripple factor of a rectifier	Understanding about the rectifier, its applications and performance
5	Build and test wave shaping circuits	Understanding about diode based wave-shaping circuits and its applications in electronic circuits.
6	To plot input and output VI characteristics of CB configuration using BJT	Basic knowledge about the semiconductor NPN transistor in common base configuration and applications in this mode,
7	To plot input and output VI characteristics of CE configuration using BJT	Basic knowledge about the semiconductor NPN transistor in common emitter configuration and applications in this mode,
8	To plot input and output VI characteristics of CC configuration using BJT	Basic knowledge about the semiconductor NPN transistor in common collector configuration and applications in this mode,
9	To plot drain and transfer characteristics of a JFET	Basic knowledge about the semiconductor JFET transistor and its behavior.
10	To build and test inverting and non-inverting amplifier	Basic knowledge about operational amplifier and its application as an amplifier.
11	To build an LED driver circuit and test	Basic understanding of an transistor based driver circuit and its application as LED driver.
12	To build and test an integrator and differentiator with Op Amp	Application of the operational amplifier as an integrator and differentiator circuit.

Subject: **Materials Science**								
Program: **B.Tech. (All Branches)**				Subject Code: **MT0001**			Semester: **I**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	24/60	0	16/40	0	100

Course Objectives

1. To evaluate different materials for engineering applications.
2. To categorize material according to their properties and requirement.
3. To classify materials and understand the importance of each material in order to find applications in other fields of engineering.

CONTENTS

UNIT-I

[8 hours]

Materials

Introduction, Engineering requirement of different materials, Classification of Engineering materials, Properties of engineering materials , Criteria for selection of materials for engineering application.

Crystal Physics

Structure of crystalline solids; Lattices, unit cells; Indexing of directions and planes, notations, Interplanar spacings and angles, Crystalstructure analysis - Bragg's law for X-ray diffraction..

UNIT-II

[12 hours]

Ferrous metals & Alloys

Pig iron, cast iron, carbon steel, alloy steels- Classification, properties, composition and applications.

Non-Ferrous Metals & Alloys

Important non-ferrous metals (Al, Cu, Pb, Zn, Sn, Mg, Ti, Ni,), Non-ferrous alloys (Cu alloys, Al alloys, Mg-alloys, Ni-alloys) – Composition, properties, classification and applications.

UNIT-III

[12 hours]

Ceramics

Introduction, Simple crystal structure, Classification- Traditional (clay-products, refractories, abrasives, cement) and Engineering Ceramics- Glass Ceramics, Properties of ceramics, Application of Ceramics, Glasses, Glass structure, Properties and application of Glass, Types of glass.

Polymers

Introduction, Classification and forms of Polymers, Thermosetting & thermoplastic polymer, types of polymerizations, Molecular weight, Plastics, Natural rubber and synthetic rubber, Applications of polymeric materials.

UNIT-IV

[14 hours]

Composites

Introduction, Classification & Applications, Dispersion-strengthened, Composites, Particulate Composites, Fiber-reinforced Composites: Influence of Fiber Length, Influence of Fiber Orientation and Concentration, The Fiber Phase, The Matrix Phase, Polymer-Matrix.
Composites, Metal-Matrix Composites, Ceramic - Matrix Composites, Carbon–Carbon Composites, Processing of Fiber-Reinforced Composites.

Advanced Materials

Smart materials (Shape memory material, Piezo electric material) Photoconductors, Bio-materials, Nano materials, Dielectric materials, magnetic materials, metamaterials, Cryogenics, Optical Fiber.

Course Outcomes

1. To apply the fundamentals of mass, matter and materials from daily life.
2. To acquaint the student with applications and properties of materials used from engineering aspects.
3. To apply student's knowledge about advanced materials to be used in futuristic applications.

Text Books

1. O. P. Khanna, "Material Science and Metallurgy", Dalpat Rai Publications, 2nd Edition, 2014, ISBN: 9789383182459.
2. R. K Rajput, "Engineering Materials", S. Chand Publications, 4th Edition, 2000, ISBN: 9788121919609.
3. W.D. Callister, "Material Science & Engineering – An Introduction", John Wiley Publishers, 7th Edition, 2007, ISBN: 9780471736967.

Reference Books

1. J. Shackelford, "Introduction to Materials Science for Engineers", Pearson-Prentice Hall Publications, 8th Edition, 2006, ISBN: 8131700909.
2. L.H. Vanvlack, "Elements of Materials Science and Engineering", Pearson Education India, 6th Edition, 2002, ISBN: 8131706001.
3. D. Swarup, "Elements of Metallurgy", Rastogi Publications, 2005, ISBN: 8171338135.
4. V. Raghavan, "Materials Science and Engineering – A First Course", Prentice Hall India Learning Private Limited, 6th Edition, 2015, ISBN: 8120350928.

Web Resources

1. MOOC Course on "Materials Science and Engineering" (https://www.edx.org/course/materials-science-engineering-misisx-mse1x)

Subject: **Technical English**		
Program: **B.Tech. All**	Subject Code: **SH0102**	Semester: **I**

Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	2	0	2	24/60	-	16/40	-	100

Course Objectives:

1. To describe comprehension and soft skills to students.
2. To analyze and increase student's ability to improve and utilize the technical skills necessary for reading and writing.
3. To analyze and improve students' communication skills in both technical and professional contexts.

CONTENTS

UNIT I

[05 hours]

Business Communication

Role of Communication in Information Age
Concept and meaning of communication
Skills necessary for technical communication
Communications in a technical organization
Barriers to the process of communication
Style and organization in technical communication covering
Language skills- Objectivity, clarity, precision, and organizational etiquettes as defining features of technical communication.

UNIT II

[15 hours]

Effective Presentation Skills

Sub-Verb-Agreement
Tenses
Numerical Adjectives
Conjunction
Preposition clauses
Noun and adjective clauses and Relative clauses
Imperative and infinitive structures
Question pattern
Auxiliary verbs (Yes or No questions)

Contrasted time structures
Adverbial clauses of time, Intensifiers and Simple, Complex & Compound Constructions

UNIT III

[05 hours]

Reading
Intensive reading
Predicting content
Interpretation
Inference from text
Skimming & Scanning techniques of reading
Critical Interpretation & Editorial of newspapers.

UNIT IV

[10 hours]

Writing
Basic Writing skill development
Paragraph development (Unity, coherence, cohesive devices),
Letters: Inquiry- reply to inquiry, Complaint, Request
Business Letters
Using e-mail for business communication
Language in e-mail.

Course Outcome

1. To apply familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type.
2. To apply the knowledge of English language in describing experiences and events, dreams, hopes and ambitions and briefly give reasons and explanations for opinions and plans.
3. Can introduce themselves and others and can ask and answer questions about personal details such as where he/she lives, people they know and things they have.

Reference Books

1. English for Engineers and Technologists, Volumes 1 and 2, Department of Hum and Social Sciences, Anna University, Chennai, Orient Longmans Pul 2008. ISBN: 9788125017240
2. Balasubramanyam, M and Anbalagan, G., Perform in English, Anuradha Publica Kumbakonam, 2010.
3. Meenakshi Raman and Sangeetha Sharma, Technical Communication: Principle Practice, Oxford University Press, New Delhi, 2004. ISBN: 9780199794576
4. KiranmaiDutt, P. et al., A Course on Communication Skills, Edition Foundation New Delhi, 2007. ISBN: 9780521369589
5. Ashraf Rizvi, M., Effective Technical Communication, Tata McGraw Hill Publi New Delhi, 2008. ISBN: 9780097057997
6. Geoffrey Leech, Jan Swartvik, 'A Communicative Grammar of English', ELBS Longman. ISBN: 9781138836891

7. Norman and Lewis, ‘English Made Easy’, Oxford Publication. ISBN : 9780804845243
8. E- Writing: 21st –Century Tools for Effective Communication, Dianna Booher, Macmillan India Ltd., 2007, ISBN – 1403932026

Web Resources

1. Business Conversation Rule 1 :https://www.youtube.com/watch?v=wB8mr4iViy0
2. Business English Conversations Rule 2:https://www.youtube.com/watch?v=wB8mr4iViy0
3. Business English Conversations 3:https://www.youtube.com/watch?v=wB8mr4iViy0
4. Business English Conversations Rule 4:https://www.youtube.com/watch?v=wB8mr4iViy0
5. Business English Conversations Rule 5:https://www.youtube.com/watch?v=wB8mr4iViy0
6. English Presentation Video:https://www.youtube.com/watch?v=wB8mr4iViy0
7. Powerful Presentation Skills: Body Language:https://www.youtube.com/watch?v=wB8mr4iViy0
8. Make Body Language Your Superpower:https://www.youtube.com/watch?v=wB8mr4iViy0
9. Make a Presentation Like Steve Jobs:https://www.youtube.com/watch?v=wB8mr4iViy0

2ND SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –II TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017													
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	SH0201	Integral Calculus and Linear Algebra	04	02	00	05	06	30	10	60	00	00	100
2	SH0002	Engineering Chemistry	03	00	02	04	05	30	10	60	40	60	200
3	ME0004	Mechanical Workshop	00	00	02	01	02	00	00	00	40	60	100
4	ME0002	Elements of Mechanical Engineering	03	00	02	04	05	30	10	60	40	60	200
5	CE0001	Computer Programming	03	00	02	04	05	30	10	60	40	60	200
6	CV0002	Engineering Mechanics	03	02	00	04	05	30	10	60	00	00	100
7	CV0001	Environmental Science	01	00	02	02	03	30	10	60	40	60	200
8	SH0202	Business Communication and Presentation Skill	01	02	00	02	03	30	10	60	00	00	100
TOTAL			**18**	**06**	**10**	**26**	**34**	**210**	**70**	**420**	**200**	**300**	**1200**

Subject: **Integral Calculus and Linear Algebra**								
Program: **B.Tech. All**				Subject Code**: SH0201**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	2	0	5	24/60	-	16/40	-	100

Course Objectives

1. To analyze mathematical knowledge and skills needed to support their concurrent and subsequent engineering studies.
2. To describe knowledge of basic science and engineering fundamentals.
3. To analyze different mathematical models within science and technology and work creatively, systematically and critically.
4. To describe solution of different types of mathematical models using knowledge about the possibilities and limitations of the different methods and tools.
5. To analyze abstract, logical and critical thinking and the ability to reflect critically upon their work and work of others.
6. To analyze their strengths and weakness as learners and to appreciate the value of errors or mistakes as powerful motivators to enhance learning and understanding.

CONTENTS

UNIT-I

[08 hours]

Infinite Series

Standard Infinite Series: Geometric Series and Harmonic Series
Tests for Convergence and Divergence
Comparison Test, Cauchy's Integral test, D'alembert's ratio Test, Cauchy's nth Root Test
Alternating Series Leibnitz's Theorem, Absolute Convergence and Conditionally Convergence, Power Series

UNIT-II

[13 hours]

Multiple Integration

Curve Tracing: Curves in Cartesian and Polar Form
Reduction Formulae
Double Integral, Change of order of Integration in Double integral
Change of Variables in Double Integral from Cartesian to polar
Application of Double Integral to find area and volume
Triple Integral

UNIT-III

[14 hours]

Linear Algebra

Eigen Values and Eigen Vectors - Properties of Eigen Values and Eigen Vectors
Cayley-Hamilton Theorem – Diagonalization, Powers of a Matrix
Real Matrices: Symmetric, Skew Symmetric, Orthogonal
Complex Matrices: Hermition, Skew Hermition, Unitary Matrices.

UNIT-IV

[13 hours]

Vector Integral Calculus

Vector Integration: Integration of a Vector Function of a Scalar Argument
Line Integrals: Work Done, Potential, Conservative Field and Area
Introduction to Surface Integrals, Volume Integrals
Green's Theorem in Plane, Stokes' Theorem, Gauss Divergence Theorem

Course outcomes:

1. Apply basic concepts of convergence and divergence of infinite series
2. Apply and analyze various tests to investigate the convergence of the series.
3. Apply the knowledge of curve tracing in solving various problems.
4. Apply the concept of double integrals to find area and volumes.
5. Apply the knowledge of multiple integrals, line integrals, surface integrals.

Text Books

1. B.V.RAMANA: "HIGHER ENGINEERING MATHAMATICS", TATA McGraw Hill**.** 6th Edition", 2006, ISBN: 007063419X
2. R K Jain, S R K Iyengar: " Advanced Engineering Mathematics. Narosa Publishing House, 3rd Edition", 2002, ISBN: 817319730X

Reference Books

1. Erwin Kreyszig: "Advanced Engineering Mathematics (8th Edition) ",Wiley Eastern Ltd., New Delhi. 8th Edition , 2004, ISBN: 9971512831
2. Murray Spiegel : "Advanced Mathematics for Engineering & Science: Schaum's Outline Series" ,Tata - McGraw Hill Publication 3rd Edition, 2010, ISBN: 9780071623667
3. Dr. B.S. Grewal : "Higher Engineering Mathematics", Khanna Publishers, New Delhi , 44th Edition, 2010, ISBN:8174091955
4. Merel C Potter, J L Goldberg: "Advanced Engineering Mathematics (3rd Edition)"Oxford India Publication. . 3rd Edition, 2005, ISBN: 0195681428

Web Resources & Moocs:

1.Calculus by IIT Kanpur (https://www.youtube.com/watch?v=0lzOAW8yMTc)
2. Linear Algebra by Prof. K. C. Shivakumar (http://nptel.ac.in/courses/111106051/)

Subject: **Engineering Chemistry**								
Program**: B.Tech. All**				Subject Code**: SH0002**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	24/60	16/40	16/40	200

Course Objectives

1. To describe the basic concepts of chemistry & Engineering Applications of Chemistry.
2. To describe the principles of general chemistry and specific topics relevant to various engineering disciplines, wherein the students should apply this learning in their respective areas of expertise.
3. To describe the role of Applied Chemistry in the field of science and engineering.
4. To describe the problem solving techniques to identify, formulate & solve engineering chemistry related problems.

CONTENTS

UNIT-I

[13 hours]

Electrochemistry

Electrochemical Cell, Galvanic Cell, Electrolytic Cell, Types of electrodes, Single electrode potentials, Reference Electrodes, Standard Hydrogen Electrode (SHE), Standard Calomel Electrode (SCE), Glass Electrode, Quinhydrone Electrode, Nernst equation, Conductance, Cell constant and its determination, Conductometric titrations, Numerical.

Corrosion

Definition and types of corrosion water line, pitting, stress, erosion and soil corrosion, Caustic embrittlement, Factors affecting on corrosion (Metallic and Environmental), Pourbaix diagram, Protective measures to control Corrosion, Sacrificial anode and Cathode process for corrosion control., Dry (chemical corrosion), Wet (Electrochemical corrosion) and its mechanisms; Types of electrochemical corrosion, (differential aeration, galvanic, concentration cell.

UNIT-II

[10 hours]

Water Treatment Technology

Sources of water, Soft Water & Hard Water, Types of hardness, Units of hardness measurement, Impurities in water, Disadvantages of hard water, Determination of water hardness by EDTA method, Alkalinity of water and its significance, Boiler feed water, Scale and sludge formation in boilers and pipes etc , Boiler Corrosion, Water softening through Soda lime process, Zeolite Process & Ion-exchange Process, Characteristics of Potable water, Sources and quality of

drinking water, Treatment of water for domestic use: Filtration, Coagulation, Sedimentation and Disinfection, Desalination through Electro Dialysis & Reverse Osmosis, Numerical problems.

UNIT-III

[12 hours]

Dimensions, Units & Energy balances

Dimensions and Units: Basic chemical calculations – atomic weight, molecular weight, equivalent weight, Mole concept, Inter-conversion of concentration units. Material Balance without chemical reactions: Flow diagram for material balance, simple material balance. Numerical problems. Material Balance involves chemical reactions: concept of limiting reactant, conversion, yield, selectivity, unit process for chemical reactions. Numerical problems.

Instrumental Techniques

Fundamentals of Spectroscopy; Principles and applications of UV-visible, IR, NMR, Mass & Atomic absorption Spectroscopy; Principles and applications of Chromatographic techniques including TLC, PC, Gas, HPLC.

UNIT-IV

[13 hours]

Advance Organic Materials

Liquid Crystals: Introduction, classification and applications, Organic Electronic Materials: Introduction, types and applications, Chemical Sensors: Introduction, types and applications, Ionic Liquids: Introduction and applications, Chromic Materials: Introduction, types and applications.

Catalysis & Adsorption

Catalysis: Types of catalysis, Positive & Negative catalysis, Homogeneous and Heterogeneous catalysis, Characteristics of Catalytic action, Poisoning of catalysis, Promoters, Auto Catalysis, Acid-Base Catalysis, Theories of Catalysis process, Industrial Applications of Catalysts.

Adsorption: Types of adsorption, adsorption isotherm: Freundlich adsorption isotherm, Langmuir adsorption Isotherm, Determination of surface area by BET method, Application of adsorption.

Course Outcomes

1. To apply the various basic concepts used in engineering and process calculations.
2. To apply the fundamental chemistry concepts with direct application to the built environment.
3. To apply the basics of electrochemistry process in practical applications.
4. To apply consciousness about the quality of water for industrial process, problems and troubleshooting techniques.
5. To apply the understanding of various smart organic materials and their applications in different engineering fields.

Text Books

1. P.C. Jain, M. Jain, Engineering Chemistry 15th edition, Dhanpat Rai Publishing Company, New Delhi, 2005.ISBN 8187433175

2. Shashi Chawla, Textbook of Engineering Chemistry, Dhanpat Rai Publishing Co.2004.ISBN 9788126519880

Reference Books

1. Dara, S.S., Umare S.S.; A Text Book of Engineering Chemistry (Twelfth edition); S. Chand. Co. 2014, ISBN: 8121903599.
2. P. Atkins, J.D. Paula, Physical Chemistry, Oxford University Press, 2017, ISBN :9780198769866.
3. A. J. Mee, Physical Chemistry, 6th Ed. English Language Book Society and Heinemann Educational Books Ltd. London, 1962.ISBN: 0435665766
4. Douglas A. Skoog, Donald M. West, Fundamentals of Analytical Chemistry, Cengage Learning, Ninth Edition, 2014.ISBN: 9780495558347
5. Puri B. R., Sharma L. R. , Pathania M.S; Principles of Physica Chemistry; Vishal Publishing Co. (46nd Edition), 2013.ISBN :9789382956013.
6. Arthur E. Morris, Gordon Geiger and H. Alan Fine, Handbook on Material & Energy Balance Calculations in Material Processing,Third Edition, 2011. ISBN:9781118065655

Web Resources

1. Electrochemistry (http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/ Engineering% 20Chemistry%201/Course_home_Lec22.html, http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Engineering%20Chemistry%201/Course_home_Lec24.html)
2. Corrosion (http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Engineering%20Chemistry%201/Course_home_Lec25.html)
3. Water Treatment (https://www.youtube.com/watch?v=O-MRC0dskHg, https://www.youtube.com/watch?v=SvCIfcovf9k)
4. Spectroscopic methods (http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/ Engineering%20Chemistry%201/TOC-mainM3.htm)
5. Adsorption (http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Engineering% 20Chemistry%201/Course_home_Lec36.html)

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes
1	Determination of the alkalinity of unknown water sample.	a) Able to find out alkalinity in water sample. b) Aware about limit of alkalinity in potable water. c) To gain knowledge about acid-base titration.

2	Estimation of hardness of water sample by EDTA method.	a) Able to find out total ,permanent & temporary hardness in unknown water sample. b) To gain knowledge about complex-metric titration.
3	Estimation of dissolved oxygen in water sample.	a) Able to find out dissolved oxygen in unknown water sample. b) Significance of dissolved oxygen. c) To gain knowledge about redox titration.
4	Determination of metal ions (Ca^{2+}/Zn^{2+}) from the mixture by EDTA titration.	a) Able to find out Ca & Zn ions in unknown water sample containing mixture of metal ions.
5	Determination of metal ions (Pb^{2+}/Mg^{2+}) from the mixture by EDTA titration.	a) Able to find out Pb & Mg ions in unknown water sample containing mixture of metal ions.
6	Determination of the concentration of chloride ions in unknown water sample.	a) Able to find out chloride ions in unknown water sample. b) Awareness about limits of chloride ions in potable water. c) To gain knowledge about precipitation titration.
7	Thin Layer Chromatography (TLC) and Paper Chromatography (PC).	a) Able to find out separate component from given mixture of pigments. b) To understand principle of absorption & partition chromatography.
8	Determination of strength of Acid or Base by pH meter.	a) Understanding of calibration of pH ‘meter. b) Able to find out strength or conc. of unknown acid & base. c) To understand construction of glass electrode.
9	Determination of strength of Acid or Base by Conductometer.	a) Understanding of calibration of conductometer. b) To gain knowledge conduction of ions in aqueous sample. c) To identify strong or weak acid & base.
10	To calculate the Acid value of the given sample of oil.	a) Able to check quality of lubrication oil used for industrial purpose.
11	Determination of iron content from unknown sample by	a) Able to find out iron content in unknown water sample.

	spectrophotometer.	b) Understanding of spectro-photometer.
12	Determination of the saponification value of a given oil sample.	a) Able to find out the saponification Value of lubricating oil sample. b) To gain knowledge about esterification process.

Subject: **Mechanical Workshop**								
Program **: B.Tech. All**				Subject Code**: ME0004**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
0	0	2	1	-	24/60	-	16/40	100

Course Objectives

1. Analyze various basic Manufacturing/Fabrication processes involved in Mechanical Workshop.
2. Describe various shops like Carpentry, Fitting, Welding in Mechanical Workshop.
3. Describe use of various tools and equipments used in different shops.
4. Describe rules and regulations to follow safety in mechanical workshop.

CONTENTS

UNIT-I

[02 hours]

Introduction

Introduction to Mechanical Workshop, Safety, and Safety rules, Safety Slogans, Tools and Equipments used for safety purpose.

UNIT-II

[14 hours]

Fitting Shop

Introduction, Fitting materials, Tools and Equipments used in Fitting, Fitting Joints.
1 Job in for practical demonstration

UNIT-III

[04hours]

Carpentry Shop

Introduction, Carpentry materials, Tools and Equipments used in Carpentry, Carpentry Joints.
1 Job in for practical demonstration

UNIT-IV

[11 hours]

Welding Shop

Introduction, Welding Tools, Equipments and Machines, Various Welding Joints
1 Job in for practical demonstration

Course Outcomes

1. Apply hand tools and power tools in various shops like Carpentry, Fitting, Welding, used in Mechanical Workshop.
2. Apply various operations involved in different shops in workshop.
3. Apply appropriate tools required for specific operation in different shops.

Text Books

1. Workshop Technology Vol. 1 and 2, by Raghuvanshi B.S. Dhanpat Rai & Sons ISBN: 1234567144613 (10^{th} Edition, 2009).

Reference Books

1. Workshop Technology by Chapman W.A. J and Arnold E. Viva low priced student ISBN13: 9780713132724 edition, 1998.
2. Workshop Practices, H S Bawa, Tata McGraw-Hill, ISBN: 9780070671195, 2009.

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes
1	To Study Safety Rules in Mechanical Workshop.	a) Students will able to understand the mean of safety and its importance. b) Students will able to understand use of tools and equipments used for safety. c) Students will able to understand general precautions should be taken care while working in workshop and also on various machines.
2	An Introduction to Mechanical Workshop.	a) Students will able to understand the importance of various motions involved in various machine tools. b) Students will able to understand the general classification of Machine tool.
3	To Prepare a Job in Carpentry Shop.	a) Students will able to understand the basic use of tools and equipments used in Carpentry work. b) Students will able to understand various operations and the different methods involved in the Carpentry work.
4	To Prepare a Job in Fitting Shop.	a) Students will able to understand the basic use of tools and equipments used in Fitting work. b) Students will able to understand various operations and the different methods involved in the Fitting

		work.
5	To Prepare a Job in Welding Shop.	a) Students will able to understand the basic use of tools and equipments used in welding shop. b) Students will able to understand various operations and the different methods involved in the Welding shop.

Subject: **Elements of Mechanical Engineering**								
Program **: B.Tech. All**				Subject Code**: ME0002**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	24/60	16/40	16/40	200

Course Objectives

1. To describe the basic concept of thermodynamic law.
2. To analyze the properties of fuels and measuring of calorific value.
3. To describe the basic gas laws and thermodynamics for mechanical engineering applications.
4. To describe the concept of power generation by steams its properties and basics of steam boilers.
5. To describe the concept of converting energy into work efficiently.
6. To describe the concept of power and motion transfer.

CONTENTS

UNIT – I

[11 hours]

Basic Concepts of Thermodynamics

Basic units and dimensional analysis, Intensive and Extensive Properties, Energy, heat, temperature, specific heat capacity, Interchange of heat, change of state, mechanical equivalent of heat, Internal energy, enthalpy, entropy, efficiency, Open and Closed systems, statements of Zeroth Law, First law and its limitations, Second law of Thermodynamics.

Properties of Gases

Ideal and Real Gases, Gas laws, Boyle's law, combined gas law, gas constant, Internal energy, Relation between Cp and Cv, Enthalpy, Non flow process, constant volume process, Constant pressure process, Isothermal process, Poly-tropic process, Adiabatic process.

UNIT – II

[08 hours]

Fuels and Lubricants

Different types of fuels, their properties and applications. Different types of lubricants, their properties and applications.

Internal Combustion Engines

Classifications, Difference between I.C. and E.C. , Otto four-stroke engine, Diesel-four-stroke engine, Difference between Otto cycle and Diesel engine, Two-stroke engines, Difference between two- stroke and four-stroke engines, indicated power (ip), Brake power (bp), Efficiencies.

UNIT – III

[08 hours]

Properties of Steam

Introduction, steam formation, types of steam, enthalpy, specific volume of steam and dryness fraction of steam, Internal energy, steam tables, Measurement of dryness fraction throttling calorimeter, separating calorimeter, Combined calorimeter.

Steam Boilers
Introduction, Classification, Simple vertical and horizontal boiler, Boiler details, Boiler performance. Functioning of different mountings and accessories.

UNIT – IV

[04 hours]

Refrigeration and Air-conditioning
Introduction, Refrigerant, Vapor compression & absorption cycles & system, basic applications.

Transmission of Motion and Power
Introduction, Couplings methods of drive, power transmission elements, shaft and axle, Belt-drive, pulleys, power transmitted by a belt, Chain drive, Friction drive, Gear drive.

Course Outcomes

1. Apply the knowledge of basics of thermodynamics in understanding various thermal systems.
2. Apply the knowledge of various gas laws and thermodynamic processes in developing engineering projects.
3. Apply the knowledge in measuring the calorific value of fuel by Bomb calorimeter.
4. Apply the knowledge in measuring the power developed by internal combustion engine and its efficiency.
5. Apply the developing speed controlling devices used in internal combustion engine.
6. Apply the knowledge in understanding the working and constructing of boiler and its mounting and accessories.

Text Books

1. Elements of Mechanical Engineering, Prof. N M Bhatt, Publisher: Mahajan Publishing, Ahmedabad, ISBN: 978-93-81256-35-0, 6th edition, 2012.
2. Elements of Mechanical Engineering, Prof. S M Bhatt, Shri H.G. Katariya, Shri J. P. Hadiya Publisher: Mahajan Publishing, Ahmedabad, ISBN: 97893808676492nd edition 2009.

Reference Books

1. Elements of Mechanical Engineering by K.P. Roy and Prof. S.K. Hajra Chaudhary, Media Promoters and publishers Pvt. Ltd. Bombay, ISBN 13: 1234567145210, 7th Edition.
2. Basant Agrawal 'Basic mechanical Engineering' Wiley-India, 2008, ISBN: 9788126518784 First India Edition, November 2008.
3. Basic & Applied Thermodynamics by P K Nag - Tata McGraw Hill Pvt. Ltd., Mumbai, ISBN: 9780070151314, 2nd edition, 2009.

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes

1	To Study of Otto , Diesel & Carnot Cycles.	Students will have knowledge regarding the pressure, volume, temperature and entropy change during different cycles.
2	To Study of Working of two stroke & four stroke IC Engine.	Students will become learn the working of different engines. (Two and Four Stroke).
3	To determine the Swept & Clearance Volume of IC Engine.	Students will come about the difference between actual volume and swept volume.
4	To understand Methods of Lubrication in IC Engine.	Students will understand the Importance of lubrication in IC engine.
5	To understand Construction & Working of Various types of Boilers.	Students will learn the construction and working of various types of boilers.
6	To understand Construction & Working of Mountings & Accessories of the Boiler.	Students will have know the importance of installing mountings and accessories of the boiler.
7	To Study of Vapour Compression Refrigeration Cycle.	Students will learn the working of vapour compression refrigeration systems.
8	To Study of Vapour Absorption Refrigeration Cycle.	Students will learn the working of vopur absorption refrigeration system.
9	To Study Various Types of Gears & Pulleys.	Students will know regarding different ways to transmit power.
10	To Study Various types of Bearings.	Students will know regarding different types of bearings.
11	To study various types of Brakes, Couplings & Clutches.	Students will know regarding different types of brakes, couplings and clutches.
12	To determine Velocity Ratio of Belt drive & Gear drive systems.	Students will have knowledge that belt drive is used for low speed and less power transmission while gear drive is used for more speed and more power transmission.

Subject: **Computer Programming**								
Program : **B.Tech. All**				Subject Code: **CE0001**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	24/60	16/40	16/40	200

Course Objectives

1. To describe the parts of the computer system.
2. To describe functioning of computer components.
3. To describe the process of problem solving using computer
4. To describe the design an algorithmic solution for a given problem
5. To describe a writing method for maintainable C program for a given algorithm.
6. To describe the method to trace the given C program manually.
7. To describe the importance of C program for simple applications of real life using structures and files.

CONTENTS

UNIT-I

[12 hours]

Introduction to Programming

What is programming? Problem solving methods with Examples-Algorithm and Flowchart, Types of Programming languages, Characteristics of higher level language, Some Programming languages

Introduction to 'C'

Introduction, Importance of C, Sample C programs, Basic structure of C programs, Programming style, executing a C program.

Introduction, Character Set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of Variables, Defining symbolic constants

Operators and Expression:

Introduction, Arithmetic of Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operators, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of expressions, Precedence of arithmetic operators, Type conversions in expressions, Mathematical function

UNIT-II

[12 hours]

Decision Making Statements
Introduction, Decision making with IF statement, Simple IF statement, the IF ELSE statement, Nesting of IF … ELSE statements, The ELSE IF ladder, the switch statement, the turnery (? :) Operator, the GOTO statement

Looping
WHILE statement, the DO statement, The FOR statement, Jumps in loops Break and continue

Array & Handling of Character strings:
Introduction, One-dimensional arrays, Two-dimensional arrays, Initialization of two dimensional arrays, Concept of Multidimensional arrays

UNIT-III

[12 hours]

Handling of Character strings:
Introduction, Declaring and initializing string variables, reading string from terminal, writing string to screen, Arithmetic operations on characters, Putting string together, String Operations: String Copy, String Compare, String Concatenation and String Length, String Handling functions, Table of strings

User-Defined Functions:
Introduction, need for user-defined functions, return values and their types, calling a function, category of functions, no arguments and no return values, Arguments with return values, Handling of non-integer functions, Nesting of functions, Recursion, Functions with arrays, The scope and Lifetime of variables in functions

UNIT-IV

[12 hours]

Pointers:
Introduction, understanding pointers, Accessing the address of variable, Declaring and initializing pointers, Accessing a variable through its pointer, Pointer expressions, Pointer increments and scale factor, Pointers and arrays, Pointers and character strings, Pointers and Functions, Pointers and structures

Structures and Unions:

Introduction, Structure definition, Giving values to members, Structure initialization, Comparison of structures, Arrays of structures, Arrays within structures, Structures within Structures, Structures and functions, Unions.

Introduction to Object Oriented Concepts & Programming
Review of fundamental concepts of Object-oriented programming,
Introduction to C++, class and objects, Functions in C++, Constructors & Destructors

Course Outcomes

1. To apply basic programming principles using C language.
2. To apply basic C program structure in software development
3. To apply fundamental principles of problem solving in software engineering through various programming languages.

Text Books

1. Programming in ANSI C, by Balagurusamy, Publisher - Tata McGraw Hill,6th edition ,2008 ISBN: 1259004619
2. Object-oriented programming with C++,E.Balagurusamy, 2nd Edition, TMH.ISBN: 9780070669079

Reference Books

1. Introduction to C by Reema Thareja, Publisher-Oxford ,2nd Edition,2012. ISBN : 0198086393
2. Programming with ANSI and Turbo C, by Ashok N Kamthane, Publisher –Pearson Education, 6th edition ,2009. ISBN: 9788131704370
3. Let us C, by Yashwant Kanitkar, Publisher – BPB Publication 15th edition, 2017 ISBN : 9788183331630

Web Resources

1. http://nptel.ac.in/courses/106105085/2
2. https://onlinecourses.nptel.ac.in/iitk_cs_101/preview
3. https://onlinecourses.nptel.ac.in/noc15_cs15/preview

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes
1.1	Write a program to print the address of INDUS	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.
1.2	Write a program to perform basic arithmetic operators on given two numbers.	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.

1.3	Find the area and perimeter of square and rectangle and circle. Input the side(s) through the keyboard. (use PIE as symbolic constant)	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.
1.4	Write a program to swap values of 2 variables (i) with extra variable and (ii) without using an extra variable.	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.
1.5	Write a program to print the ASCII value of a given character.	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.
1.6	Write a program to enter two numbers. Make the comparison between them with conditional operator. If the first number is greater than second perform multiplication otherwise division operation.	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.
1.7	Take two binary numbers and show the use of bitwise AND, OR, NOT, XOR , Left shift and Right shift.	Basic knowledge of C programming syntax, Variable, and I/P, O/P. Keywords.
2.	**Using conditional statements**	
2.1	Write a program to check whether the given character is a vowel of not.	Knowledge of conditional statements
2.2	Write a program to check whether a given value is even or odd.	Knowledge of conditional statements
2.3.	Write a program that reads a number from 1 to 7 and accordingly it should display MONDAY to SUNDAY (if- else if).	Knowledge of conditional statements

2.4	Write a program to print number of days in a given month using switch statement. The program requires month number (between 1 to 12) as an input and then displays number of days in that month.	Knowledge of conditional statements
2.5	Write a menu driven program to perform the arithmetic operations.	Knowledge of conditional statements
2.6	Write a program to calculate total salary of an employee. total salary = basic + da + hra + ta. da = 50% of basic. Basic hra ta <6000 400 100 6001>= & <10000 1400 300 >=10000 2400 700	Knowledge of conditional statements
3.	**Using control statements**	
3.1	Write a program to read any 7 numbers and print the average value using for loop.	Knowledge of control & looping statements
3.2	Write a program to reverse a given integer number.	Knowledge of control & looping statements
3.3	Write a program to print Fibonacci series of given number.	Knowledge of control & looping statements
3.4	Write a program to find factorial of a number.	Knowledge of control & looping statements
3.5	Write a program to check whether the number is Armstrong or not. Example: 153----$1^3 + 5^3 + 3^3$ = 1 + 125 + 27 153	Knowledge of control & looping statements
3.6	Write a program to list all prime numbers within given range.	Knowledge of control & looping statements

3.7	Write a program to draw different types of patterns	Knowledge of control & looping statements
4	**Array And Strings**	
4.1	Write a program to find number of odd and even elements from the 1-D array.	concepts of array & strings
4.2	Write a program to sort elements of array.	concepts of array & strings
4.3	Write a Program to print Multiplication of two matrices.	concepts of array & strings
4.4	Write a program to reverse the string.(without inbuilt Function)	concepts of array & strings
4.5	Write a program to convert a string in to lower case and upper case.	concepts of array & strings
4.6	Write a menu driven program for the implementation of all build-in string functions.	concepts of array & strings
4.7	Find out occurrence of each character in a given string.	concepts of array & strings
5.	**Structure & Union**	
5.1	Write a program to define structure with tag state with fields state name, number of districts and total population. Read and display the data.	Knowledge of structure and union
5.2	Write a program to create a structure of 5 student's roll_no and name and display the records. Use array of structure.	Knowledge of structure and union
5.3	Write a program to create union of student's roll_no and name and display the records.	Knowledge of structure and union
6.	**Pointers & Functions**	
6.1	Write a program that demonstrates the use of address of (&) and pointer (*) operator.	Use of pointers & Functions
6.2	Write a program to display the content of 1-D array using pointer.	Use of pointers & Functions

6.3	Write a program using function to count the area of circle, triangle, rectangle and square.	Use of pointers & Functions
6.4	Write a program using function with array, takes input of five subject's marks and count the percentage and display result.	Use of pointers & Functions
6.5	Write a function which accepts a character array as argument from the user. The function should convert all the lowercase characters into uppercase case	Use of pointers & Functions
6.6	Write a function using pointer parameter that calculate maximum element from given array of integer number.	Use of pointers & Functions
6.7	Write a program that demonstrates call by value and call by reference concept in function argument.	Use of pointers & Functions
7.	**Introduction to Object Oriented Programming**	
7.1	Write a program in C++ to create the class shape, and overload the function to return the perimeters of the different shapes.	Introduction of C++ Program
7.2	Write a program in C++ demonstrating the public, protected and private parameters.	Introduction of C++ Program
7.3	Write a program in C++ to demonstrate constructor with default argument.	Introduction of C++ Program
7.4	Create a class student which stores the detail about roll no, name, marks of 5 subjects, i.e. science, Mathematics, English, C++. The class must have the following: • Get function to accept value of the data members. • Display function to display values of data members.	Introduction of C++ Program
7.5	Write a program in C++ to demonstrate destructor in inheritance.	Introduction of C++ Program

Subject: **Engineering Mechanics**								
Program : **B.Tech. All**				Subject Code: **CV0002**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	-	16/40	-	100

Course Objectives

1. To describe the fundamental knowledge of Engineering Mechanics.
2. To describe the importance of applications of Engineering Mechanics in their day-to-day life.
3. To describe and analyze the applicability aspect of the subject in their respective branch.

CONTENTS

UNIT-I

[14 hours]

Introduction

Beginning and Development of Engineering Mechanics, Fundamental Principles of Mechanics, Idealizations in Mechanics, Branches of Mechanics, Units

Coplanar Forces

Effect of Force, Characteristics of Force, Principle of Transmissibility of Forces, System of Forces, Resultant Force, Composition of Forces, Methods for Resultant Force, All major Laws of Forces, Principle of Equilibrium, Analytical Method for the Equilibrium of Coplanar Forces, Lami's Theorem.

Non-Coplanar Forces

Moment of a Force, Graphical Representation of Moments, Types of Moments, Varignon's Principle of Moments, Application of Moments, Levers, Types of Levers.

UNIT-II

[12 hours]

Beams

Types of Loads, Types of Supports, Types of Beams, Analytical Method for determination of Support Reactions of a Beam (Simply Supported Beam, Cantilever Beam)

Friction

Static Friction, Limiting Friction, Normal Reaction, Angle of Friction, Coefficient of Friction, Laws of Friction, Equilibrium of a Body on a Rough Horizontal Plane, Equilibrium of a Body on a Rough Inclined Plane, Equilibrium of a Body on a Rough Inclined Plane Subjected to a Force Acting Along the Inclined Plane, Equilibrium of a Body on a Rough Inclined Plane Subjected to a Force Acting Horizontally. Ladder & Wedge Friction

UNIT-III

[11hours]

Centre of Gravity

Centroid, Methods for Centre of Gravity, Centre of Gravity by Geometrical Considerations, Axis of Reference, Centre of Gravity of Plane Figures, Centre of Gravity of Symmetrical Sections, Centre of Gravity of Unsymmetrical Sections, Centre of Gravity of Solid Bodies, Pappus Guldinus Theorem

Moment of Inertia

Moment of Inertia of Plane area, Methods for Moment of Inertia, Moment of Inertia by Integration Method, Moment of Inertia of simple lamina, Parallel and Perpendicular Axis Theorem, Moment of Inertia of Built-up Section

UNIT-IV

[12 hours]

Graphical Method

Method for the Resultant of two Co- Planar forces, Equilibrium of Coplanar Forces (Force Polygon), Funicular Polygon Method to find Support Reactions, Graphical Method for determination of CG, MI

Kinematics and Kinetics

Linear Motion, Relative Motion, Rectilinear Motion of Particle, Curvilinear Motion of Particle Newton's Second Law of Motion, Work, Work Done by Force, Energy, Law of Conservation of Energy, Work- Energy Principle, Power, Efficiency

Mechanical Vibrations

Simple Harmonic Motion, Vibrations, D'alembert's Principle, Classification of Vibration, Damping and Vibration, Derivation of Free Vibration without Damping and Examples

Course Outcomes

1. To apply the fundamentals of mechanics.
2. To apply the knowledge of Engineering Mechanics to solve complex Problems by making them comprehensible and simple.
3. To apply the data to calculate the reactions necessary to ensure static equilibrium.
4. To apply the data to calculate centre of gravity and moment of inertia.
5. To apply the parameters of motion for the bodies in motion.

Text Books

1. R. C. Hibbeler, "Engineering Mechanics: Statics and Dynamics", Pearson Publication, 13th Edition, 2013, ISBN: 9780132915540.

Reference Books

1. F. P. Beer and E. R. Johnston, "Vector Mechanics for Engineers: Statics and Dynamics", McGraw Hill Publication, 11th edition, 2016, ISBN: 9781259639265.
2. S. Ramamrutham, "Engineering Mechanics", Dhanpat Rai Publishing Company (P) Limited, 1st Edition, 2008, ISBN: 9788187433514.
3. B. Bhattacharyya, "Engineering Mechanics", Oxford University Press, 2nd Edition, 2008, ISBN: 9780195696554.
4. R. S. Khurmi, "A Textbook of Engineering Mechanics", S. Chand Publication, 1st Edition, 2007, ISBN: 9788121926164.
5. H. J. Shah and S. B. Junnarkar, "Applied Mechanics", Charotar Publishing House Pvt. Ltd., 19th Edition, 2015, ISBN: 9789385039065.

Web Resources

1. Applied Mechanics (http://nptel.ac.in/courses/122102004/)
2. Core Applied Mechanics (https://www.youtube.com/watch?v=7moNzhLQ6OA& list=PLC3A601B6060658D3)
3. Civil-Mechanics of Solids (https://www.youtube.com/watch?v=whB7IX3NQpg& list=PL4C9BB8DDD5D888A6)
4. NOC: Engineering Mechanics Statics and Dynamics (https://www.youtube.com/watch ?v=o_f1nQDtOOk&list=PLa4KQhDlGd7Rj8ulW4uFjqBmtzZe2rwDv)
5. Introduction to Engineering Mechanics (https://www.mooc-list.com/course/introduction-engineering-mechanics-coursera)
6. Applications in Engineering Mechanics (https://www.mooc-list.com/tags/engineering-mechanics)

Subject: **Environmental Science**								
Program : **B.Tech. All**				Subject Code: **CV0001**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	0	2	2	24/60	24/60	16/40	24/60	200

Course Objectives

1. To analyze the importance of Environment in our day to day life.
2. To describe environmental Bio-diversity and related concepts.
3. To analyze the environmental legislations.

CONTENTS

UNIT-I

[03 hours]

Concepts of Environmental Sciences:

Environment, Levels of organizations in environment, Structure and functions in an ecosystem; Biosphere, its Origin and distribution on land, in water and in air, Broad nature of chemical composition of plants and animals, Natural Resources: Renewable and Non-renewable Resources, Forests, water, minerals, Food and land (with example of one case study); Energy, Growing energy needs, energy sources (conventional and alternatives)

UNIT-II

[04 hours]

Biodiversity and its conservation:

Biodiversity at global, national and local levels; India as a mega-diversity nation; Threats to biodiversity (biotic, abiotic stresses), and strategies for conservation. Environmental Pollution: Types of pollution- Air, water (including urban, rural, marine), soil, noise, thermal, nuclear; Pollution prevention; Management of pollution- Rural/Urban/Industrial waste management [with case study of any one type, e.g., power (thermal/nuclear), fertilizer, tannin, leather, chemical, sugar], Solid/Liquid waste management, disaster management.

UNIT-III

[04 hours]

Environmental Biotechnology:

Biotechnology for environmental protection- Biological indicators, bio-sensors; Remedial measures- Bio-remediation, phytoremediation, bio-pesticides, bio-fertilizers; Bio-reactors- Design and application. Social Issues and Environment: Problems relating to urban environment- Population pressure, water scarcity, industrialization; remedial measures; Climate change- Reasons, effects (global warming, ozone layer depletion, acid rain) with case studies.

UNIT-IV

[04 hours]

Legal issues

Environmental legislation (Acts and issues involved), Environmental ethics. Environmental Monitoring: Monitoring- Identification of environmental problem, tools for monitoring (remote sensing, GIS); sampling strategies- Air, water, soil Sampling techniques.

Course Outcomes

1. To apply concepts of environmental science to the environmental problems
2. To apply knowledge for the conservation of bio-diversity.
3. To apply the legal procedures pertaining to environmental legislations.

Text Books

1. Anubha Kaushik and C.P Kaushik, "Perspectives in Environmental Studies", New Age International (P) Ltd, 6th Edition, 2017, ISBN: 9789386418630.

Reference Books

1. H. S. Peavey, D. R. Rowe and G. Tchobanoglous, "Environmental engineering", McGraw Hill International Edition, 1st Edition, 1985, ISBN: 9780070491342.
2. C. S. Rao, "Environmental Pollution Control Engineering", New Age International (P) Ltd, 2nd Edition, 2015, ISBN: 9788122418354.
3. "Pollution Control Acts, Rules and Notifications issued thereunder", Central Pollution Control Board, 2010.

Web Resources

1. Introduction to Environmental Science (https://www.mooc-list.com/course/ introduction - environmental-science-edx)
2. Introduction to Environmental Science (https://www.youtube.com/ watch? v=7G3eXI_DPn8)
3. Environmental Science (https://en.wikipedia.org/wiki/Environmental_science)

LIST OF EXPERIMENTS

Experiment No.	Title	Learning Outcomes
1	Plotting of bio geographical zones and expanse of territorial waters on the map of India.	To identify the geo-graphical conditions of India with reference of water characteristics.
2	Identification of biological resources (minimum 20) (plants, animals, birds) at a specific locations	To identify different types of bio-diversity of any particular area in a way to conservation.
3	Determination of :	To determine whether sample is acidic or alkaline.

	(i) pH value (ii) Water holding capacity (iii) Electrical conductivity of different types of soils	
4	Determination of energy content of plants by bomb calorimeter	To determine energy content of plants.
5	Measurement and classification of noise pollution.	To determine the noise affected area.
6	Determination of particulate matter from an industrial area by high volume sampler.	To Determine the particulate matter in atmosphere. (Gravimetric Method)
7	Determination of iso-chemical parameters (Alkalinity, Acidity) of tap water well water, rural water supply industrial effluent and sea water & potability issues.	To determine the characteristics of water and waste water.
8	Determination of iso-chemical parameters (Salinity, COD, BOD) of tap water well water, rural water supply industrial effluent and sea water & potability issues.	To determine the oxygen content present in the particular sample.
9	Demonstration of Remote Sensing and GIS methods.	To Integrate GIS and RS data for Disaster management with the help of a case study.
10	Understanding Environmental Biotechnology Processes.	To apply the principles of microbiology to the solution of environmental problems.
11	To determine the amount of dissolved solids present in the given sample	To determine the amount of dissolved solids present in the given Sample.
12	To determine the concentration of residual chlorine in the given water sample.	To determine the concentration of residual chlorine in the given water Sample.
13	To determine the turbidity of the given water and wastewater samples.	To determine the turbidity of the given water and wastewater samples.

Subject: **Business Communication & Presentation Skills**								
Program : **B.Tech. All**				Subject Code: **SH0202**			Semester **: II**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	2	0	2	24/60	-	16/40	-	100

Course Objectives:

1. To describe the varied uses of business communication.
2. To analyze the importance of personality and its reflection in communication.
3. Train students to develop business correspondence in writing and presentation skills.

CONTENTS

UNIT I

[05 hours]

Business Communication

Role of Communication in Information Age
Concept and meaning of communication
Skills necessary for technical communication
Communications in a technical organization
Barriers to the process of communication
Style and organization in technical communication covering
Language skills- Objectivity, clarity, precision, and organizational etiquettes as defining features of technical communication

UNIT II

[15 hours]

Effective Presentation Skills

Sub-Verb-Agreement, Tenses
Numerical Adjectives, Conjunction
Preposition clauses
Noun and adjective clauses, Relative clauses
Imperative and infinitive structures, Question pattern
Auxiliary verbs (Yes or No questions)
Contrasted time structures
Adverbial clauses of time,
Intensifiers, Simple, Complex & Compound Constructions

UNIT III

[05 hours]

Reading

Intensive reading, Predicting content
Interpretation, Inference from text,Skimming &Scanning techniques of reading
Critical Interpretation, Editorial of newspapers
.

UNIT IV

[10 hours]

Writing
Basic Writing skill development
Paragraph development (Unity, coherence, cohesive devices),
Letters: Inquiry- reply to inquiry, Complaint, Request
Business Letters, Using e-mail for business communication
Language in e-mail.

Course Outcomes

1. To apply the main ideas of complex text on both concrete and abstract topics, including technical discussions in their field of specialization.
2. To apply a clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.
3. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party.

Text Books

1. B.V.RAMANA: "HIGHER ENGINEERING MATHAMATICS", TATA McGraw Hill.
2. R K Jain, S R K Iyengar: " Advanced Engineering Mathematics. Third Edition", Narosa Publishing House

Reference Books

1. Fred Luthans, Organizational Behaviour, McGraw Hill. ISBN: 9781282385252
2. Lesikar and petit, Report writing for Business. ISBN: 9780256236910
3. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill.ISBN: 9780097057997
4. Wallace and masters, Personal Development for Life and Work, Thomson Learning. ISBN: 9780538450232.
5. Hartman Lemay, Presentation Success, Thomson Learning.ISBN: 9780324100921
6. Michael Muckian, John Woods, The Business letters Handbook.ISBN: 9780831740078
7. Herta A. Murphy, Effective Business Communication. ISBN: 9780070440616.
8. Lehman, Dufrene, Sinha BCOM, Cengage Learning ISBN: 9788131516980.

Web Resources

1. Calculus by IIT Kanpur (https://www.youtube.com/watch?v=0lzOAW8yMTc)
2. Linear Algebra by Prof. K. C. Shivakumar (http://nptel.ac.in/courses/111106051/)

3RD SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –III TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	SH0301	Differential Equations and Integral Transforms	03	02	00	04	05	30	10	60	00	00	100
2	MT0301	Mineral Processing	03	00	02	04	05	30	10	60	40	60	200
3	MT0302	Structural Metallurgy and Physics of Materials	03	02	00	04	05	30	10	60	00	00	100
4	MT0303	Fuels, Furnaces and Refractories	03	02	00	04	05	30	10	60	00	00	100
5	MT0304	Physical Metallurgy of Ferrous Alloys	03	02	02	05	07	30	10	60	40	60	200
6	MT0305	Environmental Pollution and Control in Metallurgical Industries	03	00	00	03	03	30	10	60	00	00	100
7	SH0307	Human Values and Professional Ethics	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**19**	**08**	**04**	**24**	**31**	**180**	**60**	**360**	**80**	**120**	**800**

Subject: **Differential Equations and Integral Transforms**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **SH0301**			Semester: **III**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	60	00	40	00	100

Course Outcomes:

1. To provide an ability to see differential equations as a rigorous way of modelling physical phenomena.
2. To provide an ability to derive major differential equations from physical principles.
3. To provide an ability to understand the role of initial and boundary conditions in determining the solutions of equations.
4. To provide an ability to choose and apply appropriate methods for solving differential equations.
5. To provide an ability to undertake problem identification, formulation and solution.
6. To provide an ability to calculate Laplace transforms and inverse Laplace transforms and uses them to solve differential equations (Initial value problems, Boundary value problems).
7. To provide an ability to understand various concepts of Control System -Theory using Laplace Transform.

Contents:

UNIT-I **[12 Hours]**

Ordinary Differential Equations with applications: Revision of ordinary differential equation: Introduction of Mathematical Modeling, Basic Definitions, First Order First Degree Differential Equations, Variable Separable equation, Homogeneous Equation, Exact Differential Equations, Reduction of Non-exact Differential Equations to exact form using Integrating Factors, First Order Linear Differential Equation, Bernoulli Equation, Applications: Orthogonal Trajectories, Simple Electric Circuits, Solution of Linear differential equations of higher order with constant coefficients, complimentary function and particular integral.

UNIT-II **[12 Hours]**

Ordinary and Partial Differential Equations with applications: Method of variation of parameters, Method of Undetermined coefficients, Linear differential equations with variable coefficients (Cauchy's and Legendre forms), Simultaneous linear differential equations, Bessel and Legendre functions, Application of Linear differential equation - Application ofDeflection of Beams, Electric circuits, Series Solution of Ordinary Differential Equations – Power series method, Formation of Partial differential equations, Directly Integrable equations, Method of

separation of variables, solution of one dimensional wave equation, heat equation and Laplace equation.

UNIT-III **[12 Hours]**

Laplace transforms: Relation between Laplace and Fourier Transform, Definition, Linearity property, Laplace transforms of elementary functions, Shifting theorem, Inverse Laplace transforms, Laplace transforms of derivatives and integrals, Convolution theorem, Application of Laplace transform in solving ordinary differential equations, Laplace transforms of periodic, Unit step and impulse functions.

UNIT-IV **[12 Hours]**

Fourier series, Fourier Integrals, Fourier Transforms and Z-Transforms: Fourier series, Drichlet's conditions, Euler's formula, Fourier expansion of periodic functions, Fourier series of even and odd functions, Half range Fourier series, Fourier integral theorem (only statement), Fourier sine and cosine integrals, Complex form of Fourier integral, Fourier transforms, Fourier sine and cosine transforms, Introduction to Z-transforms:Definition and Standard Z-transforms, Linearity Property, dumping Rule and some standard results, Some useful Z-transforms.

Text books:

1. Erwin Kreyszig: Advanced Engineering Mathematics (8th Ed.) , Wiley Eastern Ltd., New Delhi.

Reference Books:

1) B. V. Ramana: Higher Engineering Mathematics, Mc Graw Hill, New Delhi.
2) Dr. B.S. Growl: Higher Engineering Mathematics, Khanna Publishers, New Delhi.
3) R K Jain, S R K Iyengar: Advanced Engineering Mathematics. Third Edition, Narosa Publishing House
4) Merel C Potter, J L Goldberg: Advanced Engineering Mathematics (3rd Ed.), Oxford India Publication.
5) Murray Spiegel: Advanced Mathematics for Engineering & Science: (Schaum's Outline Series), Tata – McGraw Hill Publication

Web resources

http://freevideolectures.com/blog/2010/11/130-nptel-iit-online-courses/
http://nptel.ac.in/video.php?subjectId=122107036
http://ocw.mit.edu/index.htm
https://www.khanacademy.org/

Subject: **Mineral Processing**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0301**			Semester: **III**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	60	16/40	40	200

Course Objectives

1. To make the students aware about basics of mining technology.
2. To impart the knowledge about the basic steps followed in mineral dressing and its importance before extraction of pure metal from their respective ores.
3. To develop the knowledge regarding the auxiliary operation and the advancement in mining technology.

CONTENTS

UNIT-I

[8 hours]

Introduction and scope of mineral processing in extractive metallurgy, mineral resources in India, physical characteristics exploited in mineral processing, terminology in mineral processing. Physical and chemical characteristics of industrial minerals i.e. hematite, magnetite, galena, chalcopyrite, azurite, monazite, cassiterite, chromite, bauxite, and ilmenite, economics of ore processing.

UNIT-II

[10 hours]

Liberation and its significance, Comminution and sizing, Laws of comminution, Crushing and Grinding- types, equipment, washing, sorting and hand-picking; Laboratory and industrial screening- equipment, screen efficiency.

UNIT-III

[10 hours]

Classifier- mechanical and hydraulic, sizing and sorting, classifiers, Mill calculation and Selectivity index. Gravity concentration methods, Tabling, Jigging, Heavy media separation, Separation in vertical and streaming currents, Sedimentation, Dewatering, techniques, Thickener, Filtration and Drying.

UNIT-IV

[10 hours]

Froth flotation: principles, reagents, collectors, modifiers and frothers, process variables in

floatation, Tailings disposal, Process integration and, Study of flow sheet for important minerals. Magnetic and Electrostatic separation: principles, wet and dry separators, High tension separation, Motion of solid in fluid, Strokes and Newton's law, Free and hindered settling, Thickening, Batch and continuous settling, chambers. Application of computer in mineral processing.

Mineral Processing Lab (List of Experiments)

Experiment No.	Title
1	To study the crushers (primary and secondary) like jaw crusher and roll crusher and to measure their reduction ratios and capacities
2	To determine the reduction ratio of Coal.
3	To determine the reduction ratio of Coke.
4	To determine the reduction ratio of Iron ore.
5	To determine the reduction ratio of Ceramic material.
6	To study the sieve analysis of weighed powder sample
7	To study the ball mill and measure the grind ability of Ball mill
8	To determine the grindability of Coal.
9	To determine the grindability of coke.
10	To determine the grindability of Iron ore.
11	To determine the grindability of ceramic material.
12	To study the principle , operation and efficiency of laboratory classifier
13	To determine the efficiency of magnetic separation by varying strength of magnetic field
14	To study the coal and gravel separation using jig
15	To study the froth flotation of given sample of coal

Course Outcomes

1. To apply the knowledge of mineral processing to advance in the field of extraction.
2. To apply the basic principles behind ore dressing to different ores and minerals.

Text Books

1. S. K. Jain, “Mineral Processing”, CBS Publishers & Distributors, 2nd Edition, 2012, ISBN: 9788123907536.

Reference Books

1. A. M. Gaudin, "Principles of Mineral Dressing", Tata McGraw Hill Publications, 1st Edition, 1939, ISBN: 9780070230309.
2. B. A. Wills and J. Finch, "Mineral Processing Technology", Butterworth-Heinemann, 8th Edition, 2015, ISBN: 9780080970530.
3. E. G. Kelly and D. J. Spottiswood, "Introduction to Mineral Processing", John Wiley & Sons Inc, 1982, ISBN: 9780471033790.
4. J. D. Gilchrist, "Extraction Metallurgy", Pergamon Press, 1st Edition, 1967, ISBN: 9780080120300.
5. E. J. Pryor, "Mineral Processing", Springer Netherlands, 3rd Edition, 1965, ISBN: 9789401029438.
6. J. Newton, "Extractive Metallurgy", John Wiley & Sons Inc, 1st Edition, 1959, ISBN: 9780471635918.
7. H. S. Ray, R. Sridhar and K. P. Abraham, "Extraction of Non-ferrous Metals", Affiliated East-west Press Pvt Ltd, 1st Edition, 2008, ISBN: 9788185095639.

Web Resources

1. NPTEL Course on "Non-ferrous Extractive Metallurgy"
(http://nptel.ac.in/courses/113105021/)

Subject: **Structural Metallurgy and Physics of Materials**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0302**			Semester: **III**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To give them knowledge about diffusion in solids.
2. To teach them basics on nucleation and growth and its applications.
3. To teach them about crystal defects in metallic materials their origin, causes and remedial measure.
4. To provide basic knowledge about properties of materials such as electrical and thermal Conductivity, magnetism, dielectric properties.

CONTENTS

UNIT-I

[12 hours]

Atomic Structure, types of bonds; ionic bonds, covalent bonds, Van der Waals bonds, metallic bonds, metallic properties; crystalline vs. non-crystalline solids. Inter-atomic Bonding. Interatomic distances.

Equilibrium & Kinetics:

Macro and micro structure in metallic materials, levels of structure, structure property relationships in materials, Equilibrium & kinetics: stability & met stability, Basic thermodynamic functions, The statistical nature of entropy, The kinetics of thermally activated processes.

UNIT-II

[10 hours]

The Structure of Crystalline Solids: Crystalline & non crystalline states, covalent solids, Metals & alloys. Ionic solid, unit cell, space lattice, Crystal geometry, crystal systems & Miller- Bravais lattices, Polymorphism or allotropy, direction & planes, slip planes, atom sizes and coordination. Co-ordination Number, atomic packing factor. Single crystal, Polycrystalline & Non crystals.

UNIT-III

[10 hours]

Isotropy & anisotropy, Homogenous & heterogeneous, Types of deformation elastic & anelastic deformation, viscoelastic behavior, work hardening & strain hardening, dislocation & strain

aging, The Bragg's law, Diffraction methods, structure factor and its determination, Crystal structure determination, Crystallite size determination

UNIT-IV

[10 hours]

Glass transition, Conductors and Resistors: The resistivity range, Free electron theory, conduction by free electrons, conductor, Semi- conductor, insulators and resistor materials.

Ferromagnetism, diamagnetism, paramagnetism, superconductivity, dielectric behavior, thermal conductivity principles.

Course Outcomes

1. To apply the knowledge about the basic structure of metals and alloys, which are the building block for developing macro and micro structure of metallic materials.
2. To apply the knowledge about metallic and non-metallic type of bonding and their differentiation.
3. To apply the concept of polymorphism and others.
4. To solve different numerical pertaining to crystal structure determination & phase diagram determination.

Text Books

1. C. S. Barret & T. B. Massalski, "Structure of Metals – Crystallographic Methods, Principles & Data", McGraw-Hill Book Company, 3rd Edition, 1966, ISBN: 9780070038158.
2. A. H. Cottrell, "Theoretical Structural Metallurgy", The English Language Book Society & Edward Arnold (Publishers) Ltd., 2nd Edition, 1964, OCLC: 959782723.
3. B. D. Cullity, "Elements of X-ray Diffraction", Pearson New International, 3rd Edition, 2014, ISBN: 9781292040547.
4. R. Abbaschian, L. Abbaschian and R. E. Reed-Hill, "Physical Metallurgy Principles", Stamford CT: Cengage Learning, 4th Edition, 2010, ISBN: 9780495438519.

Reference Books

1. V. Raghavan, "Materials Science & Engineering", Prentice-Hall of India Pvt. Ltd, 6th Edition, 2015, ISBN: 9788120350922.

Web Resources

1. MIT Open Courseware on "Materials Science and Engineering"
(http://ocw.mit.edu/OcwWeb/Materials-Science-and-Engineering/)
2. EdX Course on "Materials Science and Engineering"
(https://www.edx.org/course/materials-science-engineering-misisx-mse1x)
3. NPTEL MOOC Course on "Physics of Materials"
(https://onlinecourses.nptel.ac.in/noc16_mm08/preview)
4. NPTEL MOOC Course on "Physics of Materials"
(https://onlinecourses.nptel.ac.in/noc15_mm03/preview)
5. NPTEL MOOC Course on "Nature and Properties of Materials"
(https://onlinecourses.nptel.ac.in/noc17_me27/preview)
(https://onlinecourses.nptel.ac.in/noc16_me16/preview)

Subject: **Fuels Furnaces and Refractories**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0303**				Semester: **III**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To understand use of fuels and refractories in the different levels of the operational systems.
2. To co-relate the basic of the mechanical and high temperature properties and individual response and related over all logical changes and uses of the respective materials.
3. To develop creativity for Pyro- Research.
4. To know various considerations like laws of physics, chemistry and also factors of safety etc.

CONTENTS

UNIT-I

[8 hours]

Fuels: Classification of fuels, solid, liquid and gaseous fuel-their advantages and limitations, Comparative study of solid, liquid and gaseous fuels, Combustion of fuels, Combustion characteristics of fuel, Analysis and testing of fuels, Carbonization of coal-coke making and by products, producer gas, water gas, natural gas, LPG, Blast Furnace gas, Coke oven gas, LD gas, storage of Fuels in transport, nuclear fuel, other energy resources such as Solar, Wind, Geothermal, Bio-mass, Hydrogen, Nuclear Energy.

UNIT-II

[10 hours]

Furnaces and Furnace Design: Classification based on heating methods, application wise and temperature ranges, Batch furnaces, continuous furnaces, Construction and working of furnaces like Cupola, Induction Furnace, Electric Arc Furnace, Resistance Furnace, Pit furnace, Rotary Furnace, Muffle Furnace, Modern furnaces: plasma heating Furnace accessories (Burners, blowers, pumps, chimneys, drafts), thermal interactions in furnace, furnace atmosphere, heat economics, Furnace capacity and efficiency along with factors affecting it. Related numericals.

UNIT-III

[10 hours]

Refractories:

Introduction, concept of Refractoriness, requirements of good refractory material, classifications, types of the refractories and their individual manufacturing processes, Refractory properties,

Testing and related machineries and how to control those machineries, a comparative study of the ternary phase diagram of different types of refractories, Details of Blast furnace refractory and LD Converters of Ladles, Castable refractory – preparation, fabrication and uses, Supper Refractories and their uses. Refractories numerical.

UNIT-IV

[8 hours]

Pyrometry:

Basic concept of temperature measurement and control, Stefan's Boltzmann's theory and related ideas in temperature measurement, Thermometry, resistance thermometer - principle, constructional details, applications, Principle of thermocouple, construction and calibration of thermocouple, Different types of thermocouple for measurement of various temperature ranges, Optical Pyrometer and Radiation Pyrometer – Principle, construction, working principle, advantages, comparative study of Optical Pyrometer and Radiation Pyrometer

Course Outcomes

1. To apply the knowledge of various types of high temperature changes and also the mode of fabrication for such changes used in the research areas and how to design those operations.
2. To predict effectively and accurately the reasons of faults related to temperature and then correlate how to rectify.
3. To apply the basic principles, working principles laws, related details, graphical details, applications and also a comparison study with each other.

Text Books

1. O. P. Gupta, "Elements of Fuels, Furnaces and Refractories", Khanna Publishers, 2nd Edition, 2002, ISBN: 9788174090881.

Reference Books

1. J. D. Gilchrist, "Fuels, Furnaces and Refractories", Pergamon, 2nd Edition, 2013, ISBN: 9781483151977.
2. W. Trinks, M. H. Mawhinney, and R. A. Shannon, "Industrial Furnaces", John Wiley & Sons, 6th Edition, 2004, ISBN: 9780471387060.

Web Resources

1. NPTEL Course on "Fuels Refractory and Furnaces"
(http://nptel.ac.in/courses/113104008/)

Subject: **Physical Metallurgy of Ferrous Alloys**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0304**			Semester: **III**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	2	5	24/60	60	16/40	40	200

Course Objectives

1. To introduce the engineering science principles and applications associated with physical metallurgy.
2. To study the physical aspect behind metallurgical phenomena.
3. To study the structure of metals and its influence on material properties and performance.

CONTENTS

UNIT-I

[10 hours]

Introduction, solid Solution, Types of solid solution, Hume-Rothery Rules for Primary Substitutional Solid Solubility, Types of Interstitial Voids, Chemical compounds versus solid solution, Intermediate Phases, Polycrystalline Materials, Grain Size, Measurement of Grain Size, Multiple –Phase Alloys. Intermetallic compounds.

Solidification of Metals & Alloys:

Structure of Liquid Metals, Energetic of Solidification, Nucleation and growth phenomena, Homogenous & Heterogeneous Nucleation, Growth of Solid, Smooth or Stable interface growth, Temperature Inversion in pure Metals, Segregation, Porosity. Numericals.

UNIT-II

[8 hours]

Phase Diagram:

Concepts of alloy system and explanation of terms like system, component, phase, micro constituent and degree of freedom, structural constituent of an alloy, phase rule and phase equilibria, equilibrium diagrams and their classification based on solubility of components in liquid and solid states, cooling curves, morphology and distribution of phases, effect of non-equilibrium cooling on morphology. Constitutional super cooling Unary Diagram, Binary Phase Diagram, Use of Phase Diagram, Determination of Phase Diagrams, Limitation of Equilibrium Diagram, Zone Melting, Ternary Diagram, Numerical, Interpretation of Phase Diagram, Interpretation of Phase Diagram by using Lever Rule.

UNIT-III

[10 hours]

Fe-Cementite Diagram

Introduction, Allotropy of Iron, Cooling & Heating curves of Pure Iron, Effect of pressure on allotropy of Iron, Iron- carbon equilibrium diagram, phase Fe- Cementite diagram. Effect of Alloying element on Fe- Cementite diagram, effect of carbon on Fe- Cementite. Critical temperature in Fe- Cementite diagram.

Physical significance of grain size: Grain size effects, Grain size designation, Grain size measurement. Interpretation of Phase Diagram.

UNIT-IV

[10 hours]

Steels

Classification and application of carbon steels, Plain carbon steels, Advantages and limitations of Plain carbon steels, Effect of impurity elements on the properties of steels, Purpose of alloying of steel, Functions of alloying elements in steel, Effects of alloying elements on the properties of steels, Steel Specifications-according to AISI, Indian grades, and UNS.

Cast Iron

Introduction, Cast Irons, Various Types, Properties & Applications, ADI – Austempered Ductile Cast Iron. Cast Iron Specifications – according to AISI and Indian Grades.

Metallography

Microscopic examination, Polishing techniques for different metals and alloys, Etching and Mounting techniques, Difference between Macro & Micro Etching, electrolytic polishing Metallurgical microscope, Macroscopic & Microscopic examination methods, Nonmetallic inclusions.

Physical Metallurgy of Ferrous Alloys Lab (List of Experiments)

Experiment No	Title
1	Study of optical microscope.
2	Specimen preparation for metallography.
3	Study and preparation of etching agents
4	Mounting of specimen.
5	Plotting of Thermal Equilibrium Phase Diagram of Binary alloys and pure metal by Cooling Curve Method.
6	Application of Gibb's Phase Rule for confirming the accuracy of Unary and Binary Phase Diagrams
7	Microstructure observation of Pure metals

8	Application of Lever Rule for Phase, Phase Composition & Phase Fraction (Binary Alloys)
9	Microstructural observation of Steels.
10	Microstructural observation of Cast Irons.
11	Study of phase diagrams for structure-properties correlation.
12	Eutectic, Hypo- And Hyper-Eutectic Alloys: Al-Si (Unmodified), Al-Si (Modified), Pb-6wt%Sb, Pb- 11.1 Wt%Sb And Pb- 20 Wt%Sb
13	Peritectic And Monotectic Alloys: 60:40 (+) Brass, 70:30 ( ) Brass, Cu-10wt%Sn, Cu- 36wt% Pb, Cu- 50 Wt% Pb*
14	Grain size measurement
15	Understanding SAE, AISI, UNS and Indian Standards for Steels.

Course Outcomes

1. To apply the knowledge of various types of phase diagrams and alloying chemistry to design components of many areas of mechanical, manufacturing, civil, and materials engineering in the aerospace, automobile, transportation, energy, environmental, biomedical, and electronics industries.
2. To predict the mechanical properties based on the changes on a fundamental level and design for military and government applications.
3. To predict effectively and rectify the phase diagrams and its accuracy.

Text Books

1. V. Singh, "Physical Metallurgy", Standard Publishers Distributors, 1st Edition, 2010, ISBN: 9788186308639.

Reference Books

1. R. Abbaschian, L. Abbaschian and R. E. Reed-Hill, "Physical Metallurgy Principles", Stamford CT: Cengage Learning, 4th Edition, 2010, ISBN: 9780495438519.
2. D. A Porter, K. E. Easterling and M. Y Sherif, "Phase Transformations in Metals and Alloys", CRC Press, 3rd Edition, 2009, ISBN: 9781420062106.
3. S. H. Avner, "Physical Metallurgy", Tata Mcgraw –Hill, 2nd Edition, 2008, ISBN: 9780074630068.
4. P. Haasen, "Physical Metallurgy", Cambridge University Press, 3rd Edition, 1996, ISBN: 9780521550925.
5. R. M. Brick, "Structure and Properties of Alloys", McGraw-Hill, 3rd Edition, 1965, ISBN: 9780070077201.
6. G. Gottstein, "Physical Foundations of Materials Science", Springer, 1st Edition, 2004, ISBN: 9783540401391.
7. R. E. Smallman, "Physical Metallurgy and Advanced Materials Engineering", Butterworth-Heinemann, 7th Edition, 2011, ISBN: 9780750669061.

Web Resources

1. NPTEL Course on “Principles of Physical Metallurgy”
(http://nptel.ac.in/courses/113105024/
2. NPTEL MOOC Course on “Phase Diagrams in Materials Science and Engineering”
(https://onlinecourses.nptel.ac.in/noc16_mm05/preview)
3. EdX Online Course on “Symmetry, Structure and Tensor Properties of Materials”
(https://courses.edx.org/courses/MITx/3.072x/1T2015/info)

Subject: **Environmental Pollution and Control in Metallurgical Industries**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0305**				Semester: **III**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	24/60	0	16/40	0	100

Course Objectives

1. To understand the sources of Air pollution.
2. To understand the various effects of pollution on human health, vegetables etc.

CONTENTS

UNIT-I

[8 hours]

Introduction: Definition, air pollution episodes, general nature of air pollution problems

Air Pollutants, Sources & their inventory: Particulate matter, carbon dioxide, carbon Monoxide, sulphur oxide, effects of hydrocarbon, oxide of nitrogen, photochemical oxidants, asbestos and metals on materials and health.

UNIT-II

[10 hours]

Effects of Air Pollution: Effects of air pollution on human, vegetation, animals and Materials.

Meteorology: Introduction, solar radiation, wind circulation, lapse rate, stability conditions, wind velocity profile maximum mixing depth, wind rose turbulence, and general characteristics of plumes, heat island effect, and global circulation of pollutants.

UNIT-III

[10 hours]

Pollution in Metal Industries: Pollution in Iron and Steel industries and Non-ferrous Metals (Cu, Al, Zn, and Pb) industries and its control, Pollution Control in Ferrous & Non-ferrous Foundries.

UNIT-IV

[10 hours]

Air pollution and control due to toxic and non-toxic gases, fumes, dust etc. during combustion, heating and roasting processes and industrial production, control methods, cleaning of gaseous effluents, recovery of economic value from gases.

Noise pollution Sources, effects and control, Odor problem Causes and control.

Course Outcomes

1. To apply the knowledge in order to reduce or control the air pollution.
2. To apply the knowledge in order to reduce the pollution in metallurgical industries.

Text Books

1. C. S. Rao, "Environmental Pollution Control Engineering", New Age International Publishers, 2nd Edition, 2015, ISBN: 9788122418354.

Reference Books

1. G. E. Best, "Environmental Pollution Studies", Liverpool University Press, 1st Edition, 1999, ISBN: 9780853239239.
2. M. K. Hill, "Understanding Environmental Pollution", Cambridge University Press, 3rd Edition, 2010, ISBN: 9780521736695.
3. H. C. Perkins, "Air Pollution", McGraw Hill Higher Education, 1st Edition, 1947, ISBN: 9780070493025.
4. J. J. Peirce, P. A. Vesilind and R. Weiner, "Environmental Pollution and Control", Butterworth-Heinemann, 4th Edition, 1997, ISBN: 9780750698993.

Web Resources

1. NPTEL Course on "Environmental Air Pollution"
(http://nptel.ac.in/courses/105102089/

Subject: **Human Values and Professional Ethics**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **SH0307**			Semester: **III**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	0	0	0	60	00	40	00	100

Objectives:

1. To create an awareness on Engineering Ethics and Human Values.
2. To understand social responsibility of an engineer.
3. To appreciate ethical dilemma while discharging duties in professional life.

CONTENTS

UNIT-I [04 Hours]

Values and Self Development

Social Values and individual Attitudes, Work ethics, Indian vision of Humanism, Moral and non moral valuation, Standards and principles, Value judgments. Importance of cultivation of values, Sense of duty, Devotion, Self reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National unity, Patriotism, Love for nature, Discipline.

UNIT-II [04 Hours]

Personality and Behavior Development

Soul and scientific attitude. Goad and scientific attitude, positive thinking, integrity and discipline, punctuality, love and kindness. Avoiding fault, finding. Free from anger, Dignity of labor, Universal brotherhood and religious tolerance, True friendship, Happiness vs. suffering love for truth. Aware of self destructive habits, Association and cooperation, doing best, saving nature.

UNIT-III [04 Hours]

Character and Competence

Science vs. God, Holy books vs. Blind faith, Self management and good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of women, All religions and same message, Mind your mind, Self control, Honesty, Studying effectively.

UNIT-IV [04 Hours]

Engineering Ethics

Senses of 'Engineering Ethics', variety of moral issues, types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, consensus and controversy, models of professional roles, theories about right action, self interest, customs and religions, uses of ethical theories, Valuing time, Co-operation and commitment, Code of ethics, Sample codes – IEEE, ASCE, ASME and CSI.

Text Books:

1. Chakraborty, S. K., "Values and Ethics for Organization Theory and Practice", Oxford University Press, Fifth Edition, New Delhi, 2001, ISBN-13:9780195643077
2. Gaur R. R., Sangal R., Bagaria G. P., "A foundation course in Value Education", Excel Book,First Edition, 2009, ISBN 13: 9788174467812
3. Gaur R. R., Sangal R., Bagaria G. P., Teacher's Manual, Excel Books, 2009.
4. Mike Martin and RolandSchinzinger, "Ethics in Engineering", Mc Graw Hill. New York, Fourth edition, 2004, ISBN-13: 978-0072831153.

Reference Books:

1. Govindrajan M., Natrajan S. and Senthil Kumar V. S., Engineering Ethics (including Human Values), Prentice hall of India Ltd., New Delhi, 2004.
2. Frankena, W. K., *Ethics*, Prentice Hall of India, New Delhi, 1990.
3. Dhar P. L., Gaur R. R., *Science and Humanism*, Commonwealth Publishers, 1990.
4. TripathyA. N., *Human Values*, New Age International Publishers, 2003.
5. Seebauer E. G. and Robert L. Berry, *Fundamentals of Ethics for Scientists andEngineers*, Oxford University Press, 2000.
6. Banerjee B. P., *Foundations of Ethics and Management*, Excel Books, 2005.
7. Bajpai B. L., *Indian Ethos and Modern Management*, New Royal Book Company, 2004.

4TH SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –IV TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017													
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE		ESE	CIE	ESE	
			L	T	P			MID	IE				
1	SH0401	Complex Analysis and Numerical Methods	03	02	00	04	05	30	10	60	00	00	100
2	MT0401	Physical Metallurgy of Non-Ferrous Alloys	03	00	02	04	05	30	10	60	40	60	200
3	MT0402	Introduction to Process Metallurgy	03	02	00	04	05	30	10	60	00	00	100
4	MT0403	Transport Phenomena	03	02	02	05	07	30	10	60	40	60	200
5	MT0404	Metallurgical Thermodynamics	03	02	00	04	05	30	10	60	00	00	100
6	MT0405	Energy Economy and Waste Management	03	00	00	03	03	30	10	60	00	00	100
7	CE0407	Cyber Security and Intellectual Property Right	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**19**	**08**	**04**	**24**	**31**	**180**	**60**	**360**	**80**	**120**	**800**

Subject: **Complex Analysis and Numerical Methods**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **SH0401**			Semester: **IV**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	60	00	40	00	100

Objectives:

1. To provide an ability to understand, interpret and use the basic concepts: complex number, analytic function, harmonic function, Taylor and Laurent series, singularity, residue, conformal mapping, and meromorphic function.
2. To provide an ability to prove certain fundamental theorems about analytic functions, e.g. Cauchy's integral formula
3. To provide an ability to determine the images of curves under simple complex mappings.
4. To provide an ability to determine the stability of certain dynamical systems using complex functions.
5. To provide an ability to use conformal mapping to solve certain applied problems regarding heat conduction, electrical engineering and fluid mechanics.
6. To provide an ability to use Taylor and Laurent expansions to derive properties of analytic and meromorphic functions.
7. To provide an ability to compute integrals by means of residues.
8. To examine common numerical methods such as finite element and finite difference techniques, including the strengths and weaknesses of particular applications.
9. To discuss the concept of approximation in geometric and engineering applications.
10. To provide an ability to utilize a systems approach to design and operational performance.
11. To provide an ability to formulate mathematical models, choose suitable methods to investigate these models including the efficient use of computer tools.
12. To provide an ability to analyze zeros and poles of meromorphic functions, classify singularities
13. To provide an ability to identify various mathematical problems and reformulate these in a way suitable for numerical treatment.
14. To provide an ability to select a suitable numerical method for the treatment of the given problem.
15. To provide an ability to solve various engineering problems including tabular data.
16. To provide an estimate of the accuracy of the results.
17. To provide an ability to communicate effectively with professionals within applied and engineering mathematics as well as with persons working with different scientific-technological applications in an interdisciplinary context.
18. To provide an ability to develop abstract, logical and critical thinking and the ability to reflect critically upon their work and work of others.
19. To provide an ability to interlink various engineering fields with Mathematics.

CONTENTS

UNIT-I [12 Hours]

Complex Analytic Functions:
Complex Numbers, Demoivere's Theorem, Roots of Complex Numbers, Elementary complex functions, Complex planes, Curves in complex planes, Concept of neighborhood in The complex plane, Analytic function, Cauchy- Riemann equations (Cartesian and polar forms – without proof), Harmonic functions, conformal mappings, some standard conformal transformations.

UNIT-II [12 Hours]

Interpolation
Finite differences and Interpolation: Finite differences Forward, Backward & Central difference operators and difference tables. Interpolation, Interpolation Formulae with equal intervals: Newton's forward, Newton's backward, Central difference interpolation by Stirling's formulaeInterpolation Formulae with unequal intervals: Lagrange's & Newton's divided difference interpolationNumerical Integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule.Numerical differentiation: Using Newton's forward and backward interpolation formula

UNIT-III [12 Hours]

Numerical Methods: Basic Errors.
Solution of Algebraic and Transcendental Equations: Bisection method, Regula-Falsi method, Newton-Raphson method, Convergence condition for these methods.Numerical methods in Linear Algebra: Gauss-Jacobi, Gauss-seidel methodLargest Eigen values and corresponding Eigen vectors: By power methodNumerical Solutions of ordinary differential equations: Taylor's Method, Euler's Method, Improved Euler Method (Heun's Method), Runge-Kutta method of order four

UNIT-IV [12 Hours]

Complex Integration
Complex integration, Cauchy's integral theorem and Cauchy's integral formula (without proof), Singularities, Taylor's and Laurent's series, Cauchy-Residue theorem, Residues & Contour ntegration, Applications of residue to evaluate real integrals.

Text books:

1. Erwin Kreyszig: Advanced Engineering Mathematics (8^{th} Edition) Wiley Eastern Ltd., New Delhi (1999).

Reference Books:

1. R. V. Churchill and J. W. Brown: Complex variables and applications (7^{th} Edition), McGraw-Hill (2003)
2. B. V. Ramana: Higher Engineering Mathematics, McGraw Hill, New Delhi (2008).
3. Merel C Potter, J L Goldberg: Advanced Engineering Mathematics (3rd Edition) Oxford India Publication (2005).
4. Dr. B.S. Growl: Higher Engineering Mathematics, Khanna Publishers, New Delhi (2000).
5. R K Jain, S R K Iyengar: Advanced Engineering Mathematics. Third Edition, Narosa Publishing House (Reprint2014).
6. Murray Spiegel: Advanced Mathematics for Engineering & Science: (Schaum's Outline Series), TataMcGraw Hill Publication (2009).

Web Resources:

- http://freevideolectures.com/blog/2010/11/130-nptel-iit-online-courses/
- http://nptel.ac.in/video.php?subjectId=122107036
- http://ocw.mit.edu/index.htm
- https://www.khanacademy.org/

Course outcomes:

After completion of this course students will be able to gain knowledge about following

- To provide an ability to understand, interpret and use the basic concepts: complex number, analytic function, harmonic function, Taylor and Laurent series, singularity, residue, conformal mapping, meromorphic function.
- To provide an ability to prove certain fundamental theorems about analytic functions, e.g. Cauchy's integral formula
- To provide an ability to determine the images of curves under simple complex mappings.
- To provide an ability to determine the stability of certain dynamical systems using complex functions.
- To provide an ability to use conformal mapping to solve certain applied problems regarding heat conduction, electrical engineering and fluid mechanics.
- To provide an ability to use Taylor and Laurent expansions to derive properties of analytic and meromorphic functions.

Subject: **Physical Metallurgy of Non-Ferrous Alloys**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0401**				Semester: **IV**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	60	16/40	40	200

Course Objectives

1. To introduce the engineering science principles and applications associated with physical metallurgy for non-ferrous alloys.
2. To study the physical aspect behind non-ferrous materials.
3. To study the structure of metals and its influence on material properties and performance of non-ferrous materials.

CONTENTS

UNIT-I

[8 hours]

Introduction

Introduction to non-ferrous metals & their alloys: Aluminum Alloys, Copper Alloys, Nickel Alloys, Magnesium Alloys, Titanium Alloys, Lead Alloys, Zinc Alloys, Tin alloys, Babbitts (Antifriction Alloys).

UNIT-II

[10 hours]

Aluminum and its alloys:

Classification of Aluminum Alloys, Grades of Aluminum alloys, Non-heat treatable Wrought Aluminum Alloys, Heat treatable Wrought Aluminum Alloys, Cast Aluminum Alloys with their Phase Diagrams, Compositions, heat treatments, properties and applications. Heat treatment of Aluminum alloys, titanium alloys and copper alloys, Concept of age-hardening.

Copper and its alloys:

Copper, Brass and Bronze Phase Diagrams, Compositions, heat treatments, properties and applications, Grades of Copper alloys.

UNIT-III

[10 hours]

Nickel and its alloys:

Ni-Cr alloys, Ni-Al alloys, Ni-Cr-Al alloys, Ni-Cr-Al-Ti alloys, Complex Nickel- base alloys Phase diagram with compositions, Heat treatments, properties and applications, Grades of Ni alloys.

Magnesium and its alloys:

Classification of Magnesium Alloys, Wrought Magnesium Alloys, Cast Magnesium Alloys with their Phase Diagrams, Compositions, heat treatments, properties and applications.

Titanium and its alloys:

Compositions, heat treatments, properties and applications.

UNIT-IV

[10 hours]

Lead , Zinc and Tin and their alloys:

Lead and Its alloys Phase Diagrams, Compositions, heat treatments, properties and applications., Zinc and its alloys Phase Diagrams, Compositions, heat treatments, properties and applications., tin and its alloys Phase Diagrams, Compositions, heat treatments, properties and applications.

Babbitts (Antifriction alloys):

Phase Diagrams, Compositions, heat treatments, properties and applications.

Physical Metallurgy of Non-Ferrous Alloys Lab (List of Experiments)

Experiment No	Title
1	Specimen preparation for non-ferrous metallography
2	Study and preparation of etching agents for non-ferrous alloys
3	Microstructure observation of Pure non-ferrous metals
4	Application of Lever Rule for Phase, Phase Composition & Phase Fraction (Binary Alloys)
5	Microstructural observation of Aluminum Alloys
6	Microstructural observation of Copper Alloys
7	Microstructural observation of Brass
8	Microstructural observation of Bronze
9	Microstructural observation of Lead Alloys
10	Microstructural observation of Zinc Alloys
11	Aging Treatment of Al-Cu Alloy
12	Eutectic, Hypo- And Hyper-Eutectic Alloys: Al-Si (Unmodified), Al-Si (Modified), Pb-6wt%Sb, Pb- 11.1 Wt%Sb And Pb- 20 Wt%Sb
13	Peritectic And Monotectic Alloys: 60:40 (+) Brass, 70:30 ( ) Brass, Cu-

	10wt%Sn, Cu- 36wt% Pb, Cu- 50 Wt% Pb*
14	Grain size measurement
15	Understanding SAE, AISI, UNS and Indian Standards for non-ferrous alloys.

Course Outcomes

1. To apply the knowledge of various types of non-ferrous materials to design components of many areas of mechanical, manufacturing, civil, and materials engineering in the aerospace, automobile, transportation, energy, environmental, biomedical, and electronics industries.
2. To design non-ferrous materials with low weight, higher conductivity, non-magnetic property and resistance to corrosion for specific applications.

Text Books

1. Y. Lakhtin, "Engineering Physical Metallurgy", CBS Publishers & Distributors, 1st Edition, 2005, ISBN: 9788123906027.
2. D. S. Clark and W. R. Varney, "Physical Metallurgy for Engineers", Van Nostrand Reinhold Company, 2nd Edition, 1962, ISBN: 9780442015701.
3. C. R. Books, "Heat Treatment, Structure and Properties of Non-ferrous Alloys", ASM International, 1st Edition, 1982, ISBN: 9780871701381.
4. S. H. Avner, "Physical Metallurgy", Tata Mcgraw –Hill, 2nd Edition, 2008, ISBN: 9780074630068.

Reference Books

1. D. A Porter, K. E. Easterling and M. Y Sherif, "Phase Transformations in Metals and Alloys", CRC Press, 3rd Edition, 2009, ISBN: 9781420062106.
2. G. Gottstein, "Physical Foundations of Materials Science", Springer, 1st Edition, 2004, ISBN: 9783540401391.
3. R. E. Smallman, "Physical Metallurgy and Advanced Materials Engineering", Butterworth-Heinemann, 7th Edition, 2011, ISBN: 9780750669061.
4. ASM Handbook Committee, "Metals Handbook - (Volume 2 - Properties and Selection: Nonferrous Alloys and Pure Metals)", American Society for Metals, 9th Edition, 1979, ASIN: B0019QPMH0.

Web Resources

1. NPTEL Course on "Principles of Physical Metallurgy"
(http://nptel.ac.in/courses/113105024/

Subject: **Introduction to Process Metallurgy**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0402**				Semester: **IV**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To gain knowledge about the basic mechanism affecting the different extraction techniques such as Pyrometallurgical, Hydrometallurgical & Electro metallurgical extraction processes.
2. To gain knowledge about the concept of reaction kinetics & its role in understanding the extraction processes.

CONTENTS

UNIT-I

[8 hours]

Pyrometallurgical Processes

Basics of Pyrometallurgical Processes, Drying, Calcination, Agglomeration, Sintering, Roasting, Smelting. Converting, Refining processes with examples for metals like Aluminum, Copper, Zinc, and Lead.

UNIT-II

[10 hours]

Hydrometallurgical Processes

Basics of Hydrometallurgical processes, Fundamentals of Unit processes and Unit operations, Principles and types of Leaching, Kinetics of leaching, and Refining of leached solution, Solvent extraction and ion-exchange processes, Cementation, Gaseous reduction of metals.

UNIT-III

[10 hours]

Electrometallurgical Processes

Basics of Electrometallurgical processes: Electrowinning and Electrorefining, Aqueous/Fused salt electrolysis. Flow-sheets of Extraction of Important Metals, Simplified Flowsheets for the production of Iron, Steel, Aluminum, Copper, Zinc and Lead.

UNIT-IV

[10 hours]

Reaction Kinetics

Kinetics of metallurgical processes and material, velocity/rate of reaction, factors affecting rate of reaction, Order of Reaction and molecularity, zero, first, second order and order of reaction, Pseudo-unimolecular reaction, half life period, determination of order of reaction, integration method, half period method, graphical method, Ostwald's isolation method, rate constants, Arrhenius equation, collision theory, Activation Energy, activation energy profile of an exothermic reaction, activation energy barrier, theory of absolute reaction rate.

Course Outcomes

1. To understand about the requirement of various devices required for carrying out different extraction processes.
2. To analyze and apply various factors affecting these extraction processes.

Text Books

1. H. S. Ray and A. Ghosh, "Principles of Extractive Metallurgy", New Age Publishers, 2nd Edition, 1991, ISBN: 9788122403220.
2. H.S. Ray, R. Sridhar and K.P. Abraham, "Extraction of Nonferrous Metals", Affiliated East West Press Pvt Ltd, 1st Edition, 2008, ISBN: 9788185095639.
3. S. K. Dutta and A. B. Lele, "Metallurgical Thermodynamics Kinetics & Numericals", S. Chand Publications, 2nd Edition, 2014, ISBN: 9788121939645.

Reference Books

1. W. H. Dennis, "Extractive Metallurgy", Pitman Publishing, 1st Edition, 1965, ISBN: 9780273404729.
2. F. Habashi, "Principles of Extractive Metallurgy", Gordon & Breach, 1st Edition, 1970, ISBN: 9780677017808.
3. T. Rosenqvist, "Principles of Extractive Metallurgy", McGraw Hill, 1st Edition, 1974, ISBN: 9780070538474.
4. J. L. Bray, "Nonferrous Production Metallurgy", John Wiley and Sons, 2nd Edition, 1947, ASIN: B0007E2TW6.
5. R. D. Pehlke, "Unit Processed in Extractive Metallurgy", Elsevier, 1st Edition, 1973, ISBN: 9780444001306.
6. H. S. Ray, "Introduction to Melts: Molten Salts, Slags and Glasses", Allied Publishers Pvt Ltd 1st Edition, 2006, ISBN: 9788177648751.
7. H.S. Ray, B.P Singh, S. Bhattacharjee and V. N. Misra, "Energy in Minerals and Metallurgical Industries", Allied Publishers Pvt Ltd, 1st Edition, 2005, ISBN: 8177648748.

Web Resources

1. NPTEL Course on "Non-Ferrous Extractive Metallurgy"
(http://nptel.ac.in/courses/113105021/)

Subject: **Transport Phenomena**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0403**				Semester: **IV**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	2	5	24/60	60	16/40	40	200

Course Objectives

1. To provide knowledge about the basic concept of heat transfer and its different modes.
2. To analyze different modes of heat transfer with examples in day to day life.
3. To demonstrate the application of various factors & mathematical equations governing the heat transfer in the system.

CONTENTS

UNIT-I

[8 hours]

Fluid flow and its relevance to mass transfer. General mass transport equation. Modes of mass transfer. Film and boundary layer theories. Diffusion, Generalized diffusion equation. Diffusivity in gases, liquids and solids. Steady, diffusion. Pseudo-steady diffusion. Diffusion through porous solids. Convective mass transfer- Mass transfer in fluid at solid-fluid interface. Mass transfer between two fluids. Mass transfer v/s chemical control, enhancement of process rates. Applications in metallurgical system

UNIT-II

[8 hours]

Definition and classification of fluids. Viscosity, Newtonian and non- Newtonian fluids. Viscous and non-viscous fluids. General features of fluid flow. Laminar and turbulent flow, Newton's law of viscosity, Pascal's law.

UNIT-III

[12 hours]

Differential mass balance (continuity equation). Differential momentum balance (equation of motion). Navier Stokes Equation. Application of Differential Balance Equation. Overall mass balance and momentum balance. Euler's equation, Bernoulli's equation. Bernoulli's Equation, Applications of Bernoulli's Equation, Flow through porous media.

UNIT-IV

[10 hours]

Modes of heat transfer. Conduction of heat through solid. Steady and unsteady state. Fourier law of heat conduction. General equation of heat conduction in Cartesian co-ordinate, spherical and cylindrical systems.

Convective heat transfer. Free and forced convection. Application dimensional analysis of effective boundary layer.

Aspects of Radiative Heat Transfer. Reflection, absorption and transmission of radiation. Black body radiation. Planck's Law. Wein's distribution Law. Heat transfer between two bodies by radiation. Lambert's Law.

Transport Phenomena Lab (List of Experiments)

Experiment No	Title
1	To study about various fluid properties and fluid flows.
2	To determine Reynold's number for fluid flow
3	Measurement of pressure difference using manometers
4	To verify Bernoulli's theorem.
5	To apply Bernoulli's equation to Venturimeter
6	To apply Bernoulli's equation to Orificemeter
7	To study the fundamentals of heat transfer
8	To determine thermal conductivity of insulating powder using sphere in sphere method.
9	To measure overall heat transfer coefficient for given composite wall with help of composite wall apparatus.
10	To determine temperature distribution and the effectiveness of fin.
11	To determine the surface heat transfer coefficient for a vertical tube losing heat by natural convection.
12	To determine convective heat transfer coefficient in force convection
13	To determine Stefan-Boltzmann constant
14	To determine emissivity for the given surface
15	Study of mass transfer

Course Outcomes

1. To solve different numerical pertaining to all three modes of heat transfer for different systems.

2. To demonstrate the phenomena of conduction, convection & Radiation by conducting laboratory scale experiments.
3. To make the students understand the concept of fluid behavior & its relevance for different modes of mass transfer.
4. To analyze the mass & momentum balance equations to understand the diffusion phenomenon in metallurgical systems.

Text Books

1. A. K. Mohanty, "Rate Processes in Metallurgy", Prentice Hall India Learning Private Limited, 3rd Edition, 2009, ISBN: 9788120335912.
2. V. Gupta, "Elements of Heat and Mass Transfer", New Age International Publishers, 1st Edition, 1995, ISBN: 9788122408003.
3. J. H. Szekely and N. J. Themelis, "Rate Phenomena in Process Metallurgy", John Wiley & Sons, 1st Edition, 1971, ISBN: 9780471843030.
4. D. R. Poirier and G. H. Geiger, "Transport Phenomena in Materials Processing", John Wiley & Sons, 1st Edition, 1998, ISBN: 9780873392723.

Reference Books

1. R. B. Bird, W. E. Stewart and E. N. Lightfoot, "Transport Phenomena", Wiley, 2nd Edition, 2006, ISBN: 9788126508082.
2. M. Iguchi and O. J. Ilegbusi, "Basic Transport Phenomena in Materials Engineering", Springer Nature, 1st Edition, 2014, ISBN: 9784431540199.
3. D. R. Gaskell, "An Introduction to Transport Phenomena in Materials Engineering", Momentum Press, 2nd Edition, 2012, ISBN: 9781606503553.
4. J. Welty, C.E. Wicks, G.L. Rorrer and R.E. Wilson, "Fundamentals of Momentum, Heat and Mass Transfer", John Wiley & Sons, 5th Edition, 2012, ISBN: 9780470128688.

Web Resources

1. NPTEL MOOC Course on "Transport Phenomena"
(https://onlinecourses.nptel.ac.in/noc17_ch11/preview)
2. SWAYAM MOOC Course on "Transport Phenomena"
(https://swayam.gov.in/course/3719-transport-phenomena)
3. EdX Online Course on "The Basics of Transport Phenomena"
(https://courses.edx.org/courses/course-v1:DelftX+TP101x+1T2017/info)
4. EdX Online Course on "Advanced Transport Phenomena"
(https://courses.edx.org/courses/course-v1:DelftX+TP102x+3T2016/info)

Subject: **Metallurgical Thermodynamics**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0404**				Semester: **IV**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To get the knowledge about the basic concept of system, properties of system and thermodynamics.
2. To analyze and understand all the laws of thermodynamics.
3. To understand thermodynamics of solutions ideal & non ideal solution.

CONTENTS

UNIT-I

[8 hours]

Importance 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, Zeroth law of thermodynamics. First law of thermodynamics, Internal energy, Heat capacity, Specific heat and latent heat, Enthalpy, Isothermal and adiabatic processes.

.

UNIT-II

[10 hours]

State properties, Heat of reaction, Heat of formation, Standard heats, Heat of transition, Hess's law, Kirchoff's law equation. Second law of thermodynamics, Entropy of irreversible processes, Auxiliary functions, combined statements of 1^{st} and 2^{nd} laws, Maxwell's relations,

Third law of thermodynamics, Temperature dependence of entropy, Statistical interpretation of entropy, Consequences of third law, Nernst heat theorem.

UNIT-III

[10 hours]

Concept of fugacity, activity and mole fraction, Activities in concentrated solution, Activity, Gas phase Reactions (H_2O- H_2 and CO_2 –CO mixtures), Activity in industrial liquid metallic solution, Equilibrium constant, Gibb's-Helmholtz equation. Van't-Hoff equation, Clausius – Clapeyron equation, Reactions involving solid and gases, Thermodynamics of solutions, Ideal

solution, Raoult's law, Henry's law, Non-ideal solution Gibb's-Duhem equation, Partial molar properties of mixing.

UNIT-IV

[10 hours]

Excess functions, Concept of 1 wt% standard state and Interaction coefficient, Regular solutions, Sievert's law-residual gases in steel, Phase relations and phase rule-its applications, Free energy-composition and temperature-composition diagrams for binary alloy systems and their correlation, determination of liquidus, solidus and solvus lines, Effect of pressure on phase transformation and phase equilibrium, Ellingham diagram in detail for metal oxides.

Course Outcomes

1. To demonstrate the application of various factors & mathematical equations governing the thermodynamics in the system.
2. To solve different numerical pertaining to all three laws of thermodynamics for different systems.
3. To demonstrate the phenomena of Ellingham diagram & its importance pertaining to metal oxides.
4. To describe basis of phase rule & its application and various equilibrium using thermodynamics and correlation for binary alloy systems.

Text Books

1. A. Ghosh, "Introduction to Materials and Metallurgical Thermodynamics", Prentice Hall India Learning Private Limited, 1st Edition, 2002, ISBN: 9788120320918.
2. S. K. Dutta and A. B. Lele, "Metallurgical Thermodynamics Kinetics & Numericals", S. Chand Publications, 2nd Edition, 2014, ISBN: 9788121939645.

Reference Books

1. R. H. Tupkary, "Essentials of Metallurgical Thermodynamics", Khanna Publishers, 1st Edition, 2006, ISBN: 9789382609032.
2. G. S. Upadhyaya, R. K. Dube and D. W. Hopkins, "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon Press, 1st Edition, 1977, ISBN: 9780080208640.
3. L. S. Darken and R. W. Gurry, "Physical Chemistry of Metals", CBS, 1st Edition, 2002, ISBN: 9788123914794.

Web Resources

1. NPTEL MOOC Course on "Laws of Thermodynamics"
(https://onlinecourses.nptel.ac.in/noc17_mm16/preview)
2. SWAYAM MOOC Course on "Engineering Thermodynamics"
(https://swayam.gov.in/course/3808-engineering-thermodynamics)
3. EdX Online Course on "Thermodynamics"
(https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x-1)
4. NPTEL Online Course on "Advanced Metallurgical Thermodynamics"
(http://nptel.ac.in/courses/113106031/)

Subject: **Energy Economy and Waste Management**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0405**				Semester: **IV**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	24/60	0	16/40	0	100

Course Objectives

1. To understand economic and ability to apply economic and financial evaluation of energy projects.
2. To learn the basics of cost calculation for electricity and heat production from CHP and power plants.

CONTENTS

UNIT-I

[8 hours]

Introduction Energy basics; Energy defined, Alternative classifications of Energy, India and world energy consumption and trade. Energy and multidimensional interactions, Introduction to energy system, Energy balance, Analysis of energy balance information, Energy demand, Management of Energy Demand, Economy of energy supply.

UNIT-II

[10 hours]

Fossil Fuel Markets Coal, oil, natural gas.

Economics of Non-Renewable resource supply.

Financing Energy Development Energy resources and economic rent (economic rent, leasing and taxation of energy resources, government revenues), Allocation of resources over time and financing energy development (discounting, "levelized" costs of renewable resources, Cost Benefit Analysis, Laffer Curve, Interrelationship between energy system and LCOE, depletion of non-renewable resources), GDP, GNP, Energy futures.

UNIT-III

[10 hours]

Solid Waste Management & Disposal

Introduction to solid waste management, the disposal decades, the nature of the problem, Methods of waste disposal (Treatment/disposal Technologies): dumping, sanitary landfills

mechanical-biological treatment, incineration, anaerobic digestion, composting; recycling of plastics, batteries.

UNIT-IV

[10 hours]

Liquid Waste Management Introduction to liquid waste management, types and sources of liquid waste, Management of liquid waste: Human waste management, sullage management, Industrial waste management, Collection, storage, and treatment of liquid waste: septic tanks, anaerobic biogas reactor, and Centralized wastewater treatment systems.

Course Outcomes

1. To design processes for the treatment of waste water and the sludges that arise from them.
2. To discuss the operational aspects of handling hazardous wastes.
3. To describe methods for the recycling and minimization of solid wastes.

Text Books

1. S. C. Bhattacharyya, "Energy Economics: Concepts, Issues, Markets and Governance", Springer, 1st Edition, 2011, ISBN: 9780857292674.
2. F. E. Banks, "Energy Economics: A Modern Introduction", Springer, 1st Edition, 2000, ISBN: 9781461370543.
3. R. Rhyner, L. J. Schwartz, R. B. Wenger and M. G. Kohrell, "Waste Management and Resource Recovery", CRC Press, 1st Edition, 1995, ISBN: 9780873715720.

Reference Books

1. E. Enger, B. Smith, "Environmental Science", McGraw-Hill Education, 14th Edition, 2015, ISBN: 9780073532554.
2. H. S. Muralidhara, "Solid/Liquid Separation: Waste Management and Productivity Enhancement", Battelle Pr, 1st Edition, 1990, ISBN: 9780935470543.
3. L. C. Hunt, J. Evans, "International Handbook on the Economics of Energy", Edward Elgar Publishing Ltd, Reprint Edition, 2011, ISBN: 9780857938251.
4. R. J. Eden, "Energy Economics: Growth, Resources, and Policies", Cambridge University Press, 1st Edition, 1983, ISBN: 9780521281607.

Web Resources

1. The Mises Academy Online Course on "Adventures in Energy Economics" (https://www.youtube.com/watch?v=Ie8VxbIM1Kc)

Subject: **Cyber Security and Intellectual Property Rights**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **CE0407**			Semester: **IV**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
01	00	00	00	60	00	40	00	100

Course Objectives:

1. To understand the concepts of Cybercrimes and cyber security.
2. To create the awareness of how to avoid becoming victims of cybercrimes.
3. To impart knowledge about Intellectual property rights like patents, copyright, industrial design rights, trademarks, trade dress, geographical indications and some jurisdictions trade secrets.
4. To provide in-depth knowledge of Information Technology Act, 2000 including Information Technology Amendment Act, 2008

CONTENTS

UNIT-I **[03 hours]**

Introduction:

Overview of Information Security, Cyber security objectives and policies, Fundamental concepts and principles of Cyber security, Introduction of Cyber-crime, Classifications of Cybercrimes.

UNIT-II **[03 hours]**

Security Threats and vulnerabilities:

Application security (Database, E-mail and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Intrusion Detection, Access Control. Security Threats -Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce- Electronic Payment System, e-Cash, Credit/Debit Cards.

UNIT-III **[03 hours]**

Provisions in Indian Laws in dealing with Cyber Crimes:

Security Policies, Why Policies should be developed, WWW policies, Email Security policies, Policy Review Process-Corporate Policies-Sample Security Policies, Publishing and Notification Requirement of the Policies. Information Security Standards-ISO, IT Act, Copyright Act, Patent Law, Cyber Laws in India; IT Act 2000 Provisions, Intellectual Property Law.

UNIT-IV [03 hours]

Cyber law- Intellectual property right:

Introduction, Objectives of Intellectual property law, Types of IPR, Advantages of IPR, IPR in India, Offences and Penalties.

Text Books:

1. "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Nina Godbole, Sunit Belapur, Wiley India Publications, April, 2011 ISBN 13: 9788126521791

Reference Books:

1. Charles P. Pfleeger, Shari Lawerance Pfleeger, ―Analysing Computer Security, Pearson Education India. ISBN 10: 9332517428 ISBN 13: 9789332517424
2. V.K. Pachghare, ―Cryptography and information Security, PHI Learning Private Limited, Delhi India. ISBN 10: 8120350820 ISBN 13: 9788120350823
3. Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen kumar Shukla,Introduction to Information Security and Cyber Law Willey Dreamtech Press. **ISBN 13 :** 9789351194736
4. CHANDER, HARISH, Cyber Laws And It Protection , PHI Learning Private Limited ,Delhi ,IndiaISBN 10: 8120345703 ISBN 13: 9788120345706

Web Resources:

- **Security Threats and vulnerabilities:**
  https://ifap.ed.gov/presentations/attachments/**30ITSecurityThreatsVulnerabilitiesandCountermeasuresV1**.pdf
- **Threats and Attacks:**
  http://web.cse.ohio-state.edu/~champion.17/4471/4471_lecture_2.pdf
- **Introduction to Cyber Crime and Security:**
  https://www.youtube.com/watch?v=-V1coBXIsZ4
  https://www.youtube.com/watch?v=VBZLdgbTsq8
  https://www.youtube.com/watch?v=mFXIm8CJsYc
  https://www.youtube.com/watch?v=3uW-j8_BSn4
- **IPR:**
  https://www.youtube.com/watch?v=VzBzOv39iZY
  https://www.youtube.com/watch?v=tKgQDxbhpEQ

Learning outcomes:

- Students will able to do classification of cybercrime, methods used to perform crime, apply cyber security, and know the detailing of Information Technology Acts against offences.
- Students will understand and appreciate the legal and ethical environment impacting individuals as well as business organizations and have an understanding of the ethical implications of IT legal decisions.
- The understanding and knowledge of the core concepts vulnerable to threats in systems.
- Students will gain awareness about Intellectual property rights (IPRs) to take measure for the protecting their ideas, patents and methods of application of patents, Trade Secrets copyrights, Trade Marks, legal implications.

5TH SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –V TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017													
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0501	Heat Treatment Principles and Practices	03	00	02	04	05	30	10	60	40	60	200
2	MT0502	Iron Making	04	00	02	05	06	30	10	60	40	60	200
3	MT0503	Foundry Technology	04	00	02	05	06	30	10	60	40	60	200
4	MT0504	Non Ferrous Extractive Metallurgy	03	02	00	04	05	30	10	60	00	00	100
5	MT0505	Plastic Deformation of Metals	03	02	00	04	05	30	10	60	00	00	100
6	MT0506	Surface Engineering	04	00	00	04	04	30	10	60	00	00	100
7	SH0507	Technical Communication and Soft Skills	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**22**	**04**	**06**	**26**	**32**	**180**	**60**	**360**	**120**	**180**	**900**

Subject: **Heat Treatment Principles and Practices**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0501**				Semester: **V**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	5	24/60	60	16/40	40	200

Course Objectives

1. To introduce the engineering science principles and applications associated with heat treatments.
2. To study the basic heat treatment processes.
3. To study the structure of metals and its influence on material properties and performance based on different heat treatments.

CONTENTS

UNIT-I

[8 hours]

Principles of heat treatment of steels:

Phase Transformation on heating, Forming of austenite, Kinetics of formation of austenite, Nucleation sites in eutectoid steels, Austenitic grain size, Grain growth, Determination of austenitic grain size, Importance of austenitic grain size

TTT (Time Temperature Transformation) and CCT (Continuous Cooling Transformation) diagrams:

Method of plotting, Types of TTT diagram, Critical cooling rate, Effect of alloying elements on TTT diagram, Applications, Continuous cooling transformation diagram, Limitations of Iron-Iron Carbide Diagram, Effect of Alloying elements on CCT diagram.

UNIT-II

[10 hours]

Pearlitic transformation: Mechanism of transformation, Kinetics of transformation, Hull-Mehl model of pearlitic transformation, Effect of alloying elements on transformation, Interlameller spacing,

Bainitic transformation: Characteristics, Mechanism of transformation, Bainitic structure.

Martensitic transformation:

Diffusionless transformation, Mechanism of transformation, Kinetics of transformation, M_s - M_f temperatures, Athermal and isothermal martensites, Effect of applied stress on transformation, Habit planes, Bain distortion model / crystallographic theory of martensitic transformation,

Tempered Martensite, Retained austenite, Martensitic transformation in non-ferrous systems such as Fe-Ni and Cu-Al systems.

UNIT-III

[10 hours]

Heat treatment processes:

Stress relieving, Annealing – full annealing, partial annealing, bright annealing, diffusion annealing, recrystallization annealing, Spheroidizing, Normalizing, Hardening and Tempering, Hardening of typical steels, cast irons and non-ferrous alloys.

Surface hardening of metals:

Principles involved in induction and flame hardening methods and application of selective hardening, Laser hardening, Case carburizing (solid, liquid and gaseous), Cyaniding, Carbonitriding, Nitriding, Plasma nitriding etc., Depth of penetration - its measurement and relation with time and temperature, Hardening & Hardenability of steels.

UNIT-IV

[10 hours]

Special methods of heat treatment:

Austempering, Martempering, Ausforming, Patenting, Sub-zero treatment etc., Thermo Mechanical treatments. Heat treatment of carbon steels, alloy steels, tools and dies steels, stainless steels (with reference to carbide precipitation and sigma phase formation) and cast irons – specific examples, Heat treatment of Aluminum alloys, titanium alloys and copper alloys, Concept of age-hardening. Design for heat treatment, Heat treatment furnaces- their temperature and atmosphere control, Defects in heat treated parts, Causes for the defects in heat-treated parts and remedies.

Heat Treatment Principles and Practices Lab (List of Experiments)

Experiment No	Title
1	Annealing of Medium / High carbon steels
2	Characterization of annealed steel
3	Normalizing of Medium / High carbon steels
4	Characterization of normalized steel
5	Spheroidizing of High carbon steel
6	Characterization of spheroidized steel
7	Hardening of medium/ high carbon steels
8	Characterization of hardened steel

9	Tempering of medium/ high carbon steels
10	Characterization of tempered steel
11	To examine the effect of quenching media on hardening of steel
12	To measure the hardenability of steel using Jominy End-Quench test
13	To study the case hardening processes
14	Carburizing of low carbon steels
15	Case depth measurement and characterization of carburized steels

Course Outcomes

1. To apply the knowledge of various types of heat treatments to design the heat treatment cycles for different components of many areas of mechanical, manufacturing, civil, and materials engineering in the aerospace, automobile, transportation, energy, environmental, biomedical, and electronics industries.
2. To predict the mechanical properties based on the changes in heat treatment variables.
3. To apply their knowledge in the field of alloy design and microstructural engineering.

Text Books

1. D. S. Clark and W. R. Varney, "Physical Metallurgy for Engineers", Van Nostrand Reinhold Company, 2nd Edition, 1962, ISBN: 9780442015701.
2. T. V. Rajan, C. P. Sharma and A. Sharma, "Heat Treatment (Principles and Techniques)", Prentice Hall India, 2nd Edition, 2011, ISBN: 9788120340954.

Reference Books

1. S. H. Avner, "Physical Metallurgy", Tata Mcgraw –Hill, 2nd Edition, 2008, ISBN: 9780074630068.
2. Y. Lakhtin, "Engineering Physical Metallurgy", CBS Publishers & Distributors, 1st Edition, 2005, ISBN: 9788123906027.
3. S. H. Avner, "Physical Metallurgy", Tata Mcgraw –Hill, 2nd Edition, 2008, ISBN: 9780074630068.
4. V. D. Kodgire and S. V. Kodgire, "Material Science and Metallurgy for Engineers", Everest Publishing House, 31st Edition, 2011, ISBN: 9788186314005.
5. V. Singh, "Heat Treatment of Metals", Standard Publishers Distribution, 2nd Edition, 2011, ISBN: 9788180140389.
6. V. Raghvan, "Physical Metallurgy (Principles and Practice)", Prentice Hall India, 2nd Edition, 2006, ISBN: 9788120330122.
7. B. Zakharov, "Heat Treatment of Metals", University Press of the Pacific, 2nd Edition, 2002, ISBN: 9781410203052.
8. ASM International, "ASM Handbook on Heat Treating Vol. 4", 11th edition, 1991, ISBN: 9780871703798.
9. K. H. Prabhudev, "Handbook of Heat Treatment", Tata Mc-Graw Hill, 4th Reprint, 2011, ISBN: 9780074518311.

Web Resources

1. NPTEL Course on “Principles of Physical Metallurgy” (http://nptel.ac.in/courses/113105024/)
2. NPTEL MOOC Course on “Heat Treatment and Surface Hardening-I” (https://onlinecourses.nptel.ac.in/noc16_mm12/preview)
3. NPTEL MOOC Course on “Heat Treatment and Surface Hardening-Part II” (https://onlinecourses.nptel.ac.in/noc17_me19/preview)

Subject: **Iron Making**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0502**			Semester: **V**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	24/60	60	16/40	40	200

Course Objectives

1. To impart the overall idea of how Iron is produced, the history of Iron making and availability of raw materials for iron production.
2. To know about various techniques of raw material preparation for charging in iron making furnace, construction and operation of iron making furnace and reactions occurring in the furnace, reaction mechanism inside the blast furnace.

CONTENTS

UNIT-I

[8 hours]

General: History of iron making. Occurrence, distribution and evaluation of raw materials (iron ore, coal and flux) for iron making. Burden materials and burden preparation: Burden preparation, Burden qualities. Agglomeration- Sintering-process, variables and machines. Pelletization process, Theory of bonding. Mechanism of ball formation, Disc and drum pelletizer, Induration of pellets, cold bonding technique and testing of pellets.

UNIT-II

[10 hours]

Blast Furnace (B.F.) Constructional features: Profile, Refractories, Accessories, Charging mechanism, Bell and bell-less charging systems. B.F. – Reactions: Physico-chemical principles of blast furnace. Blast furnace reactions. Reaction in stack, tuyere zone, bosh and hearth. Thermodynamics equilibria, Direct and indirect reduction. Kinetics of iron-oxide reduction, Slag-metal reactions, Desiliconization, Desulphurization.

UNIT-III

[10 hours]

B.F. – Operations: Operational steps, Blast furnace irregularities and remedial measures, Blast furnace gas, properties, cleaning and utilization.

UNIT-IV

[10 hours]

Alternative Methods of Iron Making: Reduction smelting, Direct reduction processes, Fluidized bed process, Electro thermal process and mini blast furnace.

Iron Making Lab (List of Experiments)

Experiment No	Title
1	Identification of raw material for iron making
2	Bulk density Measurement
3	Determination of Angle of Repose
4	Sintering of iron ore fines
5	Pelletization of iron ore fines
6	Induration behavior of pellets
7	Box compression test of hardened or indurated pellets
8	Tumbling/Drum test of green and indurated pellets
9	Shatter Test of agglomerated products
10	Drop Test of agglomerated products
11	Study of ISP layout
12	Charge calculations for raw materials in Blast Furnace
13	Study of different parts of Blast Furnace
14	Chemical analysis of Iron based products
15	Study of Briquetting Process

Course Outcomes

1. To apply the knowledge of various types of routes of iron making to practical scenarios.
2. To innovate the existing ideas and ways of making Iron and developing the technology to make this process energy intensive and cost effective.

Text Books

1. R. H. Tupkary, "Introduction to Modern Iron Making", Khanna Publications, 1st Edition, 2004, ISBN: 9788174090218.
2. A. Ghosh and A. Chatterjee, "Iron Making and Steel Making: Theory and Practice", Prentice Hall, 1st Edition, 2008, ISBN: 9788120332898.

3. A. K. Biswas, “Principles of Blast Furnace Iron Making”, SBA Publications, 1st Edition, 1999, ISBN: 9780949917089.

Reference Books

1. A. W. Cramb, “Making, Shaping and Treating of Steels”, Association of Iron and Steel Engineers, 11th Edition, 1985, ISBN: 9780930767020.
2. J. G. Peacey and W. G. Davenport, “Blast Furnace: Theory and Practice”, Pergamon Press, Oxford, 1st Edition, 1979, ISBN: 9780080232584.
3. J. J. Gupta and Amit Chatterjee, “Blast Furnace Iron Making”, SBA Publications, 1st Edition, 1995, ISBN: 9788185164106.

Web Resources

1. NPTEL Course on “Materials and Heat Balance in Metallurgical Processes” (http://nptel.ac.in/courses/113104060/26)

Subject: **Foundry Technology**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0503**				Semester: **V**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)-Theory**	**Continuous Internal Evaluation (CIE)-Practical**	**Total**
4	0	2	5	24/60	60	16/40	40	200

Course Objectives

1. To acquire the knowledge about the fundamentals of the casting, basic terminology related to casting process.
2. To make students aware about the alternative method for the manufacturing of component for engineering applications.

CONTENTS

UNIT-I

[8 hours]

General: Introduction to metal casting and foundry industry in modern industrial scenario. Advantages and limitations of casting methods. Classification of foundries. Different sections in a foundry and their functions. Important cast metals and alloys-their composition, properties and uses.

Patternmaking: Patterns. Types. Pattern making materials and their selection, Color code, Pattern allowances, Core-boxes and their types.

UNIT-II

[10 hours]

Moulding and Core-making Materials: Ingredients of common type of moulding and core-making sands, their properties and behavior, testing of sands and clay.

Moulding Processes: Classification, Brief description of processes such as green sand, dry sand, loam, floor, Pit and machine molding. No-bake molding process. CO_2-Silicate process.

UNIT-III

[10 hours]

Casting Processes: Shell molding and casting process, Investment casting process, Permanent molding process. Gravity and Pressure Die-casting, Centrifugal casting process. Low Pressure Die-casting (LDPC) process.

Melting: Melting of cast iron, Constructional features of Cupola, Principles and operation of Cupola furnace. Advances in cupola melting operation, Melting of aluminum and Copper-based alloys. Furnaces used, Melt-treatments such as degassing, Grain refining and modification.

UNIT-IV

[12 hours]

Gating System: Elements of gating system. Classification. Gating design considerations, Gating ratio. Gating practice for ferrous and non-ferrous alloys, Pouring equipments.

Risering System: Risering practice, Functions of riser, Directional and progressive solidification. Centerline feeding resistance. Riser efficiency. Riser design considerations. Risering curves. Cain's, N.R.L. and Modulus methods, Feeding distance and feeding aids, Blind and atmospheric risers

Quality Control in Foundry: Casting defects, their causes and remedies. Shop floor quality control tests such as composition control, Wedge test, fluidity, temperature measurement etc.

Foundry Technology Lab (List of Experiments)

Experiment No	Title
1	Introduction to foundry laboratory.
2	To detrmine AFS fineness number and distribution coefficient of agiven sand sample
3	To demonstrate the working of sand muller
4	To determine the clay content of given sand sample
5	To prepare standard samples under identical condition for checking important physical properties of foundry sand
6	To determine compression strength of foundry sand
7	To determine permeability number of green sand,core sand and raw sand
8	To find out the green mould hardness of the sand mould
9	To determine shatter index of the sand sample.
10	To determine moisture content of the prepared sand
11	To prepare core sand
12	To findout the hardness of dried cores made out of core sands
13	To perform peelback test on core sand
14	To perform hot distortion and tensile tests on core sand
15	To study the aluminum melting and casting

Course Outcomes

1. To apply knowledge about how to manufacture the intricate casting what should be the process parameter, design of pattern, mould, etc.
2. To apply the theory about the melting practice of different cast alloy.
3. To apply the knowledge to overcome defects generated during casting.

Text Books

1. R. W. Heine, C. R. Loper and P. C. Rosenthal, "Principles of Metal Casting", Tata McGraw Hill, 2nd Edition, 2017, ISBN: 9780070993488.
2. P. L. Jain, "Principles of Foundry Technology", Tata McGraw Hill, 2nd Edition, 1987, ISBN: 9780074516980.

Reference Books

1. P. C. Mukherjee, "Fundamentals of Metal Casting Technology", Oxford & IBH, 1st Edition, 1988, ISBN: 9788120403635.
2. P. R. Beeley, "Foundry Technology", Butterworth-Heinemann, 2nd Edition, 2001, ISBN: 9780750645676.
3. H. F. Taylor and M. C. Flemings, "Foundry Engineering", Wiley Eastern, 1st Edition, 1959, ISBN: 9780471848431.
4. D. Kumar and S. K. Jain, "Foundry Technology", CBS Publications, 1st Edition, 2007, ISBN: 9788123902906.

Web Resources

1. NPTEL MOOC Course on "Principles of Casting Technology" (https://onlinecourses.nptel.ac.in/noc17_me11/preview)

Subject: **Non Ferrous Extractive Metallurgy**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0504**				Semester: **V**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To make the students aware about basics of non-ferrous metals and its extraction processes.
2. To impart the knowledge about the basic steps followed in extraction and their importance.

CONTENTS

UNIT-I

[10 hours]

General:

World resources of Non-ferrous metals and their occurrence. Present and future position of non-ferrous metallurgical industry in India- resources, production and consumption.

Indian scenario of non-ferrous ores and mineral deposits. Production plants for non-ferrous metals such as copper, zinc, lead, tin, Aluminum, nickel, magnesium, titanium, etc.

Basics of Pyrometallurgy, Hydrometallurgy and electrometallurgy

UNIT-II

[10 hours]

Aluminum:

Occurrence of Bauxite. Bayer's process for production of alumina. Alternatives to Bayer's process. Hall-Heroult process-conventional and new materials for construction of Aluminum reduction cell, nature of electrolyte. Electrolysis of alumina with emphasis on physico-chemical principles and secondary-reactions, factors affecting current efficiency. Alternatives to Hall-Heroult process. Refining of Aluminum.

Copper:

Occurrence of copper ores. Roasting. Matte-smelting, Converting and Refining process as applied to copper production and their physico-chemical aspects. Single step and multistep continuous processes. Hydrometallurgical process for production of primary copper. Recovery of copper from copper slag.

UNIT-III

[10 hours]

Nickel:

Occurrence of nickel ores, Pyrometallurgical and Hydrometallurgical processes for nickel production and refining.

Lead and Zinc:

Occurrence of lead and zinc ores, Pyrometallurgical and Hydrometallurgical processes for lead and zinc production and their physio-chemical aspects, Refining of lead and zinc, Recovery of byproducts.

Tin:

Occurrence of tin, various methods of extraction of tin from its ores and other sources. Uses of tin.

UNIT-IV

[12 hours]

Gold and Silver:

Occurrence of gold and silver. Various methods for production of gold and silver from their ores and other sources.

Recovery of gold, silver and platinum from secondary sources such as Copper Anode Mud, Red Mud, Zinc dross and electrolytic solutions.

Magnesium:

Occurrence of magnesium, Methods of production of magnesium oxide and magnesium chloride, Pyrometallurgical extraction of magnesium, Electrolytic extraction and refining of magnesium.

Titanium

Occurrence of titanium, Extraction, Production, recovery, properties and application.

Course Outcomes

1. To apply the knowledge regarding the auxiliary operation and the advancement in various extractive process.
2. To apply the theory about the extraction practice of different non-ferrous metals.

Text Books

1. H.S. Ray, R. Sridhar and K.P. Abraham, "Extraction of Nonferrous Metals", Affiliated East West Press Pvt Ltd, 1st Edition, 2008, ISBN: 9788185095639.

Reference Books

1. W. H. Dennis, "Extractive Metallurgy", Pitman Publishing, 1st Edition, 1965, ISBN: 9780273404729.
2. F. Habashi, "Principles of Extractive Metallurgy", Gordon & Breach, 1st Edition, 1970, ISBN: 9780677017808.
3. T. Rosenqvist, "Principles of Extractive Metallurgy", McGraw Hill, 1st Edition, 1974, ISBN: 9780070538474.

4. J. L. Bray, “Nonferrous Production Metallurgy”, John Wiley and Sons, 2nd Edition, 1947, ASIN: B0007E2TW6.
5. R. D. Pehlke, “Unit Processed in Extractive Metallurgy”, Elsevier, 1st Edition, 1973, ISBN: 9780444001306.
6. H. S. Ray, “Introduction to Melts: Molten Salts, Slags and Glasses”, Allied Publishers Pvt Ltd 1st Edition, 2006, ISBN: 9788177648751.
7. H.S. Ray, B.P Singh, S. Bhattacharjee and V. N. Misra, “Energy in Minerals and Metallurgical Industries”, Allied Publishers Pvt Ltd, 1st Edition, 2005, ISBN: 8177648748.
8. H. S. Ray and A. Ghosh, “Principles of Extractive Metallurgy”, New Age Publishers, 2nd Edition, 1991, ISBN: 9788122403220.

Web Resources

1. NPTEL Course on “Non-Ferrous Extractive Metallurgy”
(http://nptel.ac.in/courses/113105021/)

Subject: **Plastic Deformation of Metal**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0505**			Semester: **V**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To provide knowledge about the basic concept crystals their structures and their defects that is point, line, volume and surface defects.
2. To teach them basics about dislocations and how dislocations help in improving properties.
3. To teach them various strengthening mechanism of metals.

CONTENTS

UNIT-I

[8 hours]

Crystal Imperfections, Point Defects, Line Defects & Surface Defects, Dislocation and its types, Slip Phenomena, Slip Systems. Theoretical strength of a perfect Crystal, Slip by dislocation movement concept of critical resolved shear stress, Climb and its types, Twinning as a mode of deformation, Burgers vector and the dislocation loop, Stress fields and energies of dislocations, Jogs and Kinks.

UNIT-II

[10 hours]

Dislocation:

Dislocation in F.C.C (including formation of stacking fault.) B.C.C and H.C.P., Forces. Multiplication of dislocations, Techniques to observe dislocation, Dislocation point defects interactions, Intersection of Dislocations, Dislocations pile up.

Deformation of single and polycrystalline materials, Grain boundaries. Low-angle boundaries, High Angle Grain Boundaries Surface tension of the grain boundary, Strengthening from grain boundaries, Hall-petch equation, Yield point phenomenon.

UNIT-III

[10 hours]

Strain- hardening of polycrystalline metals, Strain hardening of single crystals, Relation between single and polycrystalline stress-strain curve, Solid – Solution hardening. Strengthening due to

second phase particles, Strain – ageing behavior, Annealing of cold-worked metals, Recovery, Recrystallization and grain growth.
All types of tests, Modes of Failure, Theory of ductile-brittle transition temperature (DBTT).

UNIT-IV

[12 hours]

Types of fracture in metals. Theoretical cohesive strength of metals. Griffith theory of brittle fracture, Elementary concept of fracture mechanics, Fatigue test. Theory of fatigue. Effect of metallurgical variables and temperature. Creep test, Creep curve. Stress-rupture test, Creep mechanisms. High temperature alloys. Effect of some metallurgical variables. Presentation of engineering creep data.

Course Outcomes

1. To solve different numerical pertaining to resolved shear stress and hall petch equation.
2. To apply the concepts of fracture mechanics like ductile and brittle fracture.
3. To apply the theory about testing, creep and fatigue testing in practice.
4. To solve practical example on the testing.

Text Books

1. G. E. Dieter, "Mechanical Metallurgy", McGraw-Hill, 3rd Edition, 2013, ISBN: 9781259064791.
2. R. Abbaschian, L. Abbaschian and R. E. Reed-Hill, "Physical Metallurgy Principles", Stamford CT: Cengage Learning, 4th Edition, 2010, ISBN: 9780495438519.
3. R. W. Hortzberg, "Deformation and Fracture Mechanics of Engineering Materials", John Wiley and Sons, 5th Edition, 2012, ISBN: 9780470527801.
4. J. Wulff, H. W. Hayde and W. I. Moffatt, "Structure and Properties of Materials Vol.III: Mechanical Behaviour", John Wiley and Sons, 1st Edition, 1967, ASIN: B000N91X72.

Reference Books

1. T. H. Courtney, "Mechanical Behavior of Materials", Waveland Pr Inc, 2nd Edition, 2005, ISBN: 9781577664253.
2. A. V. K. Suryanarayan, "Testing of Metallic Materials", BS Publications, 1st Edition, 2007, ISBN: 9788178001340.

Web Resources

1. NPTEL MOOC Course on "Introduction to Crystal Elasticity and Crystal Plasticity" (https://onlinecourses.nptel.ac.in/noc16_mm13/preview)
2. EdX Online Course on "Mechanical Behavior of Materials" (https://courses.edx.org/courses/MITx/3.032x/3T2014/info)
3. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc17_mm09/preview)
4. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc16_mm11/preview)

5. EdX Online Course on “Fundamentals of Manufacturing Processes”
(https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x)

Subject: **Surface Engineering**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0506**				Semester: **V**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To understand the concept and basis of surface engineering.
2. To understand the various methods of surface modification techniques.
3. To understand the phenomena behind the modification techniques.

CONTENTS

UNIT-I

[8 hours]

Scope of surface engineering in metals, ceramics, polymers and composites, Surface Preparation methods such as Chemical, Electrochemical, Mechanical- Sand Blasting, Shot peening, Shot blasting, Hydroblasting, Vapor Phase Degreasing etc., Properties of Various Coating, Coating Methods.

UNIT-II

[10 hours]

Chromating, Phosphating, Anodizing, Thermochemical processes, industrial practice, economy and energy considerations. Electrolytic and Electroless plating of important metals and alloys

UNIT-III

[10 hours]

Surface pretreatments, Hot Dipping, galvanizing, testing/evaluation of surface properties.

Coating from Vapour Phase

PVD, CVD, Various Methods used, mechanisms, important reactions involved and applications.

UNIT-IV

[12 hours]

Sputtering, Plasma Spray & Ion Implantation Methods, mechanisms & applications. Surface modification by directed energy beams like ion, electron and laser beams, novelty of composition and microstructures.

Diffusion Coating: Various Techniques For Single And Multiple Element Coating, High Temperature Coating- Carburising, Carbonitriding,Silicanizing,Chromizing, Aluminizing, Boronizing, Boronitriding.

Course Outcomes

1. To co-relate various techniques with desired properties and applications.
2. To understand various advanced machineries and their working principles like plasma, laser, and ion beam, etc.

Text Books

1. J. R. Davis, "Surface Engineering for Corrosion and Wear Resistance", CRC Press, 1st Edition, 2001, ISBN: 9780871707000.
2. R J. Rudzki, "Surface Finishing Systems: Metal and Non-metal", ASM International, 1st Edition, 1984, ISBN: 9780904477078.
3. J. A. Murphy, "Surface Preparation and Finishes for Metal", McGraw-Hill, 1st Edition, 1971, ISBN: 9780070595576.
4. ASM International, "ASM Handbook Volume 5: Surface Engineering", ASM International, 10th Edition, 1994, ISBN: 9780871703842.

Reference Books

1. P. G. Sheasby and R. Pinner, "The Surface Treatment and Finishing of Aluminum and Its Alloys", ASM International, 6th Edition, 2001, ISBN: 904477215.
2. R. S. Mishra and M. W. Mahoney, "Friction Stir Welding and Processing", ASM International, 1st Edition, 2007, ISBN: 9780871708489.

Web Resources

1. EdX Online Course on "Surface Science: Methods of Surface Analysis" (https://www.edx.org/course/surface-science-methods-surface-analysis-mephix-mephi006x)

Subject: **Technical Communication and Soft Skills**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **SH0507**			Semester: **V**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	0	0	0	60	00	40	00	100

Course Objectives:

1. To enable students to interact with a degree of fluency and spontaneity that makes regular interaction with fluent English speakers quite possible without strain for either party.
2. To understand with ease virtually everything heard or read.
3. To express themselves spontaneously, very fluently and precisely, differentiating finer shades of meaning even in the most complex situations.
4. To understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment).
5. To communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters
6. To understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in their field of specialization.

CONTENT:

	Sr. No.	**Content**
Listening	1	**Listening: Cloze test**
	2	**Listening to Talks (BBC, TED) 1**
	3	**Listening to Talks 2**

Speaking	**4**	**Phonetics: Sounds & Symbols & Accent Patterns**
	5	**Vocabulary Games: Intermediate Level**
	6	**Vocabulary Games: Intermediate Level**
	7	**Building Dialogues: Situational Conversation**
	8	**Role Play**
	9	**Group Discussion**

Reading	**10**	**How to Read effectively**
	11	**Reading to Remember : SQ3R**

Writing	**12**	**Grammar Intermediate: Sentence Transformation**
	13	**Common Errors in English**
	14	**Précis Writing**
	15	**Effective Paragraph Writing**

6TH SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –VI TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017													
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME					
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0601	Steel Making	04	02	00	05	06	30	10	60	00	00	100
2	MT0602	Electrometallurgy and Corrosion	04	00	02	05	06	30	10	60	40	60	200
3	MT0603	Powder Metallurgy	04	00	02	05	06	30	10	60	40	60	200
4	MT0604	Metal Forming	03	02	00	04	05	30	10	60	00	00	100
5	MT0605	Material Characterization (EL – 1)	03	02	00	04	05	30	10	60	00	00	100
	MT0611	Computational Materials Science (EL – 1)											
	MT0612	MOOC Course – 1 (EL – 1)											
6	MT0606	Industrial Ceramics and Polymers (EL – 2)	04	00	00	04	04	30	10	60	00	00	100
	MT0607	Nano Technology (EL – 2)											
	MT0608	Composite Materials (EL – 2)											
	MT0609	Nuclear Metallurgy (EL – 2)											
	MT0610	Modelling of Metallurgical (EL – 2)											
7	SH0607	Advanced Technical Communication and Soft Skills	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**23**	**06**	**04**	**27**	**33**	**180**	**60**	**360**	**80**	**120**	**800**

Subject: **Steel Making**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0601**			Semester: **VI**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	2	0	5	24/60	0	16/40	0	100

Course Objectives

1. To impart the overall idea of how Steel is produced the history of Steel making.
2. To know about various techniques of raw material preparation for charging in iron making furnace, construction and operation of iron making furnace and reactions occurring in the furnace, reaction mechanism inside the blast furnace and post treatment to make steel.

CONTENTS

UNIT-I

[8 hours]

General:

Old Steel Making practices. Modern equipment and practices. Integrated Steel Plants in India. Mini steel plants their advantages and limitations – present scenario.

Physical Chemistry of Steel Making:

Thermodynamic and Kinetics of Refining Reactions, Carbon, Phosphorus, Sulphur and Silicon Reactions. Refining Slag and its Properties. Importance and Mechanism of decarburization. Reaction at Slag Metal interface.

UNIT-II

[12 hours]

Basic Oxygen Steel Making:

BOF practice, Equipment, Operation and Process, slag Metal reactions in B.O.F. Raw material and flux practices. Kaldo, OBM, LD-AC, Rotor process, Top and Bottom blowing processes.

Oxygen Lance:

Design, Construction and Operation. Top and Bottom Blown processes, Its advantages and disadvantages

Electric Steel Making:

Electric Arc Furnaces: Types and construction. Sequence of operations. Various additions at Different Stages, Slag Control. UHP Arc Furnaces. Arc Furnace practices for Carbon and Low Alloy Steels. Modern developments in ARC furnaces.

UNIT-III

[10 hours]

Quality Steel Making:

Introduction, Sources of Inclusions, Sulphur, Phosphorus, and Gases in Steels. Kinetics of Deoxidation of Molten Steel, Application of Ellingham Diagrams, Thermodynamics of Reaction During Degassing of Liquid Steel, Fluid Flow and Mixing in Ladle, Kinetics and Mass Transfer, Ladle Injection Metallurgy, Desulphurization & Dephosphorization.

Secondary Steel Making:

Metallurgical Principles in Secondary Steel Making and Secondary Steel Making Processes. Ladle Furnaces (L.F.), Vacuum Systems and Vacuum treatment of Steel. Removal of Gases from steel. LF-VD processes and AOD, VOD, VAD techniques, R-H degassers. Ladle Stirring and its Advantages. ESR Principle And Technology. Deoxidation – Theory and practice, Floatation's of deoxidation products, Modifications of Inclusions. Injection Metallurgy

UNIT-IV

[10 hours]

Inclusions in Steel:

Influence of Inclusions on Mechanical Properties of Steel, Inclusion, Identification and Cleanness Assessment, Origin of Non Metallic Inclusions, Inclusion Control Continuous Casting **(C.C.) and Ingot Casting:**

6 Hrs Ingot Casting: Types of Moulds, Advantages and Disadvantages. Ingot Defects and Remedies. Continuous casting: C.C. machines with its various units and types. C.C. of Blooms, Slabs and Thin slabs EM S of Moulds. Reoxidation prevention methods during Steel Casting. Advantage of C.C. Environmental issues related to Steel Making, Heat Transfer & Solidification Rate in Ingot Casting and Continuous Casting, Distinguishing Metallurgical Aspects of Continuous Casting of Steel.

Course Outcomes

1. To apply the knowledge of various types of routes of iron making to practical scenarios.
2. To innovate the existing ideas and ways of making Iron and developing the technology to make this process energy intensive and cost effective.

Text Books

1. R. H. Tukary, "An Introduction to Modern Steel Making", Khanna Publishers, 7th Edition, 2000, ISBN: 9788174090263.
2. G. R. Bashforth, "The Manufacture of Iron and Steel: Vol I", Chapman & Hall, 3rd Edition, 1964, OCLC: 439659739.
3. G. R. Bashforth, "The Manufacture of Iron and Steel: Vol II", Nabu Press, Primary Source Edition, 1964, ISBN: 9781295841929.

Reference Books

1. A. W. Cramb, "Making, Shaping and Treating of Steels", Association of Iron and Steel Engineers, 11th Edition, 1985, ISBN: 9780930767020.
2. R. G. Ward, "An Introduction to the Physical Chemistry of Iron and Steel Making", Edward Arnold Ltd, 1st Edition, 1962, ASIN: B0007IZZGY.
3. V. A. Kudrin, "Steel Making", Mir Publisher, 1st Edition, 1985, ASIN: B0007BN3H4.

Web Resources

1. NPTEL MOOC Course on "Steel Quality: Role of Secondary Refining & Continuous Casting" (https://onlinecourses.nptel.ac.in/noc17_mm10/preview)

Subject: **Electrometallurgy and Corrosion**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0602**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	24/60	60	16/40	40	200

Course Objectives

1. To be knowledgeable of the influence of a material's composition and microstructure on its corrosion performance.
2. To be knowledgeable of the effect of an electrolyte's composition on the corrosion of metals.
3. To be able to identify materials that will exhibit adequate corrosion resistance in a particular environment.
4. To be able to propose economically viable remedial actions that will eliminate or reduce corrosion to a tolerable level.

CONTENTS

UNIT-I

[10 hours]

Basics of Electrochemistry

Faradays' laws of electrolysis, current efficiency, current density, electrode potentials, Thermodynamics and Kinetics of Electrode Processes- Polarization Curves, Concept of Over-Potential, Kinetics Of Passivity and Transpassivity, Nernst's Equation, Emf Series, Evan's Corrosion Diagram, Galvanic Series. Pourbiax Diagram for Metal Water System, Applications and Limitations.

UNIT-II

[10 hours]

Forms of Corrosion

The relevance of corrosion studies, forms of corrosion, Uniform Corrosion, Galvanic Corrosion, Crevice Corrosion, Pitting Corrosion, Intergranular Corrosion, Selective Leaching, Erosion Corrosion, stress cracking corrosion, Hydrogen Damage.

High Temperature Corrosion

High Temperature Corrosion in Different Atmosphere, Effect of Doping, Alloying Elements, Coating Methods for High Temperature Corrosion Protection, Pilling Bedworth Ratio and its applications.

UNIT-III

[10 hours]

Corrosion Protection

Principles of Protection, Selection of Suitable Design, Inhibition, Coating Methods, Anodic protection and Cathodic protection.

Electro deposition

Classification and mechanism of electrodeposition processes. Electroplating of copper, Nickel and Chromium. Principles of Alloy plating and electroless plating, Anodising, Galvanizing.

UNIT-IV

[12 hours]

Factors affecting Corrosion

Environment affecting corrosion, effects of soil, chemicals, moisture and atmospheric gases,temperature and velocity, metallurgical factors.

Corrosion Testing

Physical and Electrochemical Methods such as ASTM standard methods A262 Practice A to E and their equivalents, Surface Preparation, Exposure Technique, Corrosion Rate Measurements.

Material Selection to Combat Corrosion

Specific Corrosion Applications Such as Marine Industry, Petrochemical Industry, High Temperature Service, Chemical Industry, Automobile, High Temperature & High Pressure corrosion in Industries.

Electrometallurgy and Corrosion Lab (List of Experiments)

Experiment No	Title
1	To prepare the samples for corrosion testing.
2	To determine corrosion rate of given sample by weight loss method in H_2SO_4 Solution.
3	To determine corrosion rate of given sample by weight loss method in NaCl solution.
4	To determine corrosion rate of sample by weight loss method in HCl solution.
5	Comparative study of corrosion rate by weightless method for different acid solutions.
6	To study and perform IGC corrosion of stainless steel.
7	Determination of Inter granular corrosion susceptibility by microstructure evaluation.
8	To study and observe galvanic corrosion of two metals.
9	Observation of effect of anodic area and type of material on galvanic corrosion of

	metals.
10	To perform & observe pitting corrosion in stainless steel.
11	To study & perform the effect of current density on anodic dissolution.
12	To perform the electroplating of copper on a given base metal.
13	To perform the Anodizing of Aluminum in H_2SO_4 Solution.
14	To study and perform cathodic protection of a metal by sacrificial anode method.
15	To Study corrosion rate by Tafel Extrapolation method.

Course Outcomes

1. To understand the origin of the difference in electrical potential across an interface, in particular, metal/electrolyte interface.
2. To understand the relationship between rates of electrochemical reactions and the potential drop across interfaces.
3. To understand the causes of and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, and various modes of environmentally assisted cracking.

Text Books

1. M. G. Fontana and N. D. Greene, "Corrosion Engineering", McGraw Hill Higher Education, 2nd Edition, 1978, ISBN: 9780070214613.

Reference Books

1. P. C. Mukherjee, "Fundamentals of Metal Casting Technology", Oxford & IBH, 1st Edition, 1988, ISBN: 9788120403635.
2. D. A. Jones, "Principles and Prevention of Corrosion", Pearson, 2nd Edition, 1995, ISBN: 9780133599930.
3. H. H. Uhlig and R. W. Revie, "Corrosion and Corrosion Control", Wiley-Interscience, 4th Edition, 2008, ISBN: 9780471732792.
4. L. L. Shreir, "Corrosion: Volume 1", Newnes-Butterworth, 2nd Edition, 1976, ISBN: 9780408001090.
5. G. T. Burstein, L. L. Shreir and R. A. Jarman, "Corrosion: Volume 2", Butterworth-Heinemann, 3rd Edition, 1994, ISBN: 9780750610773.
6. M. Pourbaix, "Atlas of Electrochemical Equilibria in Aqueous Solutions", NACE International, 1st Edition, 1974, ISBN: 0915567989.
7. J. O. M. Bockris and A. K. N. Reddy, Modern Electrochemistry: Volume I", Springer, 2nd Edition, 1998, ISBN: 9780306455544.
8. J. O. M. Bockris and A. K. N. Reddy, Modern Electrochemistry: Volume II", Springer, 1970 Edition, 1973, ISBN: 9780306250026.

Web Resources

1. NPTEL Online Course on "Advances in Corrosion Engineering" (http://nptel.ac.in/courses/113108051/)

Subject: **Powder Metallurgy**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0603**			Semester: **VI**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	2	5	24/60	60	16/40	40	200

Course Objectives

1. To define and explain basic conditions of successful application of powder metallurgy technology for production of materials and components.
2. To formulate advantages and disadvantages of powder metallurgy.
3. To classify typical representatives of individual powder metallurgy technologies.

CONTENTS

UNIT-I

[8 hours]

Introduction: Historical and modern developments in P/M. Advantages limitations and applications of Powder Metallurgy.

Characteristics of metal powder in terms of particle size , shape and size distribution, Characteristics of powder mass such as apparent density, tap density, flow rate, friction conditions. Properties of green compacts and sintered compacts.

UNIT-II

[10 hours]

Important methods of metal powder manufacturing like machining, milling, atomization, electrodeposition, reduction from oxide, carbonyl process, production of alloy powders, new development.

Powder conditioning, fundamentals of powder compaction, density distribution in green compacts, types of compaction presses, compaction tooling and role of lubricants. Single and double die compaction, isostatic pressing, hot pressing, effect of variables on sintering, sintering atmospheres and sintering furnaces.

UNIT-III

[10 hours]

Powder rolling, powder forging, powder extrusion and explosive forming technique Definition of sintering, stages of sintering

UNIT-IV

[10 hours]

Mechanism of sintering, liquid-phase sintering, infiltration process. Study of sintered bearings, cutting tools, and metallic filters. Study of friction and antifriction parts and electrical contact materials.

Powder Metallurgy Lab (List of Experiments)

Experiment No	Title
1	To study the sieve analyses of metal powders and determine the correction factor.
2	To study the particle size and shape of metal powders by Image analyzer.
3	To study the importance of blending and mixing operation for powder metallurgy.
4	To determine the apparent density and tap density of metal powders.
5	To determine the friction index and flow rate by hole flow meter.
6	To study and carry out heat treatment on metal powders.
7	Demonstrations of single action die compaction of metal powders by hydraulic press.
8	To study the sintering mechanism of metal pellets.
9	Characterization of sintered product.
10	To produce metal powder by Water Atomization Technique
11	Characterization of metal powder produced by water atomization technique
12	To produce metal powder by Gas Atomization Technique
13	Characterization of metal powder by Gas Atomization Technique
14	Copper powder production by electrolysis method.
15	Characterization of copper powder produced by electrolysis method.

Course Outcomes

1. To evaluate and propose optimum technology for preparation of powder materials.
2. To evaluate and evaluate influence of individual technological parameters on basic powder metallurgy operations.
3. To optimize material and technological parameters of production.

Text Books

1. A. K. Sinha, "Powder Metallurgy", Dhanpat Rai Publications, 2nd Edition, 2006, ISBN: 9788189928513.
2. W. D. Jones, "Fundamental Principles of Powder Metallurgy", E. Arnold, 1st Edition, 1960, ASIN: B0007IXN18.

Reference Books

1. H. H. Hausner, "Handbook of Powder Metallurgy", Chemical Publishing Co Inc, 1st Edition, 1973, ISBN: 9780820602196.
2. G. S. Upadhyaya, "Powder Metallurgy Technology", Cambridge International Science Publishing, 1st Edition, 1998, ISBN: 9781898326403.

Web Resources

1. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc17_mm09/preview)
2. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc16_mm11/preview)
3. EdX Online Course on "Fundamentals of Manufacturing Processes" (https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x)

Subject: **Metal Forming**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0604**			Semester: **VI**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To provide knowledge about the basic concepts of deformations and energy requirements.
2. To understand different methods of deformations to produce various shapes.
3. To teach them various strengthening mechanism of metals.

CONTENTS

UNIT-I

[8 hours]

Fundamentals of metal working: Yield criteria, Von-Mises equation, Classification of metal forming processes, Mechanics of metal working, Flow curve for materials, Temperature in Metal Working, Hot working, Cold working & Warm working, Strain rate effect of metallurgical structure and non-metallic inclusion on the manufacturing process, Workability, Residual stresses, Annealing of cold-worked metals.

UNIT-II

[10 hours]

Forging: Classification of forgoing processes, Forging equipment and operations, Open die forging, Closed die forging, Plane strain forging analysis, Forging defects, Metallurgical variables associated with forging, Powder metallurgy forging, Residual stresses in forging.

Rolling: Terminology of rolled products, Different kinds of rolling mills, Deformation zone in rolling, Neutral point, Angle of bite, Forward slip, Roll flattening, Rolling variables, Hot rolling, Cold rolling, Rolling of blooms billets, slabs, plates, strips, sheets, bars, rods & light section, Lay out of different mills for rolling of above products, Elementary roll pass design, Forces and geometrical relationships in rolling, Defects in rolled products.

UNIT-III

[10 hours]

Extrusion: Classification of extrusion processes, Direct and indirect extrusion, Impact extrusion, Hydrostatic extrusion, Extrusion equipment, Extrusion ratio, Process variables, Lubrication &

defects in extrusion, Derivation of extrusion pressure, Extrusion of tubing, Production of seamless pipe and tubing.

Drawing: Rods, wires and tubes: Theory and practice of wire drawing, Wire drawing equipment, Variables in wire drawing, Defects in formed products.

UNIT-IV

[10 hours]

Sheet metal working: Shearing, Blanking, Bending, Stretch forming, Deep drawing, Spinning, Piercing, Swaging, Embossing, Coining, High energy rate forming, explosive forming, electromagnetic forming, electro hydraulic forming, formability diagrams, Super-plasticity.

Course Outcomes

1. To solve different numerical pertaining to different metal forming techniques.
2. To apply the concepts of forming processes and discern the effect of variables on the productivity.
3. To solve practical example on the testing.

Text Books

1. G. E. Dieter, "Mechanical Metallurgy", McGraw-Hill, 3rd Edition, 2013, ISBN: 9781259064791.

Reference Books

1. P. N. Rao, "Manufacturing Technology (Foundry, Forming and Welding)", Tata McGraw Hill Education Private Limited, 4th Edition, 2013, ISBN: 9789383286614.
2. W. F. Hosford and R. M. Caddell, "Metal Forming: Mechanics and Metallurgy", Cambridge University Press, 4th Edition, 2014, ISBN: 9781107670969.
3. K. Lange, "Deformation Handbook of Metal Forming", Society of Manufacturing Engineers, New Edition, 1985, ISBN: 9780872634572.

Web Resources

1. NPTEL MOOC Course on "Forming"
(http://nptel.ac.in/courses/112106153/)
2. EdX Online Course on "Mechanical Behavior of Materials"
(https://courses.edx.org/courses/MITx/3.032x/3T2014/info)
3. NPTEL MOOC Course on "Fundamentals of Material Processing - I"
(https://onlinecourses.nptel.ac.in/noc17_mm09/preview)
4. NPTEL MOOC Course on "Fundamentals of Material Processing - I"
(https://onlinecourses.nptel.ac.in/noc16_mm11/preview)
5. EdX Online Course on "Fundamentals of Manufacturing Processes"
(https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x)
6. NPTEL MOOC Course on "Manufacturing Process Technology I & II"
(https://onlinecourses.nptel.ac.in/noc17_me03/preview)

Subject: **Material Characterization (Elective – 1)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0605**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To provide knowledge about the basic concepts of behind material characterization.
2. To understand different methods of characterization in order to understand different properties.

CONTENTS

UNIT-I

[8 hours]

Importance of Material characterization, Classification of techniques for characterization. Image formation, resolving power, numerical aperture, empty magnification, depth of focus, components of microscopes, important lens defects and their correction, principles of phase contrast, interference and polarized light microscopy, Image analyzer.

UNIT-II

[8 hours]

Thermal Analysis techniques: Basic Principles, Working and applications of DTA, TGA, TMA and DSC.

UNIT-III

[10 hours]

Studies by electron microscopes: Principle, Construction and Working of TEM, SEM, STEM with their merits, demerit and applications, techniques of replica preparation.

UNIT-IV

[10 hours]

X-Ray diffraction and their applications: Working principles of diffractometer. Indexing of XRD patterns, determination of crystal structure, lattice parameter, and crystallite size by diffraction techniques. Numerical based on XRD.

Spectroscopic and Chemical analysis Techniques: IR & Raman spectroscopy, Energy Dispersive Spectroscopy (EDS) & Wavelength Dispersive Spectroscopy (WDS), XRF.

Course Outcomes

1. To solve different numerical pertaining to optical microscopy and X-ray diffraction.
2. To understand the basic elements of electron microscopy.
3. To understand the basic aspects of optical characterization methods including Raman and infrared spectroscopy.

Text Books

1. J. M. Walls, "Methods of Surface Analysis: Techniques & Applications", Cambridge University Press, 1st Edition, 1989, ISBN: 9780521305648.
2. J. P. Sibilia, "A Guide to Materials Characterization and Chemical Analysis", Wiley-Blackwell, 2nd Edition, 1996, ISBN: 9780471186335.
3. P. R. Khangaonkar, "An Introduction to Materials Characterization", Penram International Publishing, 1st Edition, 2010, ISBN: 9788187972808.

Reference Books

1. M. Spencer, "Fundamentals of Light Microscopy", Cambridge University Press, 1st Edition, 1982, ISBN: 9780521289672.
2. D. B. Williams and C. B. Carter, "Transmission Electron Microscopy: A Textbook for Materials Science", Springer, 2nd Edition, 2009, ISBN: 9780387765020.
3. C. R. Brundle, C. A. Evans Jr. and S. Wilson, "Encyclopedia of Materials Characterization", Butterworth-Heinemann, Braille Edition, 1992, ISBN: 9780750691680.
4. B. D. Cullity and S. R. Stock, "Elements of X-Ray Diffraction", Pearson, 3rd Edition, 2001, ISBN: 9780201610918.
5. G. W. H. Hohne, W. F. Hemminger and H. J. Flammersheim, "Differential Scanning Calorimetry", Springer, 2nd Edition, 2003, ISBN: 9783540004677.
6. D. B. Murphy and M. W. Davidson, "Fundamentals of Light Microscopy and Electronic Imaging", Wiley-Blackwell, 2nd Edition, 2012, ISBN: 9780471692140.

Web Resources

1. NPTEL MOOC Course on "Fundamentals of Optical and Scanning Electron Microscopy"
(https://swayam.gov.in/course/1399-fundamentals-of-optical-and-scanning-electron-microscopy)
2. NPTEL MOOC Course on "X-ray Crystallography & Diffraction"
(https://onlinecourses.nptel.ac.in/noc17_mm11/preview)
3. NPTEL MOOC Course on "Fundamentals of X-ray Diffraction & Transmission Electron Microscopy"
(https://onlinecourses.nptel.ac.in/noc16_mm06/preview)
4. NPTEL MOOC Course on "Electron Diffraction and Imaging"
(https://onlinecourses.nptel.ac.in/noc17_me30/preview)

Subject: **Computational Materials Science (Elective – 1)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0611**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To provide hands-on experience with popular computational materials science and engineering software through a series of projects.
2. To understand different methods of modelling and simulation in order to understand different properties, structural evolution and possible applications.

CONTENTS

UNIT-I

[8 hours]

Introduction to Computational Materials Science, multiple scales in crystalline materials, materials scales for modelling, Introduction to simple numerical methods for solving coupled differential equations and for studying correlations, applications.

UNIT-II

[8 hours]

Quantum Mechanical Modeling:

Introduction, Hartree-Fock and Density function theory (DFT), plane wave based DFT calculations, equilibrium properties and surfaces from DFT calculations, atomistic modeling of defects in materials, applications.

Monte Carlo Methods:

Introduction, Kinetic, Lattice, applications.

UNIT-III

[10 hours]

Classical Equilibrium Statistical Mechanics:

Phase space, Hamiltonian's equation, macroscopic translation and rotation, phase space coordinates, canonical transformations, applications.

Molecular Dynamics:

Introduction, brief MD algorithm, microcanonical ensemble (NVE), velocity-verlet algorithm, canonical ensemble (NVT), applications.

UNIT-IV

[10 hours]

Multiscale methods:

Introduction to multiscale models, sequential multiscale models, concurrent multiscale models, Hierarchial methods, partitioned-domain methods, spanning time scales, Statistical mechanics of systems in metastable equilibrium, applications.

Introduction to phase diagram modeling using CALPHAD and Thermo-Calc, applications.

Course Outcomes

1. To model different projects in: electronic structure calculation, molecular simulation, phase diagram modeling, finite element modeling, and materials selection.
2. To familiarize students with a broad survey of software tools in computational materials science, scientific computing, and prioritize the physical principles underlying the software to confer an understanding of their applicability and limitations.

Text Books

1. E. B. Tadmor and R. E. Miller, "Methods of Surface Analysis: Techniques & Applications", Cambridge University Press, 1st Edition, 2011, ISBN: 9780521856980.

Reference Books

1. Z. X. Guo, "Multiscale Materials Modelling: Fundamental and Applications", CRC Press, 1st Edition, 2007, ISBN: 9780849391101.
2. D. Raabe, "Computational Materials Science", Wiley-VCH Verlag GmbH, 1st Edition, 2004, ISBN: 9783527295418.

Web Resources

1. MIT OpenCourseWare Course on "Atomistic Computer Modeling of Materials" (https://ocw.mit.edu/courses/materials-science-and-engineering/3-320-atomistic-computer-modeling-of-materials-sma-5107-spring-2005/index.htm)
2. MIT OpenCourseWare Course on "Introduction to Modeling and Simulation" (https://ocw.mit.edu/courses/materials-science-and-engineering/3-021j-introduction-to-modeling-and-simulation-spring-2012/index.htm)

Subject: **Industrial Ceramics and Polymers (Elective – 2)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0606**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To understand the various types of ceramic and different between advance and traditional ceramics.
2. To understand the developing methods of raw materials.
3. To understand the sintering mechanism of ceramics and characteristics of sintered ceramics.
4. To get the knowledge of processing method of ceramics.

CONTENTS

UNIT-I

[8 hours]

Introduction, definition and scope of ceramics. Historical perspective, classification, Structure of ceramics, Pauling's Rules, Ceramic Phase Diagrams, Silicate structures.

Traditional ceramics:

An overview, history, raw materials, Shaping, sintering, abrasives, White wares, Glazing and decoration.

Refractories:

Types of refractories, fireclay, mullite, silica refractories, magnesite refractories, carbide & nitride refractories, pure oxide refractories, chrome refractories

UNIT-II

[12 hours]

Glass:

Nature of glass, structure, glass forming systems, silicate systems, non-silicate systems, Types of Glasses, manufacture of glass, Viscous Deformation of Glasses, Ceramic Glass, Advance ceramics and their application.

Processing of Ceramics:

Processing of ceramic powders, shape forming operations- Dry pressing, isostatic pressing, Hot Pressing, HIP, slip casting, Extrusion method, injection molding, hot pressing and hot isostatic pressing, Sol –gel processing and monolithic ceramics. Thermal Treatment- Drying & Firing of ceramics: kiln design & sintering mechanism and densification,

Properties:
(Thermal, Mechanical & Optical properties) of sintered ceramics. Ceramics used for energy and environment technologies (fuel cell, lithium battery, gas sensor and catalytic support), ceramic coating, ceramic in bio-medical application, nanotechnology and ceramics

UNIT-III

[10 hours]

Historical Background, Basic concepts of polymeric materials, Classification and forms of Polymers, Tacticity, Functionality, Different types of polymerization, chemistry of **Polymerization:**
Chain polymerization, Step polymerization, Polymerization Techniques: Bulk polymerization, Solution polymerization, Suspension polymerization, and Emulsion polymerization.

UNIT-IV

[10 hours]

Molecular weight & Size, Determination of molecular weight - methods for measuring number average, weight average, viscosity average MW, Molecular weight distribution, Degree of Polymerization, Polymer Degradation, Glass transition temperature, Crystallinity, Elastomers, Fiber and plastic, Additives, Processing of polymers- Extrusion, Injection Molding, Transfer Moulding, and Blow Molding.

Course Outcomes

1. To understand the process that is used to produce glass–ceramics.
2. To apply the idea about properties, applications of different clay products, refractory ceramics and abrasive ceramics.
3. To compare between traditional and advance ceramics for application of advance ceramics.
4. To understand the polymer molecule in terms of its chain structure and, in addition, how the molecule may be generated from repeat units.
5. To understand the number–average and weight–average molecular weights, and degree of polymerization.

Text Books

1. A. K. Galwey, “Chemistry of Solids”, Chapman & Hall Publication, 1st Edition, 1967, ISBN: 9780412086601.
2. T. Pollack, “Properties of Matter”, McGraw Hill publication, 3rd Edition, 1993, ASIN: B0006QP5LM.
3. M. W. Barsoum, “Fundamentals of Ceramics”, CRC Press, 1st Edition, 2002, ISBN: 9780750309028.
4. W. D. Kingery, “Introduction to Ceramics”, Wiley-Blackwell Publications, 2nd Edition, 1976, ISBN: 9780471478607.
5. J. S. Reed, “Introduction to the Principles of Ceramic Processing”, Wiley-Blackwell Publications, 2nd Edition, 1995, ISBN: 9780471597216.

6. A. Paul, “Chemistry of Glasses”, Springer publications, 2nd Edition, 1989, ISBN: 9780412278204.

Reference Books

1. D. R. Askeland, “The Science and Engineering of Materials”, Wadsworth Publishing Co Inc, 6th Edition, 2010, ISBN: 9780495296027.
2. W. F Smith, “Materials Science & Engineering”, McGraw-Hill Education; 5th Edition, 2009, ISBN: 9780073529240.
3. F. H. Norton, “Elements of Ceramics”, Addison-Wesley Press, 1st Edition, 1952, ISBN: 9781114163560.
4. S. K. H. Choudhary, “Materials Science and Processes”, Indian Book Distributing Co, 1st Edition, 1985, ISBN: 9780906216002.

Web Resources

1. NPTEL MOOC Course on “Processing of Polymers and Polymer Composites” (https://onlinecourses.nptel.ac.in/noc17_me36/preview)

Subject: **Nano Technology (Elective – 2)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0607**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To describe and explain Nanotechnology.
2. To describe Nanomaterials based on their dimensionality.
3. To explain the importance of reduction in materials dimensionality, and its relationship with materials properties.

CONTENTS

UNIT-I

[8 hours]

Introduction to Nanomaterials and nanotechnology, historical developments. An overview of scope & applications of nanotechnology, classifications and types of Nanomaterials. Basic understanding of various phenomena at nanoscale namely size confinement, interfacial surface phenomena.

UNIT-II

[10 hours]

Introduction to basic building blocks namely atoms, molecules, self-assembly, carbon nanotubes, nanocrystals, fullerenes, quantum dots, and quantum wires. Functional properties of nanomaterials such as physical, mechanical, electrical, magnetic, chemical and optical properties. Size dependence of material at nano scale. Bulk vs. nano properties of materials.

UNIT-III

[10 hours]

Synthesis & fabrication techniques ‘Top down’ vs. ‘Bottom-up’ approach of synthesis.
Review of synthesis methods namely sol-gel method, chemical vapour deposition, physical vapour deposition, sputtering, etc. Consolidation methods for nanopowders such as cold isostatic pressing (CIP), hot isostatic pressing (HIP), Dynamic compaction, Conventional and Microwave sintering.

UNIT-IV

[10 hours]

Characterization of nanomaterials by using transmission electron microscopy (TEM, atomicforce microscopy (AFM). Applications of nanomaterials namely nanograined structuralmaterials & nanocomposites, nanomagnetic materials, chemical applications etc.

Course Outcomes

1. To explain top-down approaches for Nanomaterial fabrication, and give some examples.
2. To perform a literature survey on a chosen topic in the scientific literature.
3. To write a scientific report with appropriate references and citations.

Text Books

1. A. K. Bandopadhyay, "Nano Materials", New Age International Publishers, 1st Edition, 2009, ISBN: 9781906574277.
2. K. K. Chattopadhyay and A. N. Banerjee "Introduction to Nanoscience and Nanotechnology", PHI Learning, 1st Edition, 2009, ISBN: 9788120336087
3. C. C. Koch, "Nanostructured Materials: Professing, Properties and Applications", William Andrew Publishing, 2nd Edition, 2006, ISBN: 9780815518426.

Reference Books

1. G. Timp, "Nanotechnology", Springer, 1999th Edition, 1999, ISBN: 9780387983349.
2. J. H. Fendler, "Nanoparticles and Nanostructured Films: Preparation, Characterization and Applications", Wiley-VCH, 1st Edition, 1998, ISBN: 9783527294435.
3. Z. L. Wang, Z. Zhang and Y. Lim, "Handbook of Nanophase and Nanostructured Materials", Springer, 1st Edition, 2002, ISBN: 9780306472497.
4. H. S. Nalwa, "Handbook of Nanostructured Materials and Nanotechnology", Academic Press, 5 Volume Set Edition, 1999, ISBN: 9780471958932.
5. M. Meyyappan, "Carbon Nanotubes: Science and Applications", CRC Press, 1st Edition, 2004, ISBN: 9780203494936.
6. L. L. Shaw, C. Suryanarayana and Rajiv S. Mishra, "Processing and Properties of Structural Nanomaterials", Wiley-TMS, 1st Edition, 2003, ISBN: 9780873395588.
7. A. S. Edelstein and R.C. Cammarata, "Nanomaterials: Synthesis, Properties & Applications", Taylor and Francis, 1st Edition, 1996, ISBN: 9780750303583.

Web Resources

1. NPTEL MOOC Course on "Soft Nano Technology"
(https://onlinecourses.nptel.ac.in/noc16_ch06/preview)
2. EdX Online Course on "Nanotechnology: Fundamentals of Nanotransistors"
(https://www.edx.org/course/nanotechnology-fundamentals-purduex-nano530x)

Subject: **Composite Materials (Elective – 2)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0608**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To name the three main divisions of composite materials, and cite the distinguishing feature of each.
2. To cite the difference in strengthening mechanism for large-particle and dispersion-strengthened particle-reinforced composites.
3. To distinguish the three different types of fiber reinforced composites on the basis of fiber length and orientation; comment on the distinctive mechanical characteristics for each type.

CONTENTS

UNIT-I

[8 hours]

Introduction, Review of current developments, Importance of Composites over other materials. Advantages and disadvantages of composite materials, Matrix and reinforcement phases, Classification of composite materials, Types of composite materials – dispersion strengthened composites, particulate composites, concretes, Fiber-reinforced Composites, Structural composite.

UNIT-II

[10 hours]

Types of reinforcements – Whiskers and fibers, preparation, structure and properties of different reinforcing fibers, carbon fibers, glass fibers, polymer fibers and alumina fibers. Fiber-reinforced Composites: Influence of Fiber Length, Critical Fiber Length, Short and Continuous Fibers, Influence of Fiber Orientation and Concentration, Fiber reinforced composites with different matrix systems, polymer matrix (thermoset and thermoplastic) composites, metal matrix composites and ceramic matrix composites, carbon-carbon composite, intermetallic composites.

UNIT-III

[10 hours]

Strengthening mechanisms, Aspect Ratio, Rule of Mixture, Role of interfaces in composites, Toughening mechanisms in PMCs, MMCs, and CMCs, Wettability and bonding. Properties of composites: Mechanical Properties of composite, Effect of fiber volume content, orientation of fibers & void contents on mechanical properties of composite, fracture behaviour of composites, Applications of composites in different field, Environmental effects in composites.

UNIT-IV

[10 hours]

Fabrication of composites, Fiber Forms, Prepregs, Moulding Compounds-Processes, Lay-Ups, Filament Winding, Pultrusion, vacuum bag moulding, Pressure bag moulding, vacuum impregnation and injection moulding, transfer moulding, Green composites; Synthesis and Properties of Nanocomposites, Hybrid composites.

Course Outcomes

1. To calculate longitudinal modulus and longitudinal strength for an aligned and continuous fiber reinforced composite.
2. To compute longitudinal strengths for discontinuous and aligned fibrous composite materials.
3. To note the three common fiber reinforcements used in polymer-matrix composites, and, for each, cite both desirable characteristics and limitations.
4. To cite the desirable features of metal-matrix composites.

Text Books

1. K. K. Chawla, "Composite Materials – Science & Engineering", Springer, 2nd Edition, 1988, ISBN: 9788181284907.
2. M. M. Schwartz, "Composite Materials: Volume 1: Properties, Non-destructive Testing and Repair", Prentice Hall, 1st Edition, 1996, ISBN: 9780133000474.
3. L. J. Broutman and R. M. Krock, "Modern Composite Materials", Addison-Wesley, 1st Edition, 1967, ISBN: 9780201006292.
4. D. A. Colling and T. Vasilos, "Industrial Materials: Polymers, Ceramics and Composites", Prentice Hall, 1st Edition, 1656, ASIN: B01FJ2EVOY.

Reference Books

1. D. R. Askeland and P. Phule, "The Science and Engineering of Materials", Thomson, 5th Edition, 2005, ISBN: 9780534553968.
2. G. Lubin, "Hand Book of Composites", Springer, 2nd Edition, 1982, ISBN: 9780442248970.
3. D. Hull, "An Introduction to Composites Materials", Cambridge University Press, 2nd Edition, 1996, ISBN: 9780521388559.

Web Resources

1. NPTEL MOOC Course on "Processing of Polymers and Polymer Composites" (https://onlinecourses.nptel.ac.in/noc17_me36/preview)

Subject: **Nuclear Metallurgy (Elective – 2)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0609**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To understand the importance of nuclear energy and reactors towards the growth of Indian energy scenario.
2. To understand the requirements of materials for critical components of nuclear reactors.

CONTENTS

UNIT-I

[8 hours]

Atomic Structure, Fundamental Properties. Atomic Nucleus. Radio activity, half life period and isotopes Fission, fusion and other nuclear reactions. Critical mass. Neutron cross section, Multiplication factor and nuclear disintegration.

UNIT-II

[10 hours]

Essential parts of Nuclear Reactor. Reactor types, Reactor Fuel Cycle. Indian atomic power plants, Nuclear power program me in India and future trends. Difference in separation methods as compared to conventional methods.

UNIT-III

[10 hours]

Purity requirement of nuclear metal. Separation process- Ion and Solvent extraction techniques. Occurrence, extraction mechanical and physical properties and uses of Uranium and Thorium. Occurrence, extraction mechanical and physical properties and uses of Zirconium, hafnium and plutonium.

UNIT-IV

[10 hours]

Methods of enrichment and production of ultrahigh purity metals and their importance in nuclear metallurgy. Influence of neutron damage on mechanical properties. Effects of radiation damage on steel and Zircalloys, Scope of beryllium in nuclear plants. Extraction, occurrence, physical and mechanical properties of Be and its applications, Reactor pressure vessel embrittlement (indicating parameters, mechanisms, mitigation methods).

Course Outcomes

1. To apply the knowledge of extraction of nuclear fuels.
2. To predict the mechanisms for failures in the materials used in nuclear reactors.

Text Books

1. A. R. Kaufmann, "Nuclear Reactor Fuel Elements – Metallurgy & Fabrication", John Wiley and Sons, 1st Edition, 1962, ISBN: 9780470460689.

Reference Books

1. H. S. Ray, R. Shridhar and K. P. Abraham, "Extraction of Non-Ferrous Metals", Affiliated East-West Press Pvt Ltd, 1st Edition, 2006, ISBN: 9788185095639.
2. D. G. Cacuci, "Handbook of Nuclear Engineering: Vol. 1: Nuclear Engineering Fundamentals", Springer, 2010 Edition, 2010, ISBN: 9780387981307.

Web Resources

1. EdX Online Course on "Nuclear Reactor Physics Basics"
(https://www.edx.org/course/nuclear-reactor-physics-basics-mephix-mephi005x)
2. EdX Online Course on "Understanding Nuclear Energy"
(https://www.edx.org/course/understanding-nuclear-energy-delftx-nuclear01x-0)

Subject: **Modelling of Metallurgical Processes (Elective – 2)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0610**				Semester: **VI**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To understand metallurgical and materials processes and some simulation applications.
2. To understand fundamental principles, methods, and approaches of simulation and modeling.
3. To develop the theoretical background of metallurgical processes' simulation and modeling.

CONTENTS

UNIT-I

[8 hours]

Introduction to modelling & simulation, Basic principles of modelling & simulation, Mathematical and physical basis of modeling & its methodology, Basic approaches and techniques of modelling & simulation, Examples of metallurgical and materials processes.

UNIT-II

[10 hours]

Mass and energy balances, and simultaneous solutions, In-class demonstration of modelling software, Modelling and Simulation in Materials Science, Application of the methodology for materials behavior and processing problems, Modeling of structural materials, Description of certain metallurgical processes (roasting, smelting, leaching, precipitation, electrolysis, refining, etc.) and steps of their mathematical modelling and approaches.

UNIT-III

[10 hours]

Concepts of batch, and continuous processes in metallurgy, Determining the effect of controlling parameters, such as composition, temperature, particle size, concentration, pressure, gas/liquid/solid flow rate, stirring speed, current density, etc., and mathematical modelling thereof. Assigning these parameters to the student groups as term projects.

UNIT-IV

[10 hours]

Case studies on mathematical modelling from iron and steel making will be discussed such as modelling of blast furnace, basic oxygen furnace, electric arc furnace, ladle furnace, ingot casting, continuous casting, forging, electroslag refining, sheet metal forming etc. some case studies on physical modelling such as ladle furnace, tundish, continous casting etc.

Course Outcomes

1. To understand the importance and necessity of simulation and modelling studies in metallurgical and materials processes.
2. To improve his/her theoretical background on simulation and modelling of metallurgical and materials processes.
3. To be aware of the resulting innovations by applying simulation and modelling software.
4. To create a model of a given metallurgical process by considering the related control parameters.

Text Books

1. R. I. L. Guthrie, "Engineering Process Metallurgy", Oxford University Press, Revised Edition, 1993, ISBN: 9780198563679.
2. Z. H. Barber, "Introduction of Materials Modeling", Maney Publishing, 1st Edition, 2005, ISBN: 9781902653761.
3. R. P. King, C. L. Schneider and E. A. King, "Modeling and Simulation of Mineral Processing Systems", Society for Mining, Metallurgy, and Exploration, 2nd Edition, 2012, ISBN: 9780873353458.

Reference Books

1. K. Popovich and P. J. Masterman, "Real-Time Simulation Technologies: Principles, Methodologies, and Applications", CRC Press, 1st Edition, 2012, ISBN: 9781439846650.
2. N. Ghasem, "Computer Methods in Chemical Engineering", CRC Press, 1st Edition, 2011, 2012, ISBN: 9781439849996.
4. Bautista G.R., Wesely J.R., Warren W.G., 1986, "Hydrometallurgical Reactor Design and Kinetics", TMS, 1st Edition, 1987, ISBN: 9780873390552.

Web Resources

1. MIT OpenCourseWare Course on "Atomistic Computer Modeling of Materials" (https://ocw.mit.edu/courses/materials-science-and-engineering/3-320-atomistic-computer-modeling-of-materials-sma-5107-spring-2005/index.htm)
2. MIT OpenCourseWare Course on "Introduction to Modeling and Simulation" (https://ocw.mit.edu/courses/materials-science-and-engineering/3-021j-introduction-to-modeling-and-simulation-spring-2012/index.htm)

Subject: **Advanced Technical Communication And Soft Skills**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **SH0607**			Semester: **VI**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	0	0	0	60	00	40	00	100

	Sr. No.	Content
Speaking	1	Vocabulary Games: Advanced Level
	2	Role Play 1
	3	Role Play 2
	4	Role Play 3
	5	Selected speeches & Songs: Declamation 1
	6	Selected speeches & Songs: Declamation 1
	7	Report Presentation Seminar
	8	Report Presentation Seminar
	9	Report Presentation Seminar
	10	Interview Skills (Mock Interview Sessions 2)
Writing	11	Writing Reports
	12	Making Proposals
	13	Resume Building
	14	Letter, Email application

Reference Books:

1. Fred Luthans, Organizational Behaviour, McGraw Hill
2. Lesikar and petit, Report writing for Business
3. M. Ashraf Rizvi, Effective Technical Communication, McGraw Hill
4. Wallace and masters, Personal Development for Life and Work, Thomson Learning
5. Hartman Lemay, Presentation Success, Thomson Learning
6. Malcolm Goodale, Professional Presentations
7. Farhathullah, T. M. Communication skills for Technical Students
8. Michael Muckian, John Woods, The Business letters Handbook

9. Herta A. Murphy, Effective Business Communication
10. Lehman, Dufrene, Sinha BCOM, Cengage Learning

Web resources/ MOOCs:

Introduction to English Language & Literature Mod-1 Lec-1
https://www.youtube.com/watch?v=xC3M9EqduyI

The English Language Mod-1 Lec-
https://www.youtube.com/watch?v=HsR4jFszFdw#action=share

International English Mod-1 Lec-4
https://www.youtube.com/watch?v=FT4cQkXCc8g

Effortless EnglishRule-1 English Phrases:
https://www.youtube.com/watch?v=r5z-lilm-gg
Pronunciation Training Techniques:
https://www.youtube.com/watch?v=wB8mr4iViy0

Make Body Language Your Superpower:
https://www.youtube.com/watch?v=wB8mr4iViy0

English Job Interviews | Best Answers to
Questions:https://www.youtube.com/watch?v=wB8mr4iViy0

7TH SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –VII TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
								CIE		ESE	CIE	ESE	
			L	T	P			MID	IE				
1	MT0701	Metal Joining Processes	03	00	02	04	05	30	10	60	40	60	200
2	MT0702	Non-Destructive Testing	04	00	00	04	04	30	10	60	00	00	100
3	MT0703	Alloy Design	03	02	00	04	05	30	10	60	00	00	100
4	MT0704	Material Testing and Standards	03	00	02	04	05	30	10	60	40	60	200
5	MT0705	Selection of Materials and Failure Analysis	03	02	00	04	05	30	10	60	00	00	100
6	MT0706	Advanced Ferrous Metallurgy (EL – 3)	04	00	00	04	04	30	10	60	00	00	100
	MT0707	Advanced Materials and Applications (EL – 3)											
	MT0708	Advanced Foundry Technology (EL – 3)											
	MT0709	Phase Transformations (EL – 3)											
	MT0710	Advances in Thin Film Technology (EL – 3)											
	MT0711	Industrial Welding Codes and Standards (EL – 3)											
	MT0712	MOOC Course – 2 (EL – 3)											
7	CV0712	Disaster Management	01	00	00	00	01	00	00	00	00	00	00
TOTAL			**21**	**04**	**04**	**24**	**29**	**180**	**60**	**360**	**80**	**120**	**800**

Subject: **Metal Joining Processes**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0701**			Semester: **VII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	60	16/40	40	200

Course Objectives

1. To understand the basics & importance of joining processes.
2. To understand the various types of joining operations used in the industries.
3. To co-relate the basic machine products with the of product applicability & use skills for specific joining processes.

CONTENTS

UNIT-I

[8 hours]

Introduction:

History, Importance of metal joining processes, Classification of metal joining processes - Classification based on application of filler material & without filler material, source of energy, fusion and pressure welding processes, joint design and edge preparation, physics of arc, characteristic of arc. Welding positions. Soldering and brazing: Difference between both the processes, consumables used, methods of brazing, fluxes used, and their purpose and flux residue treatment, comparison with welding process.

UNIT-II

[10 hours]

Metal transfer, forces acting on the arc, different modes of metal transfer, heat flow in metals, prediction of heating and cooling rates. Manual metal arc(MMA) or shielded metal arc (SMA) welding, Submerged arc welding (SAW), Gas metal arc welding (GMAW) or MIG/MAG welding, TIG welding, Plasma Arc welding: Principle, Equipment requirement, electrodes for welding of structural steels, electrode coating classification, process description, shielding gases, advantages and disadvantages, application of processes.

UNIT-III

[12 hours]

Resistance welding, general principle of heat generation in resistance welding, application of resistance welding processes. Process details and working principle of spot, seam, and projection

welding, electrode materials, shapes of electrodes, electrode cooling, selection of welding currents, voltages.

UNIT-IV

[12 hours]

Other welding processes like Electron beam welding, Laser beam welding, Friction welding, Friction Stir Welding explosive welding, ultrasonic welding, diffusion welding, Electroslag and Electro gas welding etc. Weldability and defects: introduction, Weldability test, Weldability of ferrous and non ferrous materials, joining metallurgy of the dissimilar metals, clad metals etc., Welding defects.

Metal Joining Processes Lab (List of Experiments)

Experiment No	Title
1	To study the edge preparation and preparation of different types of weld joints.
2	To study effect of proportion of oxygen and acetylene on the gas welding flame.
3	To study the effect of welding parameters on weld quality by SMAW welding.
4	Characterization of weldments prepared by SMAW
5	Preparation of joints using Tungsten Inert Gas welding.
6	Characterization of weldments prepared by TIG
7	Preparation of joints using Metal Inert Gas welding.
8	Characterization of weldments prepared by MIG
9	Preparation of different type of joints uses spot welding and butt welding.
10	Characterization of weldments prepared by spot and butt welding
11	To study the effect of rpm on weld microstructure by friction welding.
12	Characterization of weldments prepared by friction welding
13	To study the effect of gas flow rate on weld quality by MIG welding.
14	Application of welding Gauge.
15	Effect of GTAW parameters on weld bead morphology.

Course Outcomes

1. To develop the capability to analyze and select the various criteria of quality joining of the metals.
2. To implement effectively and accurately the suitable joining process to improve the efficiency & life of the product / Machines.

3. To learn various quality dimensions of joints, cost factor, factor of safety etc.
4. To understand the advance processes of joining& its applicability.

Text Books

1. J. F. Lancaster, "The Metallurgy of Welding, Brazing and Soldering", George Allen and Unwin, 2nd Edition, 1970, ASIN: B000OA77G6.
2. D. R. Milner and R. L. Apps, "Introduction to Welding and Brazing", Elsevier, 1st Edition, 1968, ISBN: 9780080123066.

Reference Books

1. P. N. Rao, "Manufacturing Technology (Foundry, Forming and Welding)", Mcgraw Hill Higher Education, 3rd Edition, 2008, ISBN: 9780070087989
2. J. F. Lancaster, "The Physics of Welding", Pergamon Press, 2nd Edition, 1986, ISBN: 9780080340760.
3. R. S. Parmar, "Welding Processing and Technology", Khanna Publishers, 2nd Edition, 2003, ISBN: 9788174091260.
4. O. P. Khanna, "A Textbook of Welding Technology", Dhanpat Rai Publications, 2013 Edition, 2013, ISBN: 9788189928360.
5. ASM International, "ASM Handbook - Vol. 6", ASM International, 10th Edition, 1993, ISBN: 9780871703828.

Web Resources

1. NPTEL MOOC Course on "Joining Technologies for Metals"
(https://onlinecourses.nptel.ac.in/noc17_me09/preview)

Subject: **Non Destructive Testing**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0702**				Semester: **VII**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To understand the significance of testing of metallic and non metallic materials and components without destroying them.
2. To study the application of these methods in assessing reliability of components & plants.
3. To study the life time assessment of components.

CONTENTS

UNIT-I

[8 hours]

Fundamentals and introduction to non-destructive testing. Scope and limitations of NDT

Visual examination methods. Different visual examination aids.

Leak and pressure testing of industrial components. Various methods of pressure and leak testing underlying principles of these testing systems.

UNIT-II

[10 hours]

Dye penetrant Methods, Basic Principles, Capillary Action, Wetting and Non-Wetting Characteristics, Different Types of Penetrants, Detailed Procedure and Recent Developments in DPT.

Magnetic Particle Testing methods, Basic Principles of MPT, magnetization methods demagnetization methods, MPT equipment & instruments, sensitivity calibration of MPT equipment.

Ultrasonic methods of NDT-Basic principles of wave propagation, types of waves, transducers and transducer materials, advantages and limitations of UT.

UNIT-III

[12 hours]

Pulse Echo and Through Transmission techniques of UT, Calibration methods, use of standard blocks, Thickness determination by ultrasonic method. Study of A, B and C scan presentations.

Radiographic testing of metallic components. X-ray and Gamma-Ray radiography. Their principles, methods of generation. Industrial radiography techniques. Types of films, screens and penetrameters. Interpretation of radiographs. Film Processing. Radiography Contrast.

UNIT-IV

[10 hours]

Eddy current testing: Basic principles and applications such as detection of defects and characterization, sorting of materials, determination of film/coating thickness, measurement of electrical conductivity and magnetic permeability of materials. Eddy current testing equipments and its block diagram, different types of test coils and their applications.

Acoustic Emission Technique. Conductivity & resistivity methods and their applications. Thermal methods of NDT.

Selection Criteria for various NDT techniques.

Course Outcomes

1. To understand the principle and application of visual testing methods.
2. To understand principle of liquid penetration testing technique.
3. To understand the principle of magnetic particle testing and its applications.

Text Books

1. B. Raj, T. Jayakumar and M. Thavasimuthu, "Practical Non-Destructive Testing", Norosa Publishing House, 3rd Edition, 2014, ISBN: 9788173197970.
2. W. J. McGonnagle, "Non Destructive Testing", Routledge, 1st Edition, 1971, ISBN: 9780677005003.

Reference Books

1. J. Krautkramer, "Ultrasonic Testing of Materials", Allen & Unwin, 2nd Edition, 1969, ISBN: 9780046200015.
2. J. Prasad and C. G. K. Nair, "Non-Destructive Test and Evaluation of Materials", McGraw Hill Education, 2nd Edition, 2011, ISBN: 9781259061615.
3. R. Halmshaw, "Non-Destructive Testing (Metallurgy and Materials Science)", Butterworth-Heinemann, 2nd Edition, 1991, ISBN: 9780340545218.
4. L. Filipczynski, Z. Pawłowski and J. Wehr, "Ultrasonic Methods of Testing Materials", Butterworth, 1st Edition, 1966, ASIN: B00MJ3OOIU.

Web Resources

1. NPTEL MOOC Course on "Theory and Practice of Non Destructive Testing" (https://onlinecourses.nptel.ac.in/noc16_mm07/preview)

Subject: **Alloy Design**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0703**			Semester: **VII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To provide knowledge about the basic concept of alloys and its properties.
2. To impart the importance of overall design in metallurgy.
3. To help them understand all newer types of alloys and its applications.

CONTENTS

UNIT-I

[8 hours]

Concept & Effect on properties

Concept of alloy design, Steps in alloy design, Significance of alloy design Single phase, dual phase and multiphase materials, Effect of matrix on properties of materials, Effect of size, shape and distribution of second phase on mechanical properties of alloys.

UNIT-II

[10 hours]

Strengthening Mechanisms

Precipitation and particle coarsening, recrystallization and grain growth. Solid/Liquid phase transformation in pure metals, single phase alloys, constitutional super cooling and eutectic alloys.

UNIT-III

[10 hours]

Alloy Design for better mechanical properties

Alloy design for better tensile strength, ductility, toughness, fatigue strength, creep strength, wear resistance and elevated temperature.

UNIT-IV

[10 hours]

Types of Alloy Steels & its applications

Types of Stainless Steels – Its Introduction, properties and applications High strength low alloy steels, Maraging steels, High speed steels, Hadfield steel and Super alloys. Alloy design of

lightweight and high Strength powder metallurgical Al based alloys Application of computer-based methods for alloy designing.

Course Outcomes

1. To make them understand strengthening mechanisms used in alloying.
2. To study alloy design for particular mechanical properties & its overall importance.
3. To apply the knowledge to develop new materials that can be useful in new technologies and development.

Text Books

1. H. E. Boyer, "Selection of Materials for component Design: Source Book", ASM International, 1st Edition, 1986, ISBN: 9780871702562.
2. M. F. Ashby, "Materials Selection in Mechanical Design", Butterworth-Heinemann; 4th Edition, 2010, ISBN: 9781856176637.
3. S. Ranganathan, V. S. Arunachalam and R. W. Cahn, "Alloy Design", Indian Academy of Science, 1st Edition, 1981, OCLC: 10804290.
4. J. K. Tien and G. S. Ansell, "Alloy and Microstructural Design", Academic Press, 1st Edition, 1977, ISBN: 9780126908503.

Reference Books

1. ASM International, "ASM Handbook - Vol. 1", ASM International, 10th Edition, 1990, ISBN: 9780871703774.
2. R. M. Brick, A. W. Pense and R. B. Gordon, "Structure & Properties of Alloys", Mcgraw-Hill College, 4th Edition, 1977, ISBN: 9780070077218.
3. B. P. Bardes, "Metals Hand Book - Vol. 1", ASM International, 9th Edition, 1978, ISBN: 9780871700070.
4. ASM International, "ASM Handbook - Vol. 2", ASM International, 10th Edition, 1990, ISBN: 9780871703781.

Web Resources

1. NPTEL Online Course on "Materials Selection and Design"
(http://nptel.ac.in/courses/112104122)

Subject: **Material Testing and Standards**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0704**			Semester: **VII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	24/60	60	16/40	40	200

Course Objectives

1. To understand different types of Mechanical testing (i.e. destructive testing and non destructive testing).
2. To understand different types of standards related to different mechanical testing.
3. To understand standard procedure for mechanical testing.

CONTENTS

UNIT-I

[8 hours]

Introduction:

Importance of Material Testing. Classification of various types of testing methods. Selection of testing methods. Importance of calibration of testing instruments. Calibration methods and standards for various tests.

Non-destructive testing:

Importance, scope, advantages and limitations – Dye penetrant, radiographic magnetic, ultrasonic and eddy current testing and their application.

UNIT-II

[10 hours]

Tensile test:

Engineering stress –strain curve, true stress –strain curve, Instability in tension, Stress distribution at neck, principle of stress and strain measurement, bend test measurement of ductility and formability, compression test, yield stress and proof stress, universal tensile testing machine and tensometer, Numericals of Tensile test, Fatigue and Ductile Brittle Transition Temperature

Hardness test:

Introduction, Brinell, Vickers and Rockwell hardness tests, Meyer hardness test, Analysis of indentation by an indenter, Relationship between hardness and the flow curve, Micro-hardness tests, Hardness conversion, Hardness at elevated temperature.

UNIT-III

[12 hours]

Impact testing:

Types of impact tests and their relative merits and demerits. Ductile-brittle transitions behavior and its significance.

Torsion test:

Introduction, Mechanical properties in torsion, Torsional stresses for large plastic strains, Types of torsion failures, Torsion test vs. tension test, Hot torsion test.

UNIT-IV

[12 hours]

Fatigue and Creep Testing:

Elementary treatment of fatigue phenomenon, S – N curve and corrosion fatigue, fatigue testing principle, Signification of Creep testing procedure , creep curve and its interpretation, stress-rupture test. Metallurgical and mechanical factors affecting, creep and fatigue failures.

Introduction to various standards for mechanical testing:

ASTM E8/E8M - Standard Test Methods for Tension Testing of Metallic Materials, ASTM E21 - Standard Test Methods for Elevated Temperature Tension Tests of Metallic Materials, ASTM E18: Standard Test Methods for Rockwell Hardness of Metallic Materials, ASTM E384: Standard Test Methods for Standard Test Method for Strain-Controlled Fatigue Testing of Metallic Materials, ASTM 139: Standard Test Methods for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials, ASTM E606: Standard Test Method for Strain-Controlled Fatigue Testing, ASTM E466: Standard Practice for Conducting Force Controlled Constant Amplitude Axial Fatigue Tests of Metallic Materials, ASTM E9: Standard Test Methods of Compression Testing of Metallic Materials at Room Temperature, ASTM E209, SA 370- Hardness Testing, SA370-Impact Testing, ASTM E6- D- Ductility and Bend Testing, ASTM E6- E- Creep and Stress Relaxation Testing, ASTM E6- G- Measurement and Calibration, ASTM E 190, ASTM E 527, ASTM E 92, ASTM E 139.

Material Testing and Standards Lab (List of Experiments)

Experiment No	Title
1	To study the Brinell hardness testing machine & perform the Brinell hardness test.
2	To study the Rockwell hardness testing machine & perform the Rockwell hardness test.
3	To study the Vickers hardness testing machine & perform the Vickers hardness test.
4	To determine the impact toughness of a given specimen by Izod test and Charpy test.
5	To determine the tensile strength of specimen.

6	To study room temperature creep strength of specimen.
7	To study room temperature fatigue strength of specimen.
8	To perform compression & bending tests on UTM.
9	Visual Inspection of fractured surfaces.
10	To perform Dye Penetration Test for given sample.
11	To study of Magnetic particle tester.
12	To study Ultrasonic Flaw Detector
13	To study Eddy Current Tester.
14	Detailed study of Radiographic Testing Method.
15	To study In situ Metallographic using replica technique

Course Outcomes

1. To develop the capability to analyze and select the various testing techniques for materials.
2. To understand various standards available to perform specific tests on different materials.

Text Books

1. G. E. Dieter, "Mechanical Metallurgy", McGraw Hill, 3rd Edition, 2013, ISBN: 9781259064791.
2. A. V. K. Suryanarayana, "Testing of Metallic Materials", B. S. Publications, 2nd Edition, 2007, ISBN: 9788178001340.

Reference Books

1. R. Abbaschian, L. Abbaschian and R. E. Reed-Hill, "Physical Metallurgy Principles", Wadsworth Publishing Co Inc, 4th Edition, 2008, ISBN: 9780495082545.
2. R. W. Hertzberg, R. P. Vinci and J. L. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", John Wiley & Sons, 5th Edition, 2012, ISBN: 9780470527801.
3. T. H. Courtney, "Mechanical Behavior of Materials", McGraw-Hill Education, 2nd Edition, 2017, ISBN: 9781259027512.
4. ASM International, "ASM Handbook: Nondestructive Evaluation and Quality Control", ASM International, 9th Edition, 1989, ISBN: 9780871700230.
5. H. E. Davis, G. E. Troxell and C. T. Wiscosil, "Testing and Inspection of Engineering Materials", Mcgraw-Hill Book Company, 2nd Edition, 1954, ASIN: B000I1C8DI.
6. R. A. Beaumont, "Mechanical Testing of Metallic Materials", Sir Isaac Pitman & Sons, 1st Edition, 1945, ASIN: B0010XYLO2.
7. C. W. Richards and E. A. Trabant, "Engineering Materials Science", Literary Licensing, 1st Edition, 2012, ISBN: 9781258243067.
8. W. J. McGonnagle, "Non Destructive Testing", Routledge, 1st Edition, 1971, ISBN: 9780677005003.

Web Resources

1. NPTEL MOOC Course on “Theory and Practice of Non Destructive Testing” (https://onlinecourses.nptel.ac.in/noc16_mm07/preview)

Subject: **Selection of Materials and Failure Analysis**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0705**				Semester: **VII**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	2	0	4	24/60	0	16/40	0	100

Course Objectives

1. To impart broad knowledge of Metallurgical aspects of engineering materials selection & technology practices to support design, application, installation, manufacturing, operation and maintenance for successful careers in Academics/ Research & industry that meet the needs of Society and multinational companies.
2. To understand various failure mechanisms for engineering materials.

CONTENTS

UNIT-I

[8 hours]

Philosophy of material selection, motivation for selection, relationship to available resources, concept of resource base, Criteria for selection of engineering materials – service requirements, ease of manufacturing, availability of materials and cost effectiveness. Selection for mechanical properties like strength, toughness, stiffness, fatigue, creep and temperature resistance.

UNIT-II

[10 hours]

Selection for surface durability like corrosion resistance, wear resistance. Relationship between material selection and material processing.

Identification of required properties. Selection of materials based on available property data and optimization to select the best material.

Case studies in material selection like materials for bearings, gears, automobile structures, aircraft components, ship structures, etc.

UNIT-III

[10 hours]

Importance of failure analysis and its relationship to material selection, fundamental causes of failure, general practice in failure analysis.

Failure- types and characteristics: Identification and characterization of ductile and brittle type of failures. Fracture mechanism, fracture modes and micro fractographic features.

UNIT-IV

[10 hours]

Concept and Mechanism of Failure: Identification and characterization of fatigue failures, types of fatigue, corrosion fatigue and contact fatigue, etc. Corrosion and corrosion related failures such as hydrogen embrittlement, stress corrosion cracking and high temperature failures.
In-process failures: Case studies, Service failures: Case studies.

Course Outcomes

1. To develop basic scientific principles and engineering fundamentals necessary to formulate, analyze and solve engineering & technical problems & demonstrate the ability to synthesize data and technical concepts for application to product design & developments.
2. To analyze and apply their understanding in order to perform failure analysis of various engineering materials and components.

Text Books

1. F. A. A. Cranes and J. A. Charles, "Selection and Use of Engineering Materials", Butterworth-Heinemann, 3rd Edition, 1989, ISBN: 9780750615495.
2. M. F. Ashby and D. R. H. Jones, "Engineering Materials – Vol. 1", Butterworth-Heinemann, 4th Edition, 2011, ISBN: 9780080966656.
3. H. J. Sharp, "Engineering Materials-Selection and Value Analysis", Heywood Books-Elsevier, 1st Edition, 1966, ASIN: B0000CMZQ9.
4. V. J. Colangelo and F. A. Heiser, "Analysis of Metallurgical Failures", Wiley-Interscience, 2nd Edition, 1987, ISBN: 9780471891680.
5. C. R. Brooks and A. Chaudhary, "Failure Analysis of Engineering Materials", McGraw-Hill Education, 1st Edition, 2001, ISBN: 9780071357586.
6. A. K. Das, "Metallurgy of Failure Analysis", McGraw-Hill Professional, 1st Edition, 1997, ISBN: 9780070158047.
7. M. F. Ashby and D. R. H. Jones, "Engineering Materials – Vol. 1", Butterworth-Heinemann, 4th Edition, 2012, ISBN: 9780080966687

Reference Books

1. American Society of Metals, "Metals Handbook –Failure Analysis and Prevention", American Society of Metals, 8th Edition, 1975, ASIN: B0026SIT3E.
2. American Society of Metals, "Metals Handbook – Fractography and Atlas of Fractographs", American Society of Metals, 8th Edition, 1974, ASIN: B000I1VM9Y.
3. M. Kutz, "Handbook of Materials Selection", Wiley, 1st Edition, 2002, ISBN: 9780471359241.
4. G. T. Murray and M. Dekker, "Handbook of Materials Selection for Engineering Applications", CRC Press, 1st Edition, 1997, ISBN: 9780824799106.

Web Resources

1. NPTEL Online Course on "Materials Selection and Design"
(http://nptel.ac.in/courses/112104122)

Subject: **Advanced Ferrous Metallurgy (Elective – 3)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0706**				Semester: **VII**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To impart the overall idea of how Steel is produced the history of Steel making.
2. To know about various techniques of raw material preparation for charging in iron making furnace, construction and operation of iron making furnace and reactions occurring in the furnace, reaction mechanism inside the blast furnace and post treatment to make steel.

CONTENTS

UNIT-I

[8 hours]

Thermodynamics of oxides and their reduction:

Thermodynamics and kinetics of iron oxide reduction. Kinetics of solid- solid and solid-gas reactions.

UNIT-II

[10 hours]

General Problems related to Indian Steel plants: Problems of Indian Steel Plants. High temperature properties of iron bearing materials.

UNIT-III

[10 hours]

Pre-treatment Techniques:

Pre-treatment of hot metal. Physico-chemical aspects of pre-treatment processes. Status of hot metal treatment in India.

Electric Arc Furnace (EAF) steel making:

Design of EAF-AC, DC electric arc. Latest trends in EAF design and operation.

Secondary steel making processes:

Alloy steel making in EAF using secondary refining. Continuous casting.

UNIT-IV

[10 hours]

Roll of synthetic slags. Electro-slag refining. Slag-metal reaction in iron and steel making. Ferro-alloy production. Application of plasma technology.

Course Outcomes

1. To apply the knowledge of various types of routes of iron making to practical scenarios.
2. To innovate the existing ideas and ways of making Iron and developing the technology to make this process energy intensive and cost effective.

Text Books

1. A. Ghosh, "Principles of Secondary Processing and Casting of Liquid Steel", South Asia Books, 1st Edition, 1990, ISBN: 9788120405585.
2. F. P. Edneral, "Electrometallurgy of Steel and Ferro-alloys, Vol. I & II", Mir Publishers, 1st Edition, 1979, ISBN: 9780828515184.

Reference Books

1. A. W. Cramb, "Making, Shaping and Treating of Steels", Association of Iron and Steel Engineers, 11th Edition, 1985, ISBN: 9780930767020.
2. J. G. Peacey and W. G. Davenport, "Blast Furnace: Theory and Practice", Pergamon Press, Oxford, 1st Edition, 1979, ISBN: 9780080232584.

Web Resources

1. NPTEL MOOC Course on "Steel Quality: Role of Secondary Refining & Continuous Casting" (https://onlinecourses.nptel.ac.in/noc17_mm10/preview)
2. NPTEL Course on "Materials and Heat Balance in Metallurgical Processes" (http://nptel.ac.in/courses/113104060/26)

Subject: **Advanced Materials and Applications (Elective – 3)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0707**			Semester: **VII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To impart the knowledge on special steels, alloy cast iron, light metals and some super alloys.
2. To know about various techniques for manufacturing of advanced materials.

CONTENTS

UNIT-I

[8 hours]

Special steels Ferritic, Austenitic, Martensitic, Duplex and Precipitation hardenable stainless steels, Dual phase steels, TRIP steels, Maraging steels, High speed steels, Hadfield steels, Free cutting steels, Ausformed steels, Tool Steels, manganese steels, chrome steels, electrical steels, bearing steels, spring steels, heat resistant steels, creep steels, HSLA steels.

Alloy cast iron High silicon cast iron, Ni-hard, Heat resistant cast iron.

UNIT-II

[10 hours]

Light metals and their alloys Aluminum, magnesium and titanium alloys, Metallurgical aspects, Mechanical Properties and applications.

Super alloys Iron base, nickel base and cobalt base super alloys, Composition, Properties and their application.

Rapid Solidification Techniques, Production of metallic glasses, Atomic arrangement, Comparison with crystalline alloys, properties & applications.

UNIT-III

[10 hours]

Nanomaterials & technology Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Methods for creating nano structures, Processes for producing ultrafine powders - physical synthesis and chemical synthesis, Physical and mechanical properties and their applications.

Smart materials Shape memory alloys, piezoelectric materials, Electro-rheological fluid, Magneto- rheological fluid.

UNIT-IV

[10 hours]

Biomaterials Property requirement, Concept of biocompatibility, Cell-material interaction and body response to foreign materials, important biometallic alloys, Ni-Ti alloy, Co-Cr-Mo alloys Miscellaneous Advanced Materials Magnetic materials, Engineering polymers, ceramics and composites, aerospace materials, cryogenic materials, semi conducting and superconducting materials.

Course Outcomes

1. To apply the knowledge of various types of advanced materials to develop new technologies and applications.
2. To innovate the existing ideas and ways of making advanced materials in order to reduce the cost of manufacturing and increasing the applications.

Text Books

1. D. R. Askeland and P. P. Phule, "The Science and Engineering of Materials", Wadsworth Publishin, 6th Edition, 2010, ISBN: 9780495296027.

Reference Books

1. R. K. Dogra and A. K. Sharma, "Advances in Material Science", S. K. Kataria and Sons, 1st Edition, 2013, ISBN: 9788188458318.
2. L. H. V. Vlack, "Elements of Materials science", Pearson Publication, 6th Edition, 2008, ISBN: 9780201093148.
3. R. A. Flinn and P. K. Trojan, "Engineering Materials and Applications", Jaico Publishing House, 1st Edition, 1999, ISBN: 9788172246778.
4. I. J. Polmear, "Light Alloys: Metallurgy of Light Metals", Halsted Publications, 3rd Edition, 1982, ISBN: 9780470235652.
5. G. Timp, "Nano Technology", Springer, 1st Edition, 1999, ISBN: 9780387983349.

Web Resources

1. NPTEL Online Course on "Advanced Materials and Processes" (http://nptel.ac.in/courses/113105057/)

Subject: **Advanced Foundry Technology (Elective – 3)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0708**			Semester: **VII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To have adequate knowledge and understanding of the newer materials which are in the state of development so also the newer processes that are more competitive, case of solidification software and ISO 9000 as measures of producing quality castings.
2. To have adequate knowledge and understanding of the mechanization of foundry plants for faster rate of production and specifications for major equipment.

CONTENTS

UNIT-I

[8 hours]

New materials, processes & software applications: new core & mould binders & additives, new lining & refractory materials, magnetic moulding process, full mould process, vacuum moulding process, ISO-9000 computer applications in metal casting, use of solidification software & simulation, energy conservation in foundry industries.

UNIT-II

[10 hours]

Foundry mechanization: mechanical equipment in a foundry, sand preparation & control, sand handling & conveying system, moulding machines:- sand slingers, pneumatic rammers, simultaneous jolt & squeeze, high pressure moulding, typical specifications for major equipment in foundry

UNIT-III

[10 hours]

Plant site location: plant layout of small scale & medium scale & large scale foundry, plant engineering /maintenance /services: plant machinery & equipment, environmental pollution & its control in foundry, consideration on layout & material handling system, modernization & mechanization of a foundry.

UNIT-IV

[10 hours]

Casting defects analysis & salvaging of defective castings by using techniques such as welding, brazing, braze welding & soldering, burning on, patches & plugs, impregnations of castings, quality control in pattern & mould making, melting & heat treatment, fettling & cleaning, use of statistical methods in quality control of casting.

Course Outcomes

1. To have an understanding on the layout of foundry plants, maintenance of machinery, equipment and material handling system.
2. To have an understanding on the quality control measures at various sections in foundry including analysis of defects and salvage of defective castings.

Text Books

1. T. V. R. Rao, "Metal Casting: Principles and Practice", New-Age International Publishers, 1st Edition, 1998, ISBN: 9788122408430.
2. O. P. Khanna, "Foundry Technology", Dhanpat Rai Publications, 17th Edition, 2011, ISBN: 9788189928346.
3. P. Bidulya, "Steel Foundry Practices", Moscow Mir publications, 2nd Edition, 1968, OLCL: 841189189.

Reference Books

1. R. Trivedi, J. A. Sekhar and J. Mozumdar, "Principles of Solidification and Materials Processing (Vol. 1 & Vol. 2)", Trans Tech Publication, 1st Edition, 1990, ISBN: 9780878495948.
2. R. C. Gupta, "Proceedings of the International Conference on Environmental Management in Metallurgical Industries", Allied Publishers Limited, 1st Edition, 2000, ISBN: 8177641042.

Web Resources

1. NPTEL MOOC Course on "Principles of Casting Technology" (https://onlinecourses.nptel.ac.in/noc17_me11/preview)

Subject: **Phase Transformations (Elective – 3)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0709**			Semester: **VII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To provide the student with an understanding of the basic principles and mechanisms underlying both solid-solid and liquid-solid phase transformations with an emphasis on metallic materials.
2. To apply the concepts of thermodynamics, diffusion and kinetics, and crystallography (crystal structure and symmetry in materials) to develop a clear understanding of the free energy changes and kinetics associated with various types of phase transformations.

CONTENTS

UNIT-I

[8 hours]

Review of Thermodynamics:

Equilibrium, Single Component Systems, Binary Solutions, Equilibrium in Heterogeneous Systems, Binary Phase Diagrams, Kinetics of Phase Transformations.

Review of Diffusion:

Atomics Mechanisms of Diffusion, Interstitial diffusion, Self Diffusion, Vacancy Diffusion, Diffusion in Substitutional Alloys.

UNIT-II

[10 hours]

Solidification:

Nucleation in pure metals, Growth of a pure Solid, Alloy Solidification, Solidification during Quenching from Melt.

UNIT-III

[10 hours]

Diffusional Transformations in Solids:

Nucleation in solids - Homogeneous and Heterogeneous, Overall Transformation Kinetics – TTT Diagrams, Precipitation in Age Hardening Alloys, Cellular Precipitation, Eutectoid Decomposition, Massive Transformations, Ordering Transformations.

UNIT-IV

[10 hours]

Diffusionless Transformations:

Characteristics of Martensitic Transformations, Martensite Crystallography, Martensite Nucleation, Martensite Growth, Tempering of Ferrous Martensite, Strain induced transformation.

Course Outcomes

1. To apply and couple the basic concepts of thermodynamics, diffusion, and crystallography.
2. To apply the concepts of phase transformations in order to design new materials/alloy systems for advancement of technologies.

Text Books

1. D. A. Porter, K. E. Easterling and M. Sherif "Phase Transformations in Metals and Alloys", CRC Press, 3rd Edition, 2009, ISBN: 9781420062106.

Reference Books

1. P.G. Shewmon, "Transformations in Metals", Indo American Books, 1st Edition, 2007, ISBN: 9788189617189.
2. M. Hillert, "Phase Equilibria, Phase Diagrams and Phase Transformations: Their Thermodynamic Basis", Cambridge University Press, 2nd Edition, 2007, ISBN: 9780521853514.
3. V. Raghavan, "Solid State Phase Transformations", Prentice Hall India Learning Private Limited, 1st Edition, 1987, ISBN: 9788120304604.

Web Resources

1. SWAYAM MOOC Course on "Phase Transformation in Materials" (https://swayam.gov.in/course/3796-phase-transformation-in-materials)

Subject: **Advances in Thin Film Technology (Elective – 3)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0710**				Semester: **VII**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To discuss the differences and similarities between different vacuum based deposition techniques.
2. To evaluate and use models for nucleating and growth of thin films.

CONTENTS

UNIT-I

[8 hours]

Role of Thin films Technology and Devices, Vacuum evaporation- Hertz- Knudsen equation, evaporation from a source and film thickness uniformity.

UNIT-II

[10 hours]

Basics of vacuum science, creation of vacuum: rotary, diffusion, getter ion, turbo molecular, and cryo pumps, measurement of vacuum: Penning, Pirani, ionization gauges, B-A gauge. Designing a typical vacuum system, vacuum leak detection: helium leak detector, residual gas analyzer.

UNIT-III

[10 hours]

Thin film properties like Mechanical properties: adhesion and stress measurements, electrical properties, resistivity variation, Hall Effect, Optical properties: reflection, refraction, ellipsometry, reflecting and antireflecting films.

UNIT-IV

[10 hours]

Thin film analysis ion beam sputtering, selective surfaces, depth profiling, Study of inter Diffusion in thin films using XPS, AES, SIMS and RBS. Study on special coatings like Graphene and Photovoltaic

Course Outcomes

1. To assess the relation between deposition technique, film structure, and film properties.

2. To apply thin film technology to different applications.
3. To be able to select most apt deposition technique for various applications.

Text Books

1. M. Ohring, "The Materials Science of Thin Films", Academic Press, 2nd Edition, 2001, ISBN: 9780125249751.
2. D. L. Smith, "Thin-Film Deposition, Principles and Practice", McGraw-Hill, 1st Edition, 1995, ISBN: 9780070585027.
3. K. L. Chopra, "Thin Film Phenomena", McGraw-Hill Inc., 1st Edition, 1969, ISBN: 9780070107991.

Reference Books

1. D. M. Mattox, "Handbook of Physical Vapor Deposition (PVD) Processing", William Andrew, 2nd Edition, 2010, ISBN: 9780815520375.
2. P. M. Martin, "Handbook of Deposition Technologies for Films and Coatings", William Andrew, 3rd Edition, 2009, ISBN: 9780815520313.
3. D. Glocker and S. I. Shah, "Handbook of Thin Film Process Technology", CRC Press, 1st Edition, 1995, ISBN: 9780750308335.
4. W. N. G. Hitchon, "Plasma Processes for Semiconductor Fabrication", Cambridge University Press, 1st Edition, 2005, ISBN: 9780521018005.
5. A. Elshabini-Riad and F. D. Barlow, "Thin Film Technology Handbook", McGraw-Hill International, 1st Edition, 1997, ISBN: 9780070190252.
6. H. Lüth, "Solid Surfaces, Interfaces and Thin Films", Springer, 5th Edition, 2010, ISBN: 9783642135910.

Web Resources

1. EdX Online Course on "Vacuum Systems and Technology"
(https://www.edx.org/course/vacuum-systems-technology-mephix-mephi004x)

Subject: **Industrial Welding Codes and Standards (Elective – 3)**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0711**				Semester: **VII**
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
4	0	0	4	24/60	0	16/40	0	100

Course Objectives

1. To describe different welding codes and materials specifications.
2. To understand the fundamental principles, methods, and approaches of welding processes.
3. To develop the theoretical background of welding processes' applicability and effectiveness.

CONTENTS

UNIT-I

[8 hours]

Fabrication In Piping Industry: Process and product standards for manufacturing of pipe – welding procedure and welder qualification, field welding and inspection. Structural Welding Codes: Design requirements, allowable stress values, workmanship and inspection.

UNIT-II

[10 hours]

Fabrication of Pressure Vessel: Design requirements, fabrication methods, joint categories, welding and inspection, post weld heat treatment and hydrotesting, (ASME Sec VIII-1 & 2).

UNIT-III

[10 hours]

Welding procedure: Welding procedure specification, procedure qualification records. Welder Qualification: Performance qualification, variables.

UNIT-IV

[10 hours]

Materials: Introduction to materials standard and testing of materials, consumables testing and qualification as per ASME / AWS requirements. Consumables: Types of consumables, Consumable testing and qualification as per ASME / AWS requirements.

Course Outcomes

1. To understand the importance and necessity of selection of appropriate consumable, welding processes, welding parameters and testing procedures.

2. To apply his/her theoretical background on applicability of a welding process, parameters and weld testing.
3. To be aware of the use of various welding codes and standards widely used in industries.

Text Books

1. R. S. Parmar, "Welding Engineering and Technology", Khanna Publishers, 1st Edition, 2004, ISBN: 9788174090287.

Reference Books

1. American Society for Mechanical Engineers, "Boiler and Pressure Vessel Code Section VIII – Division 1 and Division 2", American Society for Mechanical Engineers, 2017, ISBN: 9780791870969.
2. American Society for Mechanical Engineers, "Boiler and Pressure Vessel Code Section IX-Welding and Brazing Qualifications", American Society for Mechanical Engineers, 2017, ISBN: 9780791871003.
3. American Society for Mechanical Engineers, "Boiler and Pressure Vessel Code Section II Part C: Specifications for Welding Rods, Electrodes, and Filler Metals", American Society for Mechanical Engineers, 2017, ISBN: 9780791870792.
4. American Society for Mechanical Engineers, "Boiler and Pressure Vessel Code Section II Part A: Ferrous Material Specifications", American Society for Mechanical Engineers, 2015, ISBN: 9780791869741.
5. American Petroleum Institute, "Specification for Line Pipe" American Petroleum Institute Standard Specifications 5L, 38th Edition, 2012, ISBN: 9789997820570.
6. American Petroleum Institute, "Welding of Pipelines and Related Facilities", American Petroleum Institute Standard 1104, American Petroleum Institute, 20th Edition, 2006, ISBN: 9780871710499.
7. American Welding Society, "Structural Welding Code – Steel AWS D1.1", American Welding Society, 2015, ISBN: 9780871718648.

Web Resources

1. NPTEL MOOC Course on "Analysis and Modeling of Welding" (https://onlinecourses.nptel.ac.in/noc16_mm02/preview)
2. NPTEL MOOC Course on "Analysis and Modeling of Welding" (https://onlinecourses.nptel.ac.in/noc17_mm06/preview)
3. NPTEL MOOC Course on "Joining Technologies for Metals" (https://onlinecourses.nptel.ac.in/noc17_me09/preview)

Subject: **Disaster Management**								
Program: **B.Tech. Metallurgical Engineering**				Subject Code: **CV0712**			Semester: **VII**	
Teaching Scheme				**Examination Evaluation Scheme**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
1	0	0	0	24/60	0	16/40	0	100

Objectives:

1. To explain students the conceptual applications and principles of management to mitigate various disasters.

CONTENTS

UNIT-I [03 hours]

Introduction

Concepts and definitions: disaster, hazard, vulnerability, risk, capacity, impact, prevention,mitigation)

UNIT-II [04 hours]

Disasters classification

Natural disasters (floods, drought, cyclones, volcanoes, earthquakes,tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrialpollution, artificial flooding in urban areas, nuclear radiation, chemical spills etc); hazard andvulnerability profile of India, mountain and coastal areas, ecological fragility

UNIT-III [06 hours]

Disaster Impacts

Disaster Impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate-change and urban disasters. Disaster Risk Reduction

Disaster management cycle

Phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control); Roles and responsibilities ofgovernment,community, local institutions, NGOs and other

stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National DisasterManagementAuthority.

UNIT-IV **[03 hours]**

Applications of Science and Technology for Disaster Management and Mitigation

Geo-informatics in Disaster Management (RS, GIS and GPS), Disaster Communication System (Early Warning and Its Dissemination), Land use planning and development regulations, Disaster safe designs and Development Regulations, Disaster safe designs and Construction structural and Non-structural Mitigation of Disasters. Science and Technology Institutions for Disaster Management in India.

Text Books:

1. Ghosh G.K., 2006, Disaster management, APH Publishing Corporation., Sixth Edition 2006, ISBN-13: 978-8131300176

Reference Books:

1. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall. ISBN 10: 8120322002 / ISBN 13: 9788120322004
2. Singh B. K., 2008, Handbook of Disaster Management: techniques and guidelines, Rajat Publications 2008 ISBN (ISBN-10): 8178803550

Web Resources:

- http://nidm.gov.in/PDF/Disaster_about.pdf
- https://www.slideshare.net/Jyothi19587/disaster-ppt
- https://www.slideshare.net/SayefAmin1/natural-disaster-its-causes-effects
- https://www.slideshare.net/rahulp4/man-made-disasters-23947076
- https://www.slideshare.net/urveshprajapati3990/disaster-management-in-india-56546805
- www.ndmindia.nic.in/presentation/Presentation%20by%20JS%20(DM)%20(1).ppt
- https://www.geospatialworld.net/article/information-technology-and-natural-disaster-management-in-india/
- http://www.bvicam.ac.in/news/NRSC%202007/pdfs/papers/st_230_03_02_07.pdf
- http://eagri.tnau.ac.in/eagri50/ENVS302/pdf/lec13.pdf

- http://nptel.ac.in/courses/105105104/pdf/m16l39.pdf
- https://www.unisdr.org/we/inform/events/50220
- https://www.mooc-list.com/tags/disaster-management

Course Outcome:

1. Understand disasters, disaster preparedness and mitigation measures.
2. Understand role of IT, remote sensing, GIS in risk reduction.
3. Understand disaster management acts and guidelines along with the role of various stack-holders during disasters.

8TH SEMESTER

B-TECH METALLURGICAL ENGINEERING, SEMESTER –VIII TEACHING & EXAMINATION SCHEME WITH EFFECT FROM JULY 2017														
SR NO	CODE	SUBJECTS	TEACHING SCHEME			CREDITS	HOURS	EXAMINATION SCHEME						
								THEORY			PRACT		TOTAL
								CIE					
			L	T	P			MID	IE	ESE	CIE	ESE	
1	MT0801	Project	00	00	40	20	40	00	00	00	120	180	300
TOTAL			**00**	**00**	**40**	**20**	**40**	**00**	**00**	**00**	**120**	**180**	**300**

Subject: **Project**								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MT0801**			Semester: **VIII**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
0	0	40	20	0	180	0	120	300

Evaluation Scheme:

A four member committee designated as project evaluation committee member duly nominated by the HOD from amongst the faculty member will evaluate the project of each student under the following headings

1) CIE Internal Evaluation (120 Marks):

   CIE component will consist of Report (120 Marks): This includes the Seminar Report writing. The report should include Abstract, Introduction, Literature Survey, Review of Experimental/Computational Work, Discussion and Conclusion.

2) End Sem Evaluation (180 Marks):

   Oral Presentation (120 Marks): A presentation is the process of presenting a topic to an audience of students and minimum two professors.

   Viva (60 Marks): This includes how the student handles Question and Answer session after presentation.