Metallurgical and Materials Engineering

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

Academic Semester VII

S. No.	Code	Board of Study	Subject	Periods per week			Scheme of Examination and Marks				Credit L+(T+P)/2
				L	T	P	PRE**		ESE*	Total Marks	
							Mid Sem	TA			
1	MME4128	MME	Alloys their Properties and Selection	3	1	0	30	20	50	100	4
2	MME4129 (1-4)	MME	Professional Elective -II (**MME Annexure - II**)	3	1	0	30	20	50	100	4
3	MME4130 (1-4)	MME	Professional Elective -III (**MME Annexure - III**)	3	0	0	30	20	50	100	3
4	MME4131	MME	Corrosion and Protection of Materials Lab	0	0	3	30	20	50	100	2
5	MME4132	MME	Minor Project	0	0	8	0	30	20	50	6
6	MME4133	MME	Industrial Training and Seminar -II	0	0	2	0	30	20	50	1
7	HSS4104	Humanities	Humanities & Social Sciences	1	0	0	0	15	10	25	1
8	PFD4107	Humanities	Professional Development	0	0	1	0	30	20	50	1
			TOTAL	**10**	**2**	**14**	**120**	**185**	**270**	**575**	**22**

* End Semester Examination
** Progress Review Examination.
MME: Metallurgical and Materials Engineering

Professional Elective -II (MME Annexure - II)

S. No	Code	Subject
1	MME4129(1)	Corrosion and Protection of Materials
2	MME4129(2)	Environmental Sustainability and Materials
3	MME4129(3)	Advanced Secondary Steel Making
4	MME4129(4)	Light Metals

Professional Elective -III (MME Annexure - III)

S. No	Code	Subject
1	MME4130(1)	Metal Joining Processes
2	MME4130(2)	Design and Selection of Materials
3	MME4130(3)	Industrial Pollution and Control
4	MME4130(4)	Industrial Tribology
5	MME4130(5)	Introduction to Stainless Steel

Metallurgical and Materials Engineering

(7th Semester)

Detailed Syllabus

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Alloys their Properties and Selection **Code: MME4128**

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Course Description:

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

Course Objectives:

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

Syllabus:

UNIT – 1
Alloying elements, use of alloying, limitations of plain carbon steel, effect of alloying elements on transformation temperature, effect of alloying elements on critical cooling rate, on hardenability and on tempering, low alloy steels such as high tensile structural steel, case hardening steels, ball bearing steels, spring steels, low alloy high strength structural steels, Introduction to alloy design.

UNIT – 2
Structure properties and applications of high nickel steels, High Speed Steels, Die Steel, Hadfield steel and maraging steel.

UNIT – 3
Introduction to cast irons, structure and properties of white cast irons, gray cast iron, malleable cast iron, nodular cast iron and alloy cast irons. Introduction to Stainless steels, types of stainless steels, heat resistant high strength steels.

UNIT – 4
Non ferrous alloys, structure and properties of brasses, bronzes, babbits, structure and properties of titanium alloys, aluminum alloys, monels, brazing and soldering alloys.

UNIT –5

Metals at low temperatures, effect of low temperature on properties, effect of low temperature on notched bar test, metallurgical factors, and mechanical factors, magnetic steels and alloys, alloys for electrical applications, zirconium alloys in nuclear technology. amorphous metals, high entropy alloys, specifications of alloys: ISI, AISI and EN standards (Basic concepts only).

Text Books:

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

Reference Books:

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

Course Outcome:

1. Students will attain an ability to distinguish between various alloying effects;
2. Students will have an increased level of awareness towards alloys and their applications;
3. The knowledge of this syllabus will help in the production of alloys steel, cast iron and nonferrous alloys as per their need;
4. Students will be able to apply their basic understanding in development of alloys with better properties.

Professional Elective -II (MME Annexure - II)

S. No	Code	Subject
1	MME4129(1)	Corrosion and Protection of Materials
2	MME4129(2)	Environmental Sustainability and Materials
3	MME4129(3)	Advanced Secondary Steel Making
4	MME4129(4)	Light Metals

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Corrosion and Protection of Materials **Code: MME 4129(1)**

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Course Description:

The course provides fundamentals knowledge and applies its thorough training in corrosion and its prevention. To study the fundamental chemistry, physics, and metallurgy underpinning corrosion processes and learn about approaches to corrosion and control ranges from material selection through cathodic protection to corrosion inhibition and also the protective coatings.

Course Objectives:

1. To learn advanced topics of corrosion and advanced corrosion with emphasis on basic concepts;
2. To understand the significance of corrosion principles;
3. To understand the behavior of corrosion in acid media;
4. To understand the energy conversion in chemical cells and electrochemical cells.

Syllabus:

UNIT – 1
Introduction to corrosion, examples of corrosion, technical significance of corrosion, chemical and electrochemical reactions, electro motive force, electrode potential, galvanic series, Pilling Bed Worth ratio, electrochemical equilibrium, potential pH diagram, electrode kinetics, Evans diagram, effect of oxides, solution velocity.

UNIT – 2
Classification of various forms of corrosion such as pitting, crevice, intergranular, selective leaching, stress corrosion cracking, hydrogen embrittlement, high temperature oxidation, Bio-Corrosion, Wagner, Electrochemical oxidation theory, Hauffe's valency affects, Weld-decay.

UNIT – 3
Polarization and types of polarization, mixed potential theory, passivity, methods of testing in corrosion, potentiodynamic polarization, linear polarization, electrochemical impedance, spectroscopy, electrochemical noise.

UNIT – 4
Tafel's equation, Butler Volmer equation, Stern Geary equation, corrosion measurement techniques linear polarization, Tafel extrapolation, EIS, Mott Schottky technique, kinetics of oxidation, corrosion behaviour of industrial metals and alloys.

UNIT –5

Methods of corrosion control, inhibition, coatings, alloying, heat treatment, change in design, change in corrosive environment, Types of inhibitors, types of coatings. Cathodic and anodic protection.

Text Books:

1. Principles and Prevention of Corrosion (second edition), Denny A Jones, Prentice-Hall, N. J. (1996).
2. Corrosion Engineering (Third Edition), M. G. Fontana, McGraw-Hill Book Company (NY) (1987).
3. Corrosion and Corrosion Control, H. H. Uhlig and R. W. Revie, Wiley (NY) (1985).
4. Corrosion, L. L. Shreir, Vol I and II, Butterworths, Kent (1976).
5. Atlas of Electrochemical Equilibria in aqueous solutions, M. Pourbaix, NACE, Houston (1974).

Reference Books:

1. Modern Electrochemistry, J.O.M. Bockris and A. K. N Reddy, Vol. I and II, Plenum Press (NY) (1970).
2. Microbial Corrosion, C. A. C. Sequeira, European Federation of Corrosion, Maney Pub. (2000).
3. Microbiologically Influenced corrosion, B. J. Little, Wiley-Inter science (2007)
4. Manual of Bio-corrosion, H. Videla, J. F. Wilkes, R. A. Silva, CRC Press (1996).
5. Fundamental Aspects of Corrosion of Metals in Aqueous Environments, R. W. Staehle, Special lecture series on the fundamentals of corrosion, Univ. of Minnesota (USA), 1968.

Course Outcome:

1. Application of cathodic and anodic protection to engineering systems and understand eddy current relations;
2. Development of electrochemical reaction of alloys and cathodic and anodic relations. Multi-component in various atmosphere;
3. Analysis of Tafel curve in acid, gases and mixture of both;
4. Construction of a system for protection of materials through various coating.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Environmental Sustainability and Materials **Code: MME 4129(2)**

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Course Description:

Sustainability includes not only use of environmental resources but also social and economic goals and captures the interactions between all three elements. This course provides with the theoretical background and practical aspects. The sustainable materials, aims to reduce the impact of construction related activities. This course includes topics such as the principles of green design, industrial ecology, product life cycle assessment, and relevant materials research for environmental and energy applications. This course basically provides with the professional competitive advantage to choose careers in the application of green energy technology, environmental engineering, environmental monitoring and protection, resource and waste management as well as related materials aspects.

Course Objectives:

The goal of this course is to provide a comprehensive overview of the core concepts, strategies and practices of sustainable materials:

1. To introduce the students to the environmental aspects of materials, and the role materials engineers play in building a sustainable environment;
2. To specialize in environmentally-conscious product design and manufacturing processes involving the usage of modern materials.

Syllabus:

UNIT- 1:
Man and environment, principles of environmental management and Sustainable development, Environmental limits and the sustainability principle, the precautionary principles, concept of green technology, Energy Systems & Climate Change, global warming, adverse effects of CO_2.

UNIT- 2
Sustainable resources, related parameters, concept on nonconventional energy, solar energy, wind energy, fuel cell, photovoltaic, pyrolysis, digestion process, hydroelectricity, bio-reactors.

UNIT- 3
Sustainable construction materials, recycled glass aggregates, utilization of fly ash, slags, tailings, structural behaviour of high strength concrete in adverse conditions, particulate, filamentary, short-fiber, and laminated composites.

UNIT- 4
Material resource consumption, materials life cycle assessment, materials chemistry for sustainable energy and pollution control, waste management.

UNIT- 5

Concept of product, related parameters, product design analysis, qualifying a sustainable products, product cycles, material selection for sustainable products, case studies.

Text Books:

1. Materials and the Environment, Michael Ashby, Butterworth-Heinemann, 2009.
2. Introduction to Engineering and the Environment, Edward S. Rubin, McGraw Hill, 2001.

Reference Books:

1. Environmentally Conscious Materials and Chemicals Processing, Myer Kutz, Wiley, 2007.
2. The Physical Chemistry of Materials: Energy and Environmental Applications, Rolando M.A. Roque-Malherbe, CRC Press, 2010.

Course Outcome:

1. Understand the broad principles of environmental engineering;
2. Understand the environmental impacts of materials and chemical processing;
3. Able to evaluate and critically assess environmental life cycles of various materials;
4. Knowledgeable in advanced material usage in energy and environmental applications;
5. Demonstrate the analytical and technical skills.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Advanced Secondary Steel Making **Code: MME 4129(3)**

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Course Descriptions:
The course deals with the secondary metallurgical processes of steel making and to design and optimize the process flow route. It also helps the students to improve the quality of the steel products and efficiency of the process.

Course Objectives:

1. Study about the different process of secondary steel making;
2. Study about the benefits of adoption of different environment during secondary steel making process;
3. Learn the concept to achieve the requisite composition of final steel.

Syllabus:

UNIT- 1
History of steel making, major steel making process: BOF, EAF, CONARC, EOF; Impurities present in the liquid steel and its effects on properties of steel.

UNIT- 2
Objectives of secondary steel making, Ladle furnace method, Injection metallurgy, Degassing processes: Ladle degassing (VOD, VAD), Stream degassing process, Circulation degassing process (RH, DH), de-oxidation process.

UNIT- 3
Non-metallic inclusion in steels, Source of inclusion in steel and its control, Inclusion engineering, Impact of inclusion on properties of steels.

UNIT- 4
Continuous casing of steel, Tundish metallurgy, Moulds used for continuous casting, Use of casting powder, Electro-magnetic stirring, Developments in continuous casting technology, Ingot casting, Casting defects and its remedies, Final finishing operations.

UNIT- 5
Production of stainless steels through VOD, AOD and CLU process, production of ultra clean steel through post solidification treatments (VAR, ESR processes), Recent advances in steel making and continuous casting.

Text Books:

1. Secondary steel making – Principle & Applications, Ghosh, CRC Press – 2001.
2. Iron making and steel making Theory and Practice, Ahindra Ghosh and AmitChatterjee, Prentice-Hall of India Private Limited, 2008.
3. An Introduction to Modern steel making, R H Tupkary, Khanna Publication, India.

Reference Books:

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

Course Outcome:

On completion of the course the student should be able to:

1. Able to identify the various advanced secondary metallurgical techniques;
2. Able to acquire a good knowledge of the subject;
3. Able to a step ahead in the field of steel making;
4. Able to solve the problems in an industry.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Light Metals **Code: MME 4129(4)**

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Course Description:

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

Course Objectives:

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

Syllabus:

UNIT – 1
Aluminum alloys, Classification, Properties and physical metallurgy of Al-Cu alloys, Al-Mg alloys, Al-Zn alloys, Al-Mn alloys and Al-Si alloys aluminum alloys: Ternary phase diagrams, Al-Cu-Mg alloys, Al-Si-Mg alloys and Al-Zn-Mg alloys.

UNIT - 2
Magnesium alloys, precipitation hardening in magnesium base alloys, Mg-Al-Zn alloys, corrosion resistance of Mg-alloys. Zinc-base alloys, classification, properties and applications.

UNIT - 3
Commercially pure titanium and its properties, applications, interstitial solid solutions of titanium, strengthening mechanisms of Titanium alloys.

UNIT - 4
Alpha Ti alloys, beta Ti-alloys, alpha plus beta Ti alloys, Ti-6Al-4V, Ti-8Al-1Mo-1V, Ti-13V11Cr-3Al alloys.

UNIT - 5
Beryllium alloys, classification properties and applications zirconium alloys, classification, properties and applications.

Text Books:

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

Reference Books:

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

Course Outcome:

At the end of the course:

1. Student will attain sound knowledge on microstructures, properties, and applications of several nonferrous alloys such as Al, Be, Mg, Ti, and Zn alloys;
2. Student will be able to design light alloys for specific metallurgical applications.

Professional Elective -III (MME Annexure - III)

S. No	Code	Subject
1	MME4130(1)	Metal Joining Processes
2	MME4130(2)	Design and Selection of Materials
3	MME4130(3)	Industrial Pollution and Control
4	MME4130(4)	Industrial Tribology
5	MME4130(5)	Introduction to Stainless Steel

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Metal Joining Processes **Code: MME 4130(1)**

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Course Description:

'Metal Joining Processes' is an important manufacturing route to formulate bulk storage and processing equipment and Power generation equipment. Out of Welding, Brazing and soldering processes, welding is one of the major manufacturing processes used in the fabrication of process equipment, steel structures, piping and ship building. The subject focuses on knowledge and understanding of various joining process and equipment, the fundamental principles and their relative merits and demerits. This subject focuses on the weldability of different metals and alloys being important for students of metallurgy. This course also provides the knowledge about metallurgical effect of welding in various ferrous and nonferrous metals like carbon steel, stainless steel, aluminium and titanium. The student will be able to apply knowledge and skills of welding metallurgy in producing products of quality as per the quality standard of the industries.

Course Objectives:

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

Syllabus:

UNIT – 1
Sources of heat energy, the flame, the electric arc, chemical reactions during welding, oxidation reaction, protection of weld pool with fluxes or gases, micro structural changes during welding, the effect of heat on metals, pre-treatment and post-treatment of welds, theory of distortion, residual stress in welds.

UNIT – 2
Classification of welding processes- heat sources and shielding methods- fusion welding processes, oxy-acetylene welding, arc welding-manual, submerged arc welding, gas tungsten arc and gas metal arc welding; their advantages and disadvantages, Pressure welding, cold and hot pressure welding, friction stir welding, and diffusion welding, roll bonding, resistance welding, spot and projection welding, advantages and disadvantages.

UNIT – 3
Principle, equipment, process variables, merits, Limitations and applications of electron beam, plasma arc and laser beam welding processes, Practice of soldering, joint types and preparation, fluxes, heat sources and heat transfer, brazing practice, filler materials, heat sources, different types of brazing, braze welding.

UNIT – 4
Welding of structural steels, cast iron, stainless steels, high-alloyed steels, welding of non-ferrous alloys like Aluminum, Titanium, and copper, welding of dissimilar metals.

UNIT – 5
Mechanical testing, non-destructive testing, various weld defects and their causes and remedies.

Text Books:

1. "Welding Processes and Technology", Parmar, R.S., 2nd edn. Khanna Pub., New Delhi, 2001.
2. "Welding Brazing & Soldering", ASM Metals Handbook. Vol.6. ASM International, Metals Park, Ohio, USA, 1993.
3. AWS Welding Handbooks, AWS, New York, 1995.

Reference Books:

1. "Welding", Davies-A C, 10th edition, Cambridge University Press, UK, 1996.
2. "Modern Welding Technology", Howard B Cary., 4th Edition, Prentice Hall, New Jersey, USA, 1997.
3. "Metallurgy of Welding", Lancaster. J. F., George Allen Co, Boston, 1980.

Course Outcome:

1. Overview of joining processes; discuss in detail the welding process and the physics of welding can be assessed;
2. Practical applications of welding of ferrous and non ferrous metals can be understood.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Design and Selection of Materials **Code: MME 4130(2)**

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Course Descriptions:

The focus of this course is to study about material selection, design development and important applications. This course deals with the materials aspects of the design process. The methodology deals with the guidance through the choices that designer faces.

Course Objectives:

1. To provide the students with overall knowledge on the product design, mold design, testing & quality control, and recycling through theory as well as practical training;
2. To develop a methodology for selecting materials and processes that is design-led;
3. To make the students competent to take up the challenging positions in design;
4. To meet the requirements of designed materials to the society.

Syllabus:

Unit – 1
Concept of materials and design, principles and factors for materials selection, problems in materials selection, process of material selection, boundary conditions of materials selection, performance and materials Indices, steps of material selections, and design based on requirements of function, property, case studies.

Unit – 2
Quantitative ranking of options for material selection, roles & responsibilities of materials engineer, basic classifications of materials, selection of properties of materials, selection of materials according to their mechanical properties in static strength, temperature related selection processes, selection of corrosion resistance materials, wear resistance material parameters.

Unit – 3
Different types of materials processes, powder technology processes, Introduction to design codes, cost aspects of process selection, properties affecting design and choice of engineering materials, strengthening mechanism of materials, process selection in design.

Unit – 4
Introduction and use of materials data bases, economic, Environmental and Social issues of material usage.

Unit – 5

Advanced materials selection processes, applications of materials for aircraft wings, cutting tools, gas turbine blades, liquid nitrogen containers, artificial hip replacement, automobile value spring etc.

Text Books:

1. N A Waterman and M F Ashby, The Materials Selector, Vols. I, II and III, Chapman and Hall, London, 1996.
2. Mechanical Metallurgy: George E. Dieter, McGraw Hill Publication.
3. Testing of Metallic Materials: A. V. K. Suryanarayan, B. S. Publication.

Outcomes:

Students will be able an overall understanding for the selection and designing the engineering material and its respective applications.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Industrial Pollution and Control **Code: MME 4130(3)**

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Course Description:

This course has been intended to improve the understanding of the students about different pollution control strategies and the techniques to control pollution in three environmental compartments i.e. air, water and metals. The course will also be dealing about the sources of pollution in air, soil, water, solid-waste and heavy metals and the impacts these sources on the environment and health. Moreover, the students will be given the concept to develop the particular skills required in pollution and knowhow the management strategies.

Course Objectives:

1. To assess air pollution, water pollution and metal pollutions specially their sources and effects and respective controlling parameters;
2. To increase the awareness of the students towards the detrimental effects of the pollutants of different modes like solid, liquids or gaseous forms from various industries;
3. To encourage the curiosity and the hidden potential of students towards suggestive methods to reduce such effect.

Syllabus:

UNIT- 1:
Man and environment, principles of environmental management and Sustainable development, classification of pollutants, respective parameters, carbon emissions and global warming, role of CO_2 in pollution, biodegradable and non-biodegradable pollutants, types of pollutions like thermal pollution, radiation pollution, metal pollution, chemical pollution, marine pollution.

UNIT- 2
Types of gaseous and particulates, primary and secondary air pollutants, Air pollution in industrial units especially in ferrous and non-ferrous metallurgical industries, control of specific gaseous pollutants like SO_2, NO_2, CO_2 etc. air pollution sampling and measurement, related numerical, air pollution control methods and equipment, hazardous effect of fly ash.

UNIT- 3
Types of water pollutions, causes of water pollutions, controlling parameters for water pollution in integrated steel plants, electroplating & metal finishing industries, non ferrous industries, waste water treatment technology and its related physical, chemical & biological processes.

UNIT- 4
Metals related to pollutions, Pollution control for specific pollutants, removal of Cr, Cd, Hg, As, Sb, Pb process of operation and controlling systems.

UNIT- 5
Environmental aspects of sponge iron plants, types of solid waste from coal, steel, non-ferrous industries, different disposal techniques, waste utilization techniques. Pollution control policies and related laws, case studies on pollution control (Metallurgical aspect).

Text Books:

1. Environmental Chemistry, A.K. De (1990), Wiley Eastern Ltd.
2. Industrial Pollution Control, Ecrenfelder W. (1990), McGraw Hill Int. Ed.
3. Air pollution – V. P. Kudesia, Pragati Prakashan, India.
4. Pollution control in process industries – S.P. Mahajan, Tata McGraw-Hill Education.
5. Environmental Pollution control Engineering, Rao, New Age International.
6. Water Pollution: Causes, Effects and Control, P.K. Goel, New Age International Publishers.

Reference Books:

1. An Introduction to Environmental Engineering and Science, Gilbert M. (2007), Pearson Education.
2. Air Pollution, Perkins H.C. (1974), McGraw Hill.
3. Environmental Engineering – Pandey and Carney, McGraw-Hill Education.
4. Energy Ecology, Environment and Society, Deswal and Deswal, Dhanpat Rai & Co (P) Ltd
5. Environment pollution=- V.K. Prabhakar, Anmol Publications (P) Ltd.
6. Air Pollution: Health and Environmental Impacts, Bhola R. Gurjar, Luisa T. Molina, C.S. P. Ojha, CRC Press, Taylor and Francis Group.

Course Outcome:

1. Students will attain an ability to distinguish between various methods of pollution analysis;
2. Students will have an increased level of awareness towards environmental friendly industrial practice;
3. Students could have a conceptual blend between theory and practical knowledge;
4. Students will be able to employ their analytical skills and aptitude in solving problems;
5. The students will be able to handle any job situation related to pollution;
6. Work effectively as an individual and as a member of a multidisciplinary team.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Industrial Tribology **Code: MME 4130(4)**

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Course Descriptions:

The focus of this course is to develop an understanding of the Tribology. Tribology deals with design of fluid containment systems like seals and gasket, lubrication of surfaces in relative motion to achieve reduced friction and wear. The structure of the bearing and the nature of fluid flow determine the loads that can be supported. Modeling systems as hydrostatic squeeze film and elasto-hydrodynamic lubrication will be studied as infinite and later finite structures. Gas (air) lubricated and rolling contact type motions with deformation at contact will be studied as special systems.

Course Objectives:

1. To develop a solution oriented approach by in depth knowledge of Industrial Tribology;
2. To address the underlying concepts, methods and application of Industrial Tribology.

Syllabus:

UNIT – 1
Tribology in design, tribology in industry, viscosity, flow of fluids, viscosity and its variation absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, tribological considerations, nature of surfaces and their contact, erosion-corrosion.

UNIT – 2
Role of friction and laws of static friction, causes of friction, theories of friction, laws of rolling friction, friction of metals and non-metals, friction measurements, definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; wear of metals and non-metals.

UNIT – 3
Types and properties of lubricants, testing methods, hydrodynamic lubrication, elasto-hydrodynamic lubrication, boundary lubrication, solid lubrication, hydrostatic lubrication.

UNIT – 4
Principle of hydrodynamic lubrication, various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions, effects of side leakage - Reynolds equation in three dimensions.

UNIT – 5

Surface modifications, transformation hardening, surface fusion, thermo chemical processes, surface coatings, plating and anodizing, fusion processes, vapor phase processes, materials for rolling element bearings, materials for fluid film bearings, advance methodology to prevent wear and tear.

Text Books:

1. Fundamentals of Tribology, Basu, Sen Gupta and Ahuja/PHI.
2. Tribology in Industry, Sushil Kumar Srivatsava, S. Chand &Co.
3. Tribology H. G. Phakatkar and R. R. Ghorpade, Nirali Publications.
4. Tribology – B.C. Majumdar, McGraw Hill Co Ltd.

Reference Books:

1. Standard Hand Book of Lubrication Engg. O'Conner and Royle, McGraw Hills Co.
2. Introduction to Tribology, Halling , Wykeham Publications Ltd.

Course Outcomes:

1. The student can identify different areas of industrial Tribology;
2. Can find the applications of all the areas in day to day life.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Introduction to Stainless Steel **Code: MME 4130(5)**

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Course Description:

This course has been intended to improve the understanding of the students about the stainless steels, their varieties and applications. The use of alloying and their effect in improving the properties of the stainless steel will be reviewed thoroughly.

Course Objectives:

1. Study the various types of stainless steels, their production, properties and applications;
2. Study about alloying and its effect on final properties;
3. Understand the need for alloying and utilize the knowledge in tailoring the alloys for a particular application;
4. Study the phase transformations in stainless steels and fabrication of the same;
5. To establish a concrete understanding of alloying and their effects in a particular material atomistically.

Syllabus:

UNIT – 1
Stainless Steel (SS) making process: complete overview, advancements in technology, if any. Family tree of SS, major grades, functions of alloying elements and their impact on mechanical properties of SS, cost implications of alloy addition and using substitutes, phase transformations in Stainless Steel, secondary phase transformations, mechanism of phase transformation and its effect on properties of SS.

UNIT - 2
Stainless Steel fabrication: Hot rolling, cold rolling, shearing, cold roll forming (CRF), process mechanism, tools and equipment, issues faced during fabrication of stainless steel and their solutions, corrosion in stainless steel, galvanic corrosion, mechanism and prevention, pitting corrosion: mechanism and prevention, PREN, crack propagation mechanisms, inter-granular and trans-granular.

UNIT - 3
Welding of Stainless Steel: Sensitization/Weld decay: causes, mechanisms, remedies, high temperature sensitization, 475 embrittlement, α' phase transformation, distortion: causes, mechanisms, remedies, effect of alloying elements on weldability of SS, Schaeffler De Long diagram interpretations: Cr, Ni and C equivalent.

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

UNIT – 5

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

Text Books:

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

Reference Books:

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

Course Outcome:

1. Students will attain an ability to distinguish between various stainless steels;
2. Students will have an increased level of awareness towards stainless steel and their applications;
3. The knowledge of this syllabus will help in the understanding the phase transformations in ferrous alloys as per their need;
4. Students will be able to apply their basic understanding in development of alloys with better properties.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Corrosion and Protection of Materials Laboratory **Code: MME 4131**

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Course Objectives:

1. To learn the concept regarding the degradation of materials;
2. To understand the behavior of corrosive environment on the respective materials;
3. To learn the handling of equipment used for determination of rate of corrosion.

Syllabus:

List of Experiment to be performed (At least six experiments to be done)

1. Corrosion rate measurement by weight loss study.
2. Corrosion rate measurement by electro-chemical study.
3. Study of galvanic corrosion by different combination of metals.
4. Study of stress corrosion of brass and steel.
5. Corrosion in sulfide environment.
6. Effect of Inhibitors on corrosion behavior of steel.
7. Oxidation loss at high temperature.
8. Study of corrosion in different industries.

List of Equipment's/Machine Required:

1. Potentiostat.
2. Respective chemicals.
3. PH measuring instrument.
4. Respective metals.
5. Digital weight balance.
6. High temperature furnaces.
7. Optical Microscopes.

Course Outcome:

The student should aware of the effect of corrosive environment and must have mastery in handling the equipment relation corrosion parameter measurement.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Minor Project **Code: MME 4132**

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Course Descriptions:

Minor Project has its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of UG curriculum and related to project/research practicality of their own field of specialization.

Objectives:

1. To set out the chosen project/research methods, including their theoretical basis, and the literature supporting;
2. The method is more experimental, and what kind of reliance could place on the results and reaches a discussion section;
3. Aim to increase the analytical methods and establishment of the case studies/industrial problem solving/research topics.

Course Outcome:

1. Understand to summarize the research methods and its;
2. Able to know the Interpretation approach and problem solving skills;
3. Able to understand the key challenges that to be faced in the research/ immediate industrial problems/case studies.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Industrial Training and Seminar **Code: MME 4133**

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Industrial Training:

Industrial Training has its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of college curriculum, mainly along with this semester engineering courses to expose the students towards industrial hardcore practicalities.
This Course provides the students to work in industry to manufacture and test semi finished/finished products in foundries, heat treatment shops, steel making shops etc for diagnose problems and technical resolutions. The students need to have industry and workshop exposure, where they can experience real life equipment, materials, instruments and various kinds of metallurgical process & related equipments. This course has been designed for the students to have real life skills to help them to prepare career. At present scenario, the metallurgical sector needs skilled and managerial personnel who have technical expertise as well as entrepreneurial qualities to manage the growing metallurgy industry.

Objectives:

Industrial trainings are to provide students an insight regarding internal working of companies. We know, theoretical knowledge is not enough for making a good professional career. With an aim to go beyond academics, industrial training provides students' practical perspectives related with industrial workforce. It provides students with an opportunity to learn practically through interaction, working methods and employment practices.

It gives them exposure to current work practices as opposed to possibly theoretical knowledge being taught at college. Industrial trainings provide an excellent opportunity to interact with industries and know more about industrial environment. The visits are arranged by colleges to students with an objective of providing students functional opportunity in different sectors. Industrial visit helps to combine theoretical knowledge with industrial knowledge. Scientific realities are opened to the students through attending seminar in academic Institutes/ CSIRs/National Laboratories/Corporate Laboratories.
In brief the objectives are fully based on the concepts of:

1. Make Students Aware with Industry Practices;
2. Increase Practical Awareness of various Industrial Sectors;
3. Acquaint Students with Interesting Facts and Newer Technologies through seminar attending;
4. Practical application of instruments handled during course curriculum.

Course Outcome:

1. Students will understand the practical aspects in the industry/laboratories as trainees;
2. Students would be able to demonstrate these skills in the metallurgical process or parameters affecting;
3. Students would be able to understand the industrial ethics and professionalism.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Humanities and Social Science **Code: MME 4104**

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Course Description

This course is intended to provide Engineering Graduates an overview of public administration, budgeting and financial management. It will provide an overview of the budget process, including the players and the strategies they employ, as well as provide the basic concepts and principles necessary for sound financial management.

Course Objectives

The students should be able

1. To understand the basics of public administration and purpose of public administration;
2. To understand the organizational structure of a Public Sector Department with specific reference to the levels of authority and protocols;
3. To understand the predominant political, economic, and social factors that actively engage in the policymaking process, including expert communities, interest groups, the media, agency bureaucrats, and elected officials;
4. To understand the basics of budget preparation and performance evaluation systems for public sector institutions.

Syllabus:

UNIT - 1
Public Administration
Meaning, Nature, Scope and Significance, Public and Private Administration.

UNIT – 2
Principles Of Organization
Hierarchy, Unity of Command, Span of Control, Centralization and Decentralization, Delegation-Supervision & Control.

UNIT - 3
Administrative Behaviour
Decision- Making, Leadership, Motivation & Communication.

UNIT – 4
Introduction To Local Government
Meaning, Nature and Scope of Local Programmes, Growth and Development of Local Government, Rural Development Programmes (73rd Constitutional Amendment Act), Urban Development Programmes (74th Constitutional Amendment Act).

UNIT – 5

Introduction To Public Finance

Public Financial Management and Budgeting, Government finance at the centre, state and local levels.

Text Books:

1. Public administration - Mohit Bhattacharya.
2. Civil Services in India: Indian administration - S.R. Maheswari.
3. State District and local administration: State administration - J.D. Shukla
4. District administration -- S. S. Khera.

Reference Books:

1. Local Government in India - S.R. Maheshwari
2. Financial administration: Financial administration of India - M.J.K. Thavaray
3. Fundamentals of Financial Management , Banerjee Bhabotosh, PHI Learning Private Ltd., 1stEdition2008Effective Financial Management , Brian Finch, Kogan Page Limited, 2012

Course Outcomes:

1. Students are expected to understand administrative principles and the role of legislation in public administration;
2. Students are expected to demonstrate proficiency in communicating ideas and perspectives about public administration matters;
3. Students are expected to solve problems and make decisions in public governance;
4. Students are expected to understand the basic concepts and principles necessary for sound financial management; articulate and apply a public service perspective.

Metallurgical and Materials Engineering

Semester: VII **Branch: Metallurgical and Materials Engineering**
Subject: Professional Development **Code: PFD 4107**

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Course Descriptions:

This course provides employability skills training to Engineering Graduates. The employability skills are non-technical skills which contribute to an individual's effective participation in the workplace. The curriculum framework addresses each of the six core HRD components:

1. Assessment of an individual's assets and limitations;
2. Development of a positive self-concept;
3. Development of employability skills;
4. Development of communication skills;
5. Development of problem-solving skills;
6. Awareness of the impact of information technology in the workplace.

Course Objectives:

The objectives of this course are:

1. To make students understand what is expected of new employees;
2. To make students learn and practice communications skills;
3. To make students understand key behaviors to satisfy employer Expectations;
4. To make students learn and practice customer service skills;
5. To make students learn to deal with conflict effectively;
6. To make students learn financial skills;
7. To make students learn to create a job-search-ready resume and portfolio.

Syllabus:

Module - 1. The Rewards of Working.

Module – 2. Know Thyself: Assets, Strengths and Choices.

Module - 3. Personal Power: responding to Challenges.

Module - 4. Work Search Planning: Laying the Groundwork in the New Millennium.

Module - 5. Tools for the Journey: Proposals, Resumes and Correspondence.

Module – 6. Researching Options and Opportunities.

Module – 7. Contacting Employers: Taking it to the Streets.

Module – 8. Interviewing with Ease: Mastering the Art of Self-Presentation.

Module – 9. Researching Options and Opportunities.

.Text Books:

1. "Soft Skills" by Hariharan S. S. N. Sundararajan and S. P. Shanmugapriya, MJP Publishers.
2. "Soft Skills: Know Yourself and Know the World" by Alex.
3. "Making Work for the Highly Sensitive Person" by Beverly Jaeger, McGraw-Hill Education.

Reference Books:

1. "Get your First Job: A companion for getting your first job – A Guide to Employability Skills and Career Planning " by A J Balasubramanian and Dr J Sadakkadulla, Amazon Asia-Pacific Holdings Private Limited.
2. "Soft Skills at Work: Technology for Career Success " by Beverly Amer, Course Technology Inc.
3. "BEST: Basic Employability Skills Training: Volume 1 " by Sally J. Vonada and JoAnn Brunner, Create Space Independent Publishing Platform.

Course Outcome:

Develop an individual's employability skills, problem-solving skills, Awareness of the impact of information technology in the workplace.