Enugu State University of Science and Technology, Enugu
Faculty of Engineering
Department of Metallurgical and Material Engineering
Program Educational Objectives (PEOs), Program Objectives (POs) and Course Learning Outcomes (CLOs)

A. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives (PEOs) of Metallurgical and Material Engineering of Enugu state university are published in the departmental students handbook distributed at the point of students registration on admission, Posters displayed at strategic positions around the department and disseminated to all the stakeholders of the programme through faculty meetings, parent/staff meetings, student's awareness workshops, students orientation programmes, alumni meetings and also interaction with the industries, through electronic media. It is also hosted on the university website

The **Programme Educational Objectives** of the B. Eng. MME ESUT are to:

1. Demonstrate a strong foundation in scientific principles, technical knowledge, and practical skills necessary for the field and be equipped to apply their understanding of metallurgy and materials science to solve complex engineering problems and contribute to technological advancements.
2. Possess effective communication and teamwork skills, enabling them to collaborate with multidisciplinary teams and effectively convey technical information to diverse audiences and hence demonstrate professionalism, ethical conduct, and a commitment to social responsibility in their engineering practice.
3. Develop professionally throughout their careers, engaging in lifelong learning and adapting to emerging technologies and industry trends.
4. Demonstrate leadership qualities and contribute to the advancement of metallurgical and materials engineering through research, innovation, and entrepreneurship, thereby serving the needs of society and making meaningful contributions to sustainable development.

The PEOs are consistent with the vision (To be an outstanding internationally respected University in Africa with strong commitment to rigorous scholarship that promotes service to humanity through quality teaching, research and community social responsibility) and mission (To produce graduates that can favourably compete with their counterparts all over the world and to promote scholarship, especially in the areas of Science, Management and Technology, thereby ensuring the development of quality manpower that will utilize technology for the service of the society) of Enugu State University of Science and Technology and align with the stakeholders' requirements as follows

Consistency with the Vision: The PEOs contribute to this vision by emphasizing the development of graduates who demonstrate a strong foundation in scientific principles, technical knowledge, and practical skills necessary for the field of metallurgical and materials engineering. By equipping graduates to apply their understanding of metallurgy and materials science to solve complex engineering problems and contribute to technological advancements, the PEOs align with the vision of the university.

Consistency with the Mission: The PEOs directly support this mission by emphasizing the development of graduates who possess a strong foundation in scientific principles, technical knowledge, and practical skills. These graduates are not

only equipped to solve complex engineering problems but also demonstrate effective communication, teamwork, professionalism, ethical conduct, and a commitment to social responsibility in their engineering practice. By nurturing these qualities, the PEOs contribute to the mission of the university.

Alignment with Stakeholders' Requirements: The emphasis on a strong foundation in scientific principles, technical knowledge, and practical skills ensures that graduates are well-prepared to address complex engineering problems and contribute to technological advancements. The focus on effective communication and teamwork skills enables graduates to collaborate with multidisciplinary teams and effectively convey technical information to diverse audiences, meeting the needs of employers and industry professionals. The PEOs also highlight the importance of professionalism, ethical conduct, and a commitment to social responsibility, which are highly valued by stakeholders. Furthermore, the emphasis on lifelong learning, adaptability to emerging technologies and industry trends, and the promotion of research, innovation, and entrepreneurship demonstrate a commitment to the advancement of metallurgical and materials engineering, thereby serving the needs of society and contributing to sustainable development.

B. PROGRAMME OUTCOMES (POS)

The Programme Outcomes Objectives (POs) of Metallurgical and Material Engineering of Enugu state university are published in the departmental students handbook distributed at the point of students registration on admission, Posters displayed at strategic positions around the department and disseminated to all the stakeholders of the programme through faculty meetings, parent/staff meetings, student's awareness workshops, students orientation programmes, alumni meetings and also interaction with the industries, through electronic media. It is also hosted on the university website

POs as defined by COREN

1. COREN-PO1: Engineering Knowledge: apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of developmental and complex
engineering problems;
2. COREN-PO2: Problem Analysis: Identify, formulate, research literature and analyse developmental and complex engineering problems reaching substantiated conclusions using first
principles of mathematics, natural sciences and engineering sciences;
3. COREN-PO3: Design/Development of Solutions: Proffer solutions for developmental or complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations;
4. COREN-PO4: Investigation: Conduct investigation into developmental or complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions;
5. COREN-PO5: Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and ICT tools, including prediction, modelling and optimization to developmental and complex engineering activities, with an understanding of the limitations
6. COREN-PO6: The Engineer and Society: Apply reasoning informed by contextual knowledge including humanities and social sciences to assess societal, health, safety,

legal and cultural issues and the consequent responsibilities relevant to professional engineering practice

7. COREN-PO7: Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development
8. COREN-PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice, including adherence to the COREN engineers' codes of conduct
9. COREN-PO9: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings
10. COREN-PO10: Communication: Communicate effectively on developmental or complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;
11. COREN-PO11: Project Management: Demonstrate knowledge and understanding of engineering, management and financial principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments demonstrate knowledge and understanding of engineering, management;
12. COREN-PO12: Lifelong Learning: Recognize the need for, and have the preparations and ability to engage in independent and lifelong learning in the broadest context of technological and social changes.

C. PROGRAMME OUTCOMES (POs) OF ESUT, MME DEPARTMENT

A graduate of ESUT Metallurgical and Material Engineering is expected to possess the ability to:

PO1: Engineering Knowledge	solve developmental and complex engineering problems through applied knowledge of mathematics, science, engineering fundamentals and Metallurgical and Material Engineering principles
PO2: Problem Analysis	identify/formulate, research literature and analyse developmental and complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences;
PO3: Design/Development of Solutions:	advance solutions for developmental or complex engineering problems and design systems, components or processes that meet specified needs with appropriate consciousness for public health and safety, cultural, societal and environmental peculiarities;
PO4: Investigation	investigate into developmental or complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions;
PO5: Modern Tool Usage:	create, select and apply appropriate techniques, resources and modern engineering and ICT tools, including prediction, modelling and optimization to developmental and complex engineering activities, with an understanding of the limitations;
PO6: The	apply informed reasoning through contextual knowledge which includes

Engineer and Society:	Humanities and Social Sciences to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice;
PO7: Environment & Sustainability:	understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development;
PO8: Ethics:	imbibe ethical principles and commit to professional responsibilities and norms of engineering practice, including adherence to the COREN Engineers Code of Conducts;
PO9: Individual and Team Work:	function effectively as an individual, a member or as a leader in diverse teams and in multi-disciplinary settings;
PO10: Communication:	communicate effectively on developmental or complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions;
PO11: Project Management:	demonstrate knowledge and understanding of engineering, management and financial principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments;
PO12: Lifelong Learning:	recognize the need for, and have the preparations and ability to engage in independent and lifelong learning in the broadest context of technological and social changes.

C. COURSE LEARNING OUTCOMES (CLOS)

The Course learnong outcomes (CLOs) of Metallurgical and Material Engineering of Enugu state university are published in the departmental students handbook distributed at the point of students registration on admission, and on the University website.

GST 111 (Communication in English I), 2 units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. Identify possible sound patterns in English Language
2. List notable language skills -
3. Classify word formation processes -
4. Construct simple and fairly complex sentences in English -
5. Apply logical and critical reasoning skills for meaningful presentations -

GST 112: Nigeria People and Culture – 2 Units

CLOs: Upon completion of this course, students will be able to:

1. analyse the historical foundation of Nigerian cultures and arts in pre-colonial times;
2. identify and list the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political entity;
4. analyse the concepts of trade and economic self-reliance of Nigerian peoples in relation to national development;
5. enumerate the challenges of the Nigerian state regarding nation building;
6. identify the acceptable norms and values of the major ethnic groups in Nigeria;
7. list possible solutions to identifiable Nigerian environmental, moral and value problems.

ICH 111: General Chemistry I – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. define atom, molecules and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. rationalise the trends of atomic radii, ionization energies, electronegativity of the elements, based on their position in the periodic table;
5. identify and balance oxidation–reduction equation and solve redox titration problems;
6. draw shapes of simple molecules and hybridised orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;
8. apply the principles of equilibrium to aqueous systems using Le Chatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy;
10. determine rates of reactions and its dependence on concentration, time and temperature.

ICH 197: General Practical Chemistry I (1 Unit)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. state the general laboratory rules and safety procedures;
2. collect scientific data and correct carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. state the differences between primary and secondary standards;
5. perform redox titration;

6. record observations and measurements in the laboratory notebooks; and
7. Analyse the data to arrive at scientific conclusions.

MAT 111: Elementary Mathematics - 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. Define and explain set, subset, union, intersection, complements, and demonstrate the use of Venn diagrams;
2. Solve quadratic equations;
3. Solve trigonometric functions;
4. Identify various types of numbers; and
5. Solve some problems using binomial theorem.

PHY 111: General Physics I – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

CEE 121: Computer Programming - 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. Describe and apply computing, software engineering knowledge, best practices, and standards appropriate for complex engineering software systems;
2. Develop competence in designing, evaluating, and adapting software processes and software development tools to meet the needs of an advanced development project through practical object-oriented programming exposure taught in concrete terms with a specific modern language –preferable selected from python, java or c++;
3. Use widely available libraries to prepare them for machine learning, graphics and design simulations;
4. Develop skills in eliciting user needs and designing an effective software solution;
5. Recognize human, security, social, and entrepreneurial issues and responsibilities relevant to engineering software and the digitalization of services; and

6. Acquire capabilities that can further be developed to make them productively employable by means of short internet courses in specific areas.

PHY 197: General practical physics I (1unit)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. conduct measurements of some physical quantities
2. make observations of events, collect and tabulate data
3. identify and evaluate some common experimental errors
4. plot and analyse graphs
5. draw conclusions from numerical and graphical analysis of data
6. prepare and present practical reports.

GST112: Communication in English II (2 Units:)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. Advance paragraphs in a logical and coherent manner;
2. Change outlines and create supporting
3. Identify and write topic sentences and attain coherence in written English; sentences
4. Mark various forms of essays (narrative, descriptive, expository and argumentative/persuasive);
5. Distinguish and produce as accurately as possible, the English vowels and consonants;
6. Distribute an effective public speech

GST 118: Peace and conflict resolution (2 Units)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. define and explain the meaning and nature of conflict
2. discuss the causes and types of conflicts
3. discuss issues on conflict analysis, management, resolution and transformation
4. explain the processes of conflict resolution – mediation negotiation, arbitration, litigation, conciliation and so on
5. give detailed explanation of peace education mechanical and production engineering,
6. examine the role of communication and language in conflicts
7. explain the importance of the rules of conflict intervention
8. determine the latent stage of conflict and possible responses
9. discuss and be familiar with global issues and peace-building.

GST 114: Social Sciences (2 Units)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the concepts of geography as a scientific discipline
2. examine the sense of location specification, including an appreciation of forms and structure of nigerian settlement pattern, economic activities and challenges
3. provide understanding on the relationships in economic and political geography of both in history and in the contemporary with the aim of creating environmental consciousness

MEC 112: Basic Engineering Drawing (2 Units)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. elucidate drawing as a means of communication.
2. construct borderlines and dimensioning.
3. illustrate drawing, measuring, lettering and dimensioning of objects in various views/positions;
4. identify the various types of lines, their applications and geometry;
5. demonstrate the geometrical construction of parallel and perpendicular lines, bisection and division of lines,
6. draw construction and bisection of angles.
7. construct triangles, inscribed, ascribed and circumscribed circles of triangle, quadrilaterals, polygons, circle and geometrical construction on circle
8. demonstrate freehand sketching, symbols, conventions an scales

ICH 112: General Chemistry II (3 Units)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. state rules guiding nomenclature and functional group classes of organic chemistry;
6. determine the rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1a, iia and iva elements; and
9. describe basic properties of transition metals.

ICH 198: General Practical Chemistry II (1 Unit)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. state the general laboratory rules and safety procedures;
2. collect scientific data and correctly carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which include ignition, boiling point, melting point, test on known and unknown organic compounds;
5. carry out solubility tests on known and unknown organic compounds;
6. carry out elemental tests on known and unknown compounds; and
7. carry out functional group/confirmatory test on known and unknown compounds which could be acidic/basic/ neutral organic compounds.

MAT 112: Elementary Mathematics II (Calculus) (3 Units)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. identify the types of rules in differentiation and integration;
2. .recognise and understand the meaning of function of a real variable, graphs,

limits and continuity;
3. solve some applications of definite integrals in areas and volumes;
4. solve function of a real variable, plot relevant graphs, and identify limits and idea of continuity;
5. identify the derivative as limit of rate of change;
6. identify techniques of differentiation and perform extreme curve sketching;
7. identify integration as an inverse of differentiation;
8. identify methods of integration and definite integrals; and
9. perform integration application to areas, volumes.

PHY 112 General Physics II (3 Units)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. explain the general properties of waves.
2. describe the general properties of sound.
3. describe what static electricity is and how it originates.
4. demonstrate an understanding of electrical potential.
5. analyse electrical circuits. .
6. define the properties of magnetic fields.
7. clarify how light interacts with lenses and mirrors. .
8. label optical phenomena associated with the wave properties of light.
9. designate quantum theory and how it relates to the model of the atom

PHY 198 General Practical Physics II (1 Unit)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. prepare a written laboratory report that effectively interprets and communicates their results.
2. effectively use computers as a tool for communication, data collection, data analysis.
3. perform at least 10 laboratory activities where students collect, organize and analyse data demonstrating concepts from the 8 major objectives listed above

MME 122 Engineering Materials – 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. list the main classes of engineering materials.
2. enumerate the important properties of each of the main classes of engineering materials.
3. calculate the total energy of an electron in nth orbit.
4. describe the four quantum numbers
5. explain electronic configuration and the aufbau principles.
6. describe the different types of bonding, both primary and secondary bonding, with sketches.
7. name the three most common metal crystal structures and give examples of metals which have each of these crystal structures.

8. sketch the unit cells of bcc, fcc and hcp crystal structures and calculate the packing efficiency of each of them.
9. distinguish between a metal, an alloy and a composite material.
10. explain different fabrication methods in engineering and give examples of products made from each of them.

EEE 221: Applied Electricity I – 3 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. solve the electrical networks mathematically.
2. apply the elementary knowledge of electromagnetism.
3. distinguish between dc and ac circuits and analyse them.
4. explain the basic principles of electric machines.

MEC 223: Engineering Drawing I (2 Units)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. apply multi-view representation techniques accurately to represent objects in different views, demonstrating proficiency in both first and third angle projection methods.
2. create isometric drawings and simple pictorial assembly drawings, accurately representing the spatial relationship between components and assemblies.
3. generate oblique drawings using different techniques such as cavalier, cabinet, and angles other than 45 degrees, effectively communicating the shape and features of objects.
4. apply proper dimensioning techniques, including the selection and placement of dimension lines, the use of tolerances, and the application of gd&t symbols, ensuring clear and accurate communication of size and shape requirements.
5. interpret and create sections and auxiliary views, correctly representing the internal features and hidden details of objects, and apply the appropriate conventions for representing threads, bolted joints, keys, cottered joints, and other mechanical components based on relevant standards such as BS 308

CHE 225: Fundamentals of Fluid Mechanics.
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. explain the general concept of fluid and further identifying the properties of fluids,
2. demonstrate friction effects and losses in laminar and turbulent flows ducts and pipes
3. analyze the concept of dimensional analysis and dynamic similitude
4. explain and illustrate fluids statics conservation laws
5. analyze the phenomena regarding principles of construction and operation of selected hydraulic machinery.
6. identify and use hydro power systems.

CVE 227: Applied Mechanics – 3 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand and apply different coordinate systems and position vectors to analyze the position and orientation of particles and rigid bodies.
2. analyze the kinematics of particles in plane motion in different coordinate systems, including calculating displacement, velocity, and acceleration.
3. apply newton's laws of motion to analyze the kinetics of particles in plane motion, including understanding different types of forces and their effects on individual particles and systems of particles.
4. determine the center of mass of a system of particles and apply it to solve problems related to the equilibrium and motion of systems.
5. analyze simple harmonic motion, including calculating displacement, velocity, and acceleration, and understand the concept of impulse and momentum.
6. analyze the kinematics of a rigid body in plane motion, including different types of motions, relative motion between two points on a rigid body, and constructing velocity diagrams.
7. apply newton's laws of motion to analyze the kinetics of a rigid body in plane motion, including calculating forces, moments, and understanding equilibrium conditions.
8. apply the principles of work and energy to analyze the motion of a system of particles, including calculating work, kinetic energy, and potential energy.
9. apply general energy principles, including the conservation of energy, to analyze and solve problems related to the motion of particles and rigid bodies.
10. understand and apply the concept of virtual work and D'Alembert's principles to analyze the equilibrium and motion of particles and rigid bodies under the influence of constraints and forces.

FEG 227: Engineering Mathematics I. 3units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. carry out addition and subtraction of complex numbers, multiplication of complex numbers, conjugate complex number and division of complex numbers.
2. carry out of addition of two vectors, multiplication of vector by scalars, orthogonal triad of unit vectors, vector products, laws of cross products.
3. describe trigonometric rations and trigonometric identity.
4. explain exponential functions and logarithmic function
5. guide to solving partial fractions, solve denominator with repeated and quadratic factors.
6. carry out arithmetic series, geometric series, geometric mean.
7. see integration as reverse process of differentiation, fine a function whose derivative we already know.
8. carry out addition and subtraction of polynomials, types of polynomials, multiplication and division of polynomials, factor theorem.
9. carry out addition and subtraction of matrices, multiplication of matrices, determinant of matrix, eigenvalues and eigenvectors, linear equations.

CEE 221: Introduction to Modeling and Simulation – 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. demonstrate the fundamental concepts and principles of modeling and simulation

2. apply mastery of use of MATLAB and develop skills in MATLAB scripts, MATLAB arrays, linear models, graphing data in MATLAB, MATLAB array math, advanced graphing in MATLAB, nonlinear functions, nonlinear modeling examples, curve fitting
3. analyze and optimize designs using simulation tools link Simulink..
4. optimize and recognize/ understand the practical link to excite their creativity
5. perform and institute a concept in modeling and simulation for creative innovation.

FEG 221: Engineer-in-Society.

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. differentiate between science, engineering and technology, and relate them to innovation;
2. distinguish between the different cadres of engineering – engineers, technologists, technicians and craftsmen and their respective roles and competencies;
3. identify and distinguish between the relevant professional bodies in engineering;
4. categorise the goals of global development or sustainable development goals (SDGs)
5. identify and evaluate safety and risk in engineering practice.

ENS 222: Introduction to Entrepreneurship Skill – 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. determine capital requirements and ways of Raising capital for certain business;
2. undertake Financial planning and management of business enterprises;
3. develop feasibility studies of different categories of business enterprises;
4. identify possible business opportunities in Nigeria.

EEE 222: Applied Electricity II – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. apply different energy conservation measures and create social awareness on home energy management;
2. identify different part of electrical machines, their characteristics and uses;
3. carry out the measurements of electrical powers;
4. use three phase balanced circuits, PN junction diode, FETs, Communications, Introduction of TV, radio and Telephone system.

CHE 226: Fundamentals of Thermodynamics – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. describe the Basic concepts, and laws of thermodynamics and heat cycles;
2. state first law of thermodynamics and its applications to open and closed systems in solving engineering problems;
3. use the steady state flow equation (Bernoulli's equation) and applications in problem solving in Agricultural and bioresource.

CVE 228: Strength of Materials – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. recognise a structural system that is stable and in equilibrium;
2. determine the stress-strain relation for single and composite members based on Hooke's law;
3. estimate the stresses and strains in single and composite members due to temperature changes;
4. evaluate the distribution of shear forces and bending moments in beams with distributed and concentrated loads;
5. determine bending stresses and their use in identifying slopes and deflections in beams;
6. use Mohr's circle to evaluate the normal and shear stresses in a multi-dimensional stress system and transformation of these stresses into strains;
7. evaluate the stresses and strains due to torsion on circular members; and
8. determine the buckling loads of columns under various fixity conditions at the ends.

FEG 293: Student Workshop Experience (1 Unit)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

9. demonstrate practical knowledge and skills in general engineering, including the operation of hand and powered tools for wood and metal cutting and fabrication.
10. demonstrate a strong understanding of safety protocols and guidelines for using tools and machines, ensuring a safe working environment for themselves and others.
11. apply their knowledge and skills in using tools and machines to complete selected engineering tasks.
12. develop familiarity with various techniques and practices involved in general engineering, demonstrating the ability to select appropriate tools, cut materials, and fabricate components.
13. developed problem-solving abilities in real-world engineering scenarios.

ENS 311: Entrepreneurship Practicum – 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the overview and general concept of entrepreneurship, including its role in fostering natural economic growth and its relevance to youth entrepreneurship development.
2. analyze the characteristics of entrepreneurship and develop an entrepreneurial spirit through effective training methods and initiatives.
3. apply creative thinking and problem-solving techniques to generate and develop innovative business ideas.
4. utilize effective business decision-making techniques to evaluate options and make informed choices in entrepreneurial ventures.
5. demonstrate the ability to identify business opportunities, develop comprehensive business plans, effectively manage businesses, and navigate the specific challenges to entrepreneurship development in Nigeria.

6.

FEG 321: Engineering Mathematics III – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. apply laplace transforms to find solutions for a variety of common functions and use them to solve differential and simultaneous equations in engineering problems.
2. analyze and apply fourier series to study periodic phenomena, enabling the understanding and prediction of periodic signals in engineering applications.
3. utilize the jacobian tensor and transformation techniques to describe and analyze the behavior of multidimensional systems in engineering problems.
4. apply numerical analysis methods, including operational methods and special functions, to approximate solutions for complex engineering problems, ensuring accuracy and efficiency.
5. implement euler and runge-kutta techniques to numerically solve differential equations, demonstrating the ability to model and simulate engineering systems accurately.

MME 341: Manufacturing Technology - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the fundamental concepts of metal deformation and the factors influencing the behavior of metals during forming processes
2. analyze and evaluate various forming processes, such as forging, extrusion, wire drawing, rolling, sheet metal forming, and machining, from both analytical and applied perspectives
3. demonstrate proficiency in the operation and utilization of drilling, boring, grinding, and other material processing machines, including lathe/milling, bending, pressing, and rolling machines
4. apply manufacturing considerations, such as tolerance analysis and the determination of fillet radius, in the design and fabrication of engineering components and structures
5. develop a comprehensive understanding of wood product engineering, including the properties of wood, wood processing techniques, and the design considerations for wood-based products
6. apply theoretical knowledge and practical skills to solve real-world engineering problems related to metal forming processes and wood product engineering, incorporating critical thinking and analysis

MME 343: Welding and Joining Technology - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. demonstrate knowledge and understanding of various types of welding processes, including fusion and non-fusion methods such as electric arc, resistance, and gas welding
2. analyze the historical development of welding and its significance in industrial applications, highlighting the advancements and innovations in welding techniques over time

3. apply different welding processes and techniques, including joint design and the identification of various types of welding joints, to create strong and durable welds in different materials and applications
4. interpret welding specifications, including understanding welding positions, electrode classifications and coding, welding symbols, and quality control measures, to ensure compliance with industry standards and specifications
5. evaluate the structures of welds and the heat affected zone (haz), considering their impact on the integrity and performance of welded joints, and apply appropriate destructive and non-destructive tests to assess weld quality and detect any potential defects or flaws

MME 321: Transport Phenomenon in Metallurgy - 2 Units
Course Learning Outcomes (CLOs): At the end of the course the students should be able to:

1. discuss the principles of energy transport, including fourier's law of heat conduction, and the temperature and pressure dependence of thermal conductivity in gases, liquids, and solids.
2. analyze and apply the theory of thermal conductivity to explain the heat transfer mechanisms in gases, liquids, and solids, as well as the temperature distributions in solids and laminar flow systems.
3. evaluate the concepts of energy transport by radiation and convection, and their applications in various metallurgical processes, such as melting and heat treatment furnaces, ore roasting, sintering, and pelletizing plants, and heat flow in solidification of castings.
4. comprehend the mechanisms of mass transport, including diffusion, and its applications in liquid and solid metals, as well as the simultaneous heat and mass transfer phenomena.

MME 363: Thermodynamics of Materials - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. discuss in-depth the essential concepts of thermodynamics, including the zeroth, first, second, and third laws of thermodynamics, and their application to materials.
2. analyze and interpret thermodynamic properties such as enthalpy of reaction, entropy, and free energy, including gibbs free energy and helmholtz free energy, to predict and understand the behavior of materials in various thermodynamic processes.
3. apply thermodynamic data and principles to predict the stability of phases in aqueous and high-temperature systems, utilizing techniques such as partial pressure diagrams, eh-ph diagrams, and temperature-composition diagrams.
4. analyze the activities and equilibrium of slag-metal and gas-metal systems, considering the interactions and equilibria between different phases in metallurgical processes.
5. apply the clausius-clapeyron equation to understand phase transitions and changes in equilibrium conditions as a function of temperature and pressure, and utilize this knowledge in materials and metallurgical applications.

MME 361: Physical Chemistry of Materials - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the chemical properties, structure, and bonding of solids, and their relevance to materials engineering.
2. analyze and apply chemical kinetics and rate processes to understand the behavior and transformations of materials in various processes, including flow sheeting, reactor design, materials/metals processing, and their impact on the environment.
3. apply principles of phase equilibria in one-component systems, including the behavior of solutions, fugacity, activity, and equilibrium constants, such as raoult's and henry's laws, as well as the gibbs-duhem equation.
4. utilize thermochemistry to analyze and interpret typical metallurgical reactions, including their graphical representations of equilibria, understanding of heterogeneous equilibrium, behavior of solutions, standard states, and electrochemical thermodynamics.
5. apply principles of physical chemistry to materials engineering, making informed decisions in the design, selection, and optimization of materials and processes, considering their chemical and thermodynamic behavior.

MME 309: Fuels, Furnaces and Refractories - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the manufacture and service characteristics of acid, basic, and neutral refractories, and their application in furnaces in relation to their working parameters.
2. analyze the SiO2-Al2O3 system and various refractory minerals, fluxes, and compounds like feldspar and spinel, examining their properties and their role in refractory applications.
3. evaluate the features, processes, and classification of furnaces, including the understanding of heat circulation and furnace efficiency.
4. study different furnace types, such as blast furnaces, electric arc furnaces, cupola furnaces, converters, etc., including their design, operation, and applications in metallurgical processes.
5. examine the composition, properties, and combustion of metallurgical fuels, including solid, liquid, and gaseous fuels, and perform calculations related to fuel combustion.
6. understand the principles of temperature measurement and temperature control in furnaces, including the techniques used for accurate temperature monitoring and regulation in metallurgical processes.

MME 305: Engineering Communication - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. develop proficiency in using professional english language for writing letters, ensuring effective communication and proper tone in professional correspondence.
2. master the art of writing specification descriptions, providing clear and concise details about technical requirements, standards, and specifications for various engineering projects.

3. learn how to effectively present charts, graphs, and tables in a professional manner, ensuring clarity and proper interpretation of data and information.
4. acquire skills in writing proposals for reports, including the ability to clearly articulate project objectives, scope, methodology, timeline, and budget, while maintaining a professional tone.
5. analyze and present case studies of major engineering designs and construction/fabrication projects, highlighting successful examples and identifying lessons learned from industrial failures, employing professional writing techniques.
6. develop professional presentation skills for delivering reports and proposals, including effective use of visual aids, concise and persuasive language, and confident delivery to engage and communicate with stakeholders.

FEG 322: Engineering Mathematics IV – 3 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. use Mathematical tools in solving complex Engineering mathematical problemes.
2. employ Simple approach in Solving Numerical integration, Laplace transformation , various level of differential equations.
3. explain and Calculate Sturm-Liouville Boundary value problems and Fouries Series Partial Differential Equation.
4. discuss and Solve Linear, Homogenous and Partial differential equations of 9th order with Constant Coefficients.
5. explain and use different techniques in solving Integral Transforms .

MME 342: Foundry Theory and Practice - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the basic definitions and fundamental concepts of foundry practice, including metal casting and sand casting.
2. demonstrate knowledge of the design principles and techniques for castings, molds, and cores in foundry processes.
3. evaluate the quality and characteristics of foundry sand and its impact on casting outcomes.
4. analyze the solidification mechanism, including nucleation and rate of cooling, in metal casting.
5. apply the principles of riser and gating system design and placement for efficient casting production.
6. assess the interaction between the mold and molten metal, identify and address casting defects, and understand the stress-strain relations and casting properties of metals and alloys. additionally, analyze the economic efficiency of different casting methods and the importance of heat treatment in the casting process.

MME 324: Engrg Mats: Structure Ppties and Heat/Treatment
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the basic structure of metals, ceramics, polymers, metallic alloys, and composites, and their relationship to mechanical, electrical, magnetic, optical, thermal, and chemical properties.
2. identify and explain the principles and processes involved in heat treatment and phase transformations of materials.
3. analyze the structures and properties resulting from various heat treatments, including the formation of austenite, pearlite, bainite, and martensite in steel.
4. evaluate the decomposition of austenite, continuous cooling, isothermal transformation, cooling curves, and ttt diagrams.
5. apply knowledge of quenching, hardenability, tempering, austempering, martempering, annealing, and normalizing processes to achieve desired material properties.
6. describe the structure, properties, and heat treatment considerations of important commercial alloys such as aluminum, copper, titanium alloys, cast irons, stainless steels, tool steels, and nickel, nickel-iron, and cobalt superalloys.

MME 362: Mineral Processing - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the origin and formation of mineral deposits and identify the principal ores of common metals.
2. apply theoretical principles and practical techniques of comminution and liberation in crushing and grinding processes, including the selection and limitations of equipment.
3. explain the principles of sizing and classification in mineral processing, including the use of laboratory and industrial equipment, settling of solids in fluids, and various types of classifiers.
4. evaluate gravity concentration methods, such as jigging, spirals, tables, and heavy media separators, and their application and limitations. understand the physicochemical principles of froth flotation and its application in the flotation of simple ores. describe the use of electrostatic and electromagnetic methods of concentration.
5. analyze the theory and practice of dewatering and drying in mineral processing, including thickening, filtration, and drying processes. understand the principles of coal/washing, including coal/shale separation and coal flotation and cleaning.
6. interpret simplified flow sheets for the beneficiation of simple ores of copper, tin, lead, zinc, iron, gold, and other locally important ores.

MME 352: Mechanical Metallurgy I - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. apply stress-strain relations to determine principal stresses, strains, and directions using the mohr circle and strain gauges
2. analyze elastic and plastic deformation in single crystals and polycrystals, including plastic yield criteria
3. describe the concepts of dislocations, dislocation density, and dislocation motion and their role in material deformation

4. explain the various deformation mechanisms in metals, such as slip, twinning, grain boundary sliding, creep, and stress rupture
5. evaluate the analytical and applied perspectives of metal deformation processes, including forging, rolling, extrusion, stamping, wire drawing, and sheet metal forming
6. assess the effects of cold working, hot working, and annealing on the mechanical and physical properties of materials

MME 332: Physical Metallurgy 1 - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand crystal structure and the concept of crystallographic planes and directions. apply miller indices to describe crystallographic orientations.
2. identify and analyze imperfections and defects in crystalline materials, including vacancies, interstitials, dislocations, and grain boundaries.
3. explain the role of dislocations in plastic deformation and strain hardening of materials.
4. 4describe diffusion in solids and apply fick's 1st and 2nd laws of diffusion. differentiate between interstitial and substitutional diffusions.
5. analyze phase equilibria and equilibrium diagrams for pure metals and alloys. understand the vapor-liquid and liquid-solid solidification processes.
6. explore solid-state transformations, including nucleation, cellular, and displasive transformations.
7. examine precipitations from solid solutions, recovery, recrystallization, and grain growth. understand the interfaces and interfacial reactions in liquids and solids.

MME 395: Laboratory Practical I (2 units C: PH 90)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. demonstrate fabrication methods such as forging, extrusion, rolling, sheet metal forming
2. show how orthogonal & oblique cutting are carried out on a lathe
3. calculate machining time for cylindrical turning on a lathe
4. welding and brazing joints (using arc, mag, brazing) and evaluate the heat-affected zone of a weldment (macro and micro examination)
5. explain the melt mass flow rate (mfr) of engineering materials
6. evaluate the calorific value of coke using a bomb calorimeter, proximate analysis of coal and coke

MME 390: SIWES II – 3 Units
Third year student vacation programme.

400 LEVEL MME
MME 441: Synthesis, Processing, and Manufacturing of Materials - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. demonstrate a comprehensive understanding of the composition, structure, and properties of principal alloy, ceramic, and polymer systems

2. analyze and evaluate the effects of different processing techniques on the physical and mechanical properties of materials
3. apply design fundamentals to the selection of materials and the examination of material/design case studies for manufacturing applications
4. investigate the relationship between processing methods and material properties to optimize manufacturing processes and improve material performance
5. demonstrate proficiency in analyzing and interpreting data related to the effects of processing on material properties
6. develop critical thinking and problem-solving skills by proposing innovative approaches to synthesis, processing, and manufacturing of materials

MME 463: Extractive Metallurgy 1 - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the principles of current hydrometallurgical practices in mineral processing, metal extraction, and recovery
2. apply thermodynamics and kinetics principles to analyze and evaluate hydrometallurgical processes, including leaching, solvent extraction, and ion exchange
3. demonstrate knowledge of the extractive metallurgy of rare earth metals, including their extraction and refining processes
4. identify and describe the extractive metallurgy processes for nonferrous metals native to nigeria, such as tin, columbite, gold, lead, and others
5. analyze the environmental and economic aspects of hydrometallurgical processes in extractive metallurgy and propose sustainable solutions
6. apply critical thinking and problem-solving skills to address challenges and emerging technologies in hydrometallurgy for mineral processing and metal extraction

MME 475: Laboratory Practical II (2 Units C: PH 90)

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. explain the relationship between engineering stress and engineering strain according to the results obtained from tensile tests and hence obtain graphically the tensile strength or ultimate tensile strength, yield stress, and offset yield (proof) stress.
2. identify machines used to measure hardness, toughness, ductility, etc., and how they function.
3. produce specimens for ductility, hardness, toughness, etc., tests and carry out these tests on them.
4. conduct corrosion experiments and calculate corrosion rate through the weight loss method.
5. deduce physical and mechanical properties of materials from data generated from xrd, sem, eds, etc.
6. observe the behavior of any material under compression conditions (press or scratch).

MME 451: Material Engineering Design - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. apply physical, chemical, and mechanical principles to design devices, components, and systems
2. utilize computer-based design tools, such as powerpoint and matlab, to analyze problems and develop solutions
3. incorporate economic and ethical principles in the design process, considering cost analysis and sustainability
4. demonstrate effective communication skills through oral and written presentations of design concepts and solutions
5. work collaboratively in teams, demonstrating shared responsibility and teamwork in the design and development of devices and systems

MME 471: Corrosion Science and Engineering - 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the theories of corrosion and classify corrosion into different types based on fundamental causes
2. analyze electrochemical reactions involved in corrosion processes and apply knowledge to predict corrosion rates and prevent corrosion
3. evaluate and select corrosion prevention methods and materials based on their effectiveness in different environments
4. apply principles of basic chemistry, electrochemistry, and thermodynamics to explain corrosion phenomena and passivity in materials
5. investigate case studies of corrosion in various materials, such as stainless steel and cast iron, to identify common corrosion problems and failures
6. demonstrate knowledge of corrosion testing, monitoring, and control techniques, including cathodic and anodic protection methods

MME 403: X-ray Diffraction & Analytical Techniques – 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the principles of x-ray diffraction and its application in crystallography for the determination of crystal structures
2. analyze the bragg law and its significance in x-ray diffraction experiments for studying crystal structures and obtaining information about lattice parameters
3. utilize various x-ray diffraction methods, including the laue, rotating crystal, and debye-scherrer powder methods, for crystal structure analysis
4. operate diffractometers, spectrometers, and counters, and apply counting ratemeter and scalar circuits in x-ray diffraction experiments
5. apply fluorescent x-ray spectroscopy for chemical analysis using diffraction and spectroscopic methods and understand the principles behind these techniques
6. demonstrate knowledge of various electro-optical techniques for microstructural examination, such as Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Scanning Tunneling Microscope (STM), and Atomic Force Microscope (AFM)
7. understand other analytical techniques, including Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS), Auger Electron Spectroscopy (AES), Energy Dispersive X-ray Spectroscopy (EDS or

EDX), X-ray Photoelectron Spectroscopy (XPS), and Atomic Absorption Spectrophotometry (AAS)

MME 411: Ceramics & Glass Engineering – 2 UNITS

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the classifications of ceramics, including glass, clay, refractory, abrasive, and cement, and their unique properties and applications
2. analyze the atomic bonds and oxide structures in ceramic systems, such as caesium chloride, sodium chloride, perovskite, spinels, etc , and relate them to the properties and behaviors of ceramics
3. evaluate the structures of crystalline ceramics, including silicate structures, types of silicate structures (chain silicates, sheet silicates), and the concept of polymorphism in ceramic materials
4. interpret phase diagrams in ceramic systems and apply them to understand the relationships between composition, structure, and properties in ceramics
5. demonstrate knowledge of clay processing and component manufacture, including the techniques involved in shaping, firing, and forming clay-based ceramics
6. examine the constituents and functions of glass, distinguish different types of glasses (e g , pyrex, boro-silicate, fiber glass), and comprehend the properties, classifications, fabrication, and heat treatment of glasses

MME 433: Principles of Phase Diagrams - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the principles of phase equilibria and the gibbs phase rule for predicting and analyzing the stability of different phases in a system.
2. analyze unary and binary phase diagrams, including isomorphous phase diagrams, to interpret the phase relationships and transformations in materials.
3. identify and explain the behavior and characteristics of binary systems with eutectic, eutectoid, peritectic, peritectoid, monotectic, and syntectic reactions.
4. evaluate the effects of coring, envelopment, and liquation on microstructure in eutectic, isomorphous, and binary systems, and understand the modification techniques for eutectic alloys.
5. apply tie-lines and the (inverse) lever rule for determining phase compositions and proportions in binary systems, and comprehend their significance in phase transformations and equilibrium.
6. introduce the concept of ternary equilibrium diagrams and their applications in understanding complex systems, and explore different methods for the experimental determination of phase diagrams.

MME 490: SIWES III – 6 Units

Six months industrial Training for the student.

500 LEVEL

MME 501: Engineering Management – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the principles of organization and management and apply them to effectively manage engineering projects and teams.
2. demonstrate knowledge of financial management principles, including accounting methods, financial statements, cost planning and control, and budgeting, to make informed financial decisions in an engineering context.
3. apply personnel management techniques, such as selection, recruitment, training, job evaluation, and merit rating, to effectively manage human resources in engineering organizations.
4. apply resource management principles, including contracts, interest calculations, rate of return, and economic evaluation methods, to make optimal resource allocation decisions in engineering projects.
5. apply planning and decision-making techniques, including forecasting, scheduling, production control, gantt chart, cpm, pert, and linear programming, to effectively plan and manage engineering projects and optimize resource utilization.
6. understand the principles of work study, motion economy, and ergonomics and apply them to design efficient equipment, processes, and workplace layouts in engineering settings.

MME 551: Metallurgical Engineering Equipment and Plant Design - 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the fundamental concepts of metallurgical equipment and plant design.
2. identify and evaluate various metallurgical processes and their requirements.
3. evaluate different types of metallurgical equipment and their selection criteria.
4. apply design principles to optimize the performance of metallurgical processes and equipment.
5. analyze safety considerations and risk management strategies in metallurgical plant design.
6. incorporate environmental and sustainability factors in equipment and plant design.
7. perform economic evaluations and cost analysis for metallurgical plant design projects.
8. demonstrate effective project management and communication skills for equipment and plant design.

MME565: Chemical Metallurgy - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the thermodynamic principles governing the extraction of metals from their ores and apply them to metallurgical processes.
2. analyze and apply the kinetic principles involved in various metallurgical processes, such as roasting, agglomeration, briquetting, nodulizing, pelletizing, sintering, smelting, converting, and refining.
3. evaluate the oxidation and reduction processes in metallurgy and their role in the extraction and purification of metals.

4. assess the techniques and methods used for desulphurization and dephosphorization in metallurgical processes and their significance in achieving high-quality metal products.
5. analyze the properties and functions of metallurgical slags and fluxes and their role in the refining and purification of metals.

MME 553: Powder Metallurgy - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. explain the meaning of powder metallurgy and appreciate the numerous advantages powder metallurgy has over other conventional engineering manufacturing processes.
2. categorize the wide scope of powder metallurgy industry and the global market outlets available for powder metal products.
3. describe the various methods by which metal powders are produced, the nature of the powders produced, the shapes and characteristics of the individual powder particles and powder mass.
4. explain the methods of manufacturing powder products, tools and equipment employed, and the optional/secondary operations carried out on the powder products after manufacture.
5. describe the criticality of design of dies to be able to handle the product during compaction to ensure easy withdrawal while retaining part geometry and shape.

MME 513: Polymeric Materials Engineering - 3 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the fundamental principles of polymer chemistry and the synthesis of organic polymeric materials.
2. analyze the molecular structure of polymers and its impact on the properties and behavior of thermoplastic and thermosetting polymers.
3. evaluate the structure-property relationships in polymers and their influence on the performance and applications of polymeric materials.
4. explore the manufacturing processes involved in the production of organic polymeric materials and their implications for material properties and performance.
5. apply the knowledge of polymer chemistry and structure-property relationships to the selection and design of polymeric materials for specific applications.

MME 531: Physical Metallurgy II - 2 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand phase transformations in metallic systems, including allotropy, polymorphism, and order-disorder transformations.
2. analyze the formation and properties of substitutional and interstitial solid solutions, as well as intermediate phases such as intermetallic and electron compounds.

3. examine diffusion theory and its application to understanding diffusion processes in metallic systems, including fick's first and second laws and the kirkendall effect.
4. investigate the behavior and properties of dislocations in crystals, including dislocation theory, dislocation density, and dislocation reactions in different crystal lattices.
5. evaluate the effects of dislocations on plastic deformation, strain-hardening, and the mechanical behavior of metals.
6. explore the interaction of dislocations with point defects and second-phase particles, as well as the role of jogs, kinks, and dislocation multiplication in dislocation motion and lattice resistance stress.

MME 577: Laboratory practical III 2 units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. prepare specimen for micro examination.
2. observe the grains of the specimen under microscope.
3. evaluate the hardenability of steel and relate it to material selection to avoid thermal stress and distortions.
4. Heat steel to appropriate temperature, and quenching using different quenching media
5. List the differences between hardness and hardenability
6. Carry out size analysis using laboratory sieves

MME 577: Laboratory Practical III (2 units C: PH 90)
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. prepare specimen for micro examination.
2. observe the grains of the specimen under a microscope.
3. evaluate the hardenability of steel and relate it to material selection to avoid thermal stress and distortions.
4. heat steel to an appropriate temperature and quench using different quenching media.
5. list the differences between hardness and hardenability.
6. carry out size analysis using laboratory sieves.

MME 562: Iron and Steel Making/Heat Treatment Practice - 3 Units
Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the raw materials and agglomeration techniques used in iron making, including pelletizing, briquetting, sintering, and ore blending.
2. analyze the two main production routes for iron and steel: blast furnace and direct reduction processes, and perform charge and combustion calculations for these furnaces.
3. examine the different steel making processes, including open hearth furnaces, electric arc furnaces, converters, and their energy utilization.
4. understand the blast furnace/basic oxygen furnace and direct reduction/electric arc furnaces routes in steel making.

5. evaluate secondary steel making processes and their significance in the overall steel production.
6. study the properties and applications of industrially important ferrous alloys and their selection for specific heat treatments to achieve desired fabrication and service properties.
7. apply the principles of heat treatment to produce steels suitable for various applications and understand the impact of heat treatment on the properties and performance of steel products.

MME 502: Engineering Law – 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the history, nature, and division of common law, including its significance in the legal system.
2. explore legislation, including its codification and interpretation, and understand its role in shaping legal principles.
3. examine the concept of equity, its definition, and its main spheres of application within the legal framework.
4. analyze the fundamental principles of contract law specifically related to engineering, including offer, acceptance, communication, and termination
5. gain knowledge of general principles of criminal law, including key concepts and their application in legal proceedings.
6. study the law of torts, including its definition, classification, and liabilities, and understand its relevance to engineering practices and potential legal consequences.
7. explore intellectual property law, including patents, registered designs, and their requirements, applications, types, infringement, as well as the basics of company law, labor law, and industrial law.

MME 564: Extractive Metallurgy II - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the principles and concepts of electrometallurgy, including conductance, transference cell types, and potentials
2. analyze the conduction mechanisms in electrolytes and their significance in extractive metallurgy processes.
3. evaluate current and energy efficiency in electrometallurgical processes and their application in the production of aluminum, electrorefining of nickel and copper, and electroplating.
4. examine interfacial phenomena, such as surface energy, surface tension, and the three-phase interface, and their relevance to extractive metallurgy.
5. explore the electrical double layer, absorption, nucleation, evaporation, and flocculation in relation to metal extraction processes and their practical applications.

MME 532: Solid State Materials and Technology - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. acquire a deep understanding of the fundamental concepts of solid state materials, including their structure, bonding, and crystallography.
2. critically analyze the relationship between the structure and properties of solid state materials, considering factors such as defects, impurities, and their impact on mechanical, electrical, and magnetic properties.
3. apply their knowledge of solid state materials to solve real-world problems and explore their applications in various technological fields, such as electronics, energy storage, and advanced materials engineering.
4. develop the ability to design and conduct experiments to characterize and analyze solid state materials, utilizing techniques such as x-ray diffraction, spectroscopy, and thermal analysis.
5. effectively communicate their understanding of solid state materials through oral and written presentations, demonstrating their ability to convey complex scientific concepts, experimental findings, and research outcomes in a clear and concise manner.

MME 554: Mechanical Metallurgy II - 2 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

1. understand the flow and fracture behavior of engineering materials and the theoretical cohesive strength of solids.
2. analyze stress concentration, crack-tip stresses, and plastic zones in relation to fracture mechanics.
3. apply linear elastic fracture mechanics principles, including the griffith and orowan theories, to determine fracture toughness and plastic zone sizes.
4. conduct fracture toughness testing and understand its practical application in materials evaluation.
5. evaluate the effects of temperature and metallurgical variables on fracture behavior, including environment-assisted cracking (stress corrosion) of metals.
6. examine the theories of creep, stress rupture, and fatigue, including micromechanisms of creep and the basic equations and parameters associated with creep and fatigue life.

MME 599: Project – 3 Units

Course Learning Outcomes (CLOs): Upon completion of this course, students will be able to:

7. formulate a clear and well-defined research problem or project objective.
8. conduct a comprehensive literature review to gather relevant information and identify gaps in existing knowledge.
9. design and implement a systematic methodology or approach to address the research problem or achieve the project objective.
10. collect and analyze data using appropriate research methods and tools.
11. interpret and evaluate the results of the research or project, drawing meaningful conclusions and making relevant recommendations.
12. communicate the findings, methodology, and outcomes effectively through written reports and oral presentations.