

Department of Agricultural and Bio-Resources Engineering
Ahmadu Bello University Zaria
Courses Content

CHEM 101 INTRODUCTION TO GENERAL CHEMISTRY (2 CREDITS)

Atoms; molecules; elements and compounds; laws of chemical combination; the mole concept; gross features of atomic structures; periodic table; chemical bonding and shape of molecules; oxidation & reduction reactions; general concept of acids and bases; hydration and hydrolysis; and weak and strong electrolytes.

CHEM 121 INTRODUCTION TO INORGANIC CHEMISTRY (2 CREDITS)

Periodic table (gradation of physical and chemical properties within the table, the first transition elements series, comparison of chemistry of the elements of periods II and III); transition metal complexes (nomenclatures, isomerism and hybridization involving d-orbitals).

CHEM 161 INTRODUCTION TO PRACTICAL CHEMISTRY I (1 CREDITS)

Basic apparatus; terminologies; safety regulations; basic working skills in the chemical laboratory; acid-base titration; redox titration; weighing and gravimetric analysis.

COSC 101 PROGRAMMING IN BASICS (2 CREDITS)

ENGG 101 INTRODUCTION TO ENGINEERING(1 CREDITS)

Development of professional engineering history of technology and its effect on society, the engineering institutions, their objectives and functions. Data measurement, representation and interpretation, report writing and oral presentation of information.

GENS 101 NATIONALISM (1 CREDITS)

GENS 102: ENVIRONMENTAL HEALTH

Health: Concept of environment: Concept of health: Concept of environmental health. Relationship between environmental hazards and their effects on health. Environmental hazards and examples. Sources of environmental hazards. Effects on Human health. Control of environmental hazard. ACCIDENT Definition, Distribution, types, human factor, causes, control of Accident, prevention should focus on, first Aid, contributions of students to environmental protection. The need, their contributions leadership. Violence at Home and society, definition of Violence. Type of violence. Cause of violence. Cultural values that constitute violence in the family. Prevention and control of violence Conservation of Natural resources. Soil Air Water relationship. Soil Water plant relationship. Plant Animal Man relationship. Environmental friendly situation. Conservation of renewable and non-renewable natural resource. Need for environmental impact assessment studies.

GENS 103 ENGLISH FOR COMMUNICATION SKILLS (2 CREDITS)

Speaking Skill: Active listening skills, Electing views and comments, Agreeing and disagreeing techniques, Persuasions and counter argument, Clarifying and checking skills Interrupting skills, Signaling devices, Body language, meetings, presentation. Pronunciation: Problems individual sounds Elements of connected speech, intonation and pitch. Reading: Skimming and scanning, identifying main ideas, Understanding gist. Listening: Listening for gist and specific information, Note taking, Prediction. Writing: understanding purpose, planning and organization, Style and register changing conceptions of electronic media. Structure and Vocabulary: Overview of tense system, principles of word grammar, common idiomatic language, common transfer error Modifying techniques, hypothesis and like hood.

GENS 107 HISTORY OF SCIENTIFIC IDEAS (1 CREDITS)

MATH 101 SET THEORY AND NUMBER SYSTEM (2 CREDITS)

Sets (definition of a set, finite and infinite sets, equality of sets, subsets, union, intersection, universal set, complements, empty set, Venn diagram, symmetric difference, power sets, De-Morgan theorems, inclusion-exclusion principle, elements of relations and functions); some properties of number systems (natural numbers, integers, rational, irrational and real, order relations in the set of real numbers, open and closed intervals on the number line); complex numbers (definition of a complex number, addition, multiplication and division, geometric interpretation modulus and conjugation, polar representation, De Moivre's theorem, nth roots of a complex number, nth roots of unity).

MATH 103 TRIGONOMETRY AND NUMBER SYSTEM(2 CREDITS)

Circuit measures (trigonometric ratios of angles of any magnitude, inverse trigonometric functions); addition formula ($\sin (A-B)$, $\cos (A-B)$, $\tan (A-B)$ and their proofs, multiple and half angles, solutions of simple trigonometric equations, factor formula, solution of triangles heights and distances including three-dimensional problems); plane polar co-ordinates (relation between polar and Cartesian co-ordinates, plotting and sketching of simple curve whose polar equations are known); co-ordinate geometry of lines and circles (pair of straight lines and system of circles with emphasis on concepts rather than formulae).

MATH 105 DIFFERENTIAL AND INTEGRAL CALCULUS (2 CREDITS)

Functions of real variable (odd, even periodic functions and their symmetries, graphs limits and continuity); differentiation (first principle techniques of differentiation in general, higher derivatives); integration (integration as the inverse of differentiation, techniques of integration in general, definite integral); Rate of change (velocity, acceleration and other rates); curve sketching (asymptotes, maxima and minima, small increments, approximations and errors, newton's approximation, simple application of integration to areas and volumes); differential equations (first order differential equations only).

PHYS111: MECHANICS (2 CREDITS)

Unit and Dimensions; Dimension methods for checking correctness of equations and for deriving simple relations; vectors and Scalar Quantities; projectiles; Newton laws; Conservation laws; linear Motion; Concept of Force; Elastic Collisions; Work, Energy and power; Circular Motion; simple Harmonic motion; Motion of rigid body; Statics, Gravitational potential circular orbit, escape velocity.

PHYS131: HEAT AND PROPERTIES OF MATTER (2 CREDITS)

Structure of solids, liquids and gases; kinetic theory of ideal gases; Elasticity, Surface Tension; Fluids in motion: Solid Friction and viscosity; Bernoulli's law, Aerofoil; thermodynamics; EM radiation provost's theory of heat exchange; thermal radiation detectors; optical pyrometer; Calorimetric; Thermal Expansion and Heat Transfer.

Course Contents for 200 Level to 500 Level

MEEN201 ENGINEERING GRAPHICS (2 CREDITS)

The Principles of Engineering Drawing Engineering Lettering, Figures and Types of lines (BS 308 – 1972, Part 1, 2, 3). Dimensioning, Useful geometrical constructions. Principles of tangency, Local – conic sections (ellipse, hyperbola, parabola). Cycloids, epicycloids, involutes, helices. Orthographic projection (1st and 3rd angle orthographic projection).

MEEN202: ENGINEERING DRAWING (3 CREDITS)

Isometric projection, Free-hand sketching. Sections and sectional views. Auxiliary projections. Interpenetration of surfaces. Development of surfaces. Screw thread and threaded screwed fastenings. Conventional representation on the threaded elements on drawing.

MEEN204: STRENGTH OF MATERIALS I (2 CREDITS)

Direct stress and strain: tension, compression. Hook's Law, elastic constants, strain energy, impact load, thermal stress. Geometrical properties of areas: Centro, first and second moments of area, parallel axis theorem, product moment of area, cross-sections having and not having axes of symmetry, simple theory of bending; Classification, bending moment and shear force diagrams, relations between bending moment, shear force and load, bending stress; section modulus; strength requirements; compound bars; deflection of beams. Simple shear; Shear force; shear stress; shear strain; Hooker's Law; technical shear. Torsion of circular cross-sections: Torque diagram; angle of twist; shear stress due to torsion; transmission of power by shafts; Helical springs. Special Problems: Statically indeterminate problems; thin cylinders and spheres under pressure.

Analysis of the plane stress. Principal stresses and maximum shear stress. Mohr's Circle for 2 and 3 dimensional states of stress. Simplified analysis of three dimensional state of stress. Analysis of plane strain. Simplified analysis of three-dimensional state of strain. Mohr's Circle of strain. Strain rosettes. Generalized Hooke's law. Strain energy in tension, shear, torsion and bending Castigliano's Theorem and its applications. Linear and angular deflections and statically indeterminate problems. Strength theories. Condition of failure and strength. Combined stresses in bending and torsion. Basic equations in theory of elasticity and their applications to thick cylinders. Theory of columns. Critical load and critical stress. Euyler's theory and its limitations. Short, medium and long struts. Standards for design of members in compression. Open coiled and closed-coiled springs under axial load and torque. Parallel and series arrangements of springs. Bending of curved bars of small initial curvature. Lead springs. Fatigue of metals and mechanism of fatigue failure. Endurance limit. Fundamentals of rheology. Creep and creep rate. Relaxation. Creep strength and creep limit. Hardness of metals

MEEN 206: FUNDAMENTALS OF DYNAMICS (2 CREDITS)

Kinematics of particles: rectilinear motion, plane curvilinear motion, appropriate choice of reference frame in solving problems. Relative motion, translating axes. Kinetics of particles: Newton's second Law of Motion, Work and Kinetic energy method for deriving equations of motion, Impulse and momentum. Kinetics of systems of particles: Defining equations, Steady mass flows, Variable mass problems. Plane kinematics of rigid bodies; Absolute motion, Relative Velocity, Instantaneous center of zero velocity, Relative acceleration. Plane kinetics of rigid bodies: General equation of motion, Translation, Fixed-axis rotation. General plane motion, Work energy relations, Impulse and momentum equations for rigid bodies.

MEEN 208: BASIC THERMODYNAMICS (2 CREDITS)

Dimensions and Units: (S.I. Units to be Introduced): Fundamental concepts: Energy i.e. Potential, Kinetic, internal; property, state, process and cycle system and surroundings; pressure; temperature, Zeroth law, arbitrary nature of temperature, scales; equilibrium reversibility, heat and work.

First Law of Thermodynamics: As applied to closed and flow systems, and in the cyclic and con-cyclic (process) forms, as well as in the differential form; Application to particular processes of constant volume; constant pressure, Isothermal, adiabatic, polytropic and throttling; the flow energy equation and its application to turbines, compressors, nozzles, boilers, condensers, heat exchangers (treated as black boxes only).

Second Law of Thermodynamics: Definition of heat engines, Cannot cycles, thermodynamic temperature scale, entropy (as a property) **Properties of Pure Substances:** Condensible fluids: T-P diagram, P-V diagram, the two-phase mixture, T-S diagram, h-s diagram, the use of property tables and diagrams **Perfect Gases:** Properties of perfect gas; entropy changes in perfect gases.

MEEN301: MACHINE DESIGN I (2 CREDITS)

Introduction to machine design: Sciences involved: components; units and assemblies of machines; main trends in developments of machine design. Selection of materials sequence in machine design. Loads in machines. Factor of safety. Allowable stress. Economy in design. Standard in Machine Design: N. S. O. Standards, system of fits and limits.

Dimensional and geometrical telegraphing. Interchangeability. Surface texture; marking machine surfaces. Standard machine elements. Marking of riveted, welded and threaded joints on engineering drawing. **Design of Joints:** Riveted Joints: Friction effect: strong and tight-strong joints for structures and pressure vessels. Welded Joints: methods of welding; strength calculations of welded joints. Threaded Joints: Classification; standards. Combined loads. Forces and deformations of joined parts. Power screws, Strength and efficiency. Key and pin Joints: Unstrained; Strained, fixed and sliding joints. Short Design Assignments: 1. Jockey Pulley Assembly drawing; 2 Knuckle joint. Scope: Calculation, workshop and assembly drawings, technical description on production, operation and maintenance.

MEEN 302: MACHINE DESIGN II (2 CREDITS)

Shafts and Axles: Classification, loads, fatigue considerations; materials. Application of strength theories. Types of shafts. Axles and shafts of uniform strength. Stiffness of shafts (deflection and tensional stiffness). Axles and shafts of uniform strength. Stiffness of shafts (deflection and tensional stiffness). **Transverse vibration:** Critical velocity of shafts, semi-graphical method of shaft design. Geometry of shafts. **Power transmissions:** Types of driver; belt transmission, Euler's equation; stresses in belts; flats, veer and toothed belts. Geometry of belt pulleys. Toothed gears; Classification and shapes of teeth. Spur gears. Geometry. Standard modules. Calculations for Strength and wear. Materials selection; velocity; machining; lubrication. **Gear Trains:** Velocity ratio and efficiency; service life; minimum number of teeth. Diagrammatic (simplified) representation of various drives. Toothed gears in engineering drawing,

dimensioning.. Cast and welded gears. Short Design Assignments. 1. Pressure vessel; 2 Screw jack Scope: Calculation, workshop and assembly drawings technical description on production, operation and maintenance.

MEEN303: TOOLS (2 CREDITS)

Principle parts, kinematics, and varieties of selected machine tools such lathes, milling machines, drilling machines, shapers and slitters, broaching machines, grinding machines and other specialized machines.

Jigs and fixtures: Principles of design, methods of locations and clamping

Theory of metal cutting: Detailed geometry of cutting tool angles: Cutting forces and temperatures;

Theory of metal cutting: Detailed geometry of cutting tool angles: Cutting forces and temperatures; the variables of metal cutting: - Speed, feed, rake angle, energy and power, tool wear and life; cutting tool materials; cutting fluids (coolants); economics of metal cutting (cutting speed, feed and depth of cut and their effect on tool life, criteria of selection of a suitable machine tool, example).

MEEN304: STRENGTH OF MATERIALS III (1CREDIT)

Plane state of stress: Stress and strain components for a 3-D and 2-D state of stress; transformation of stresses; principal, normal and maximum shear stresses; Mohr's circles, hooke's law. Strain Energy Methods: Castilian's First and Second. Theorem and heir applications (linear and angular deflections, statically indeterminate cases). Buckling: Euler's theory of elastic buckling critical load and stresses; long, short and medium columns. Shear stresses in thin-walled open sections: Distribution of shear stresses across sections: Distribution of shear stresses across sections; centre of twist. Strength Theories; Combined stresses; bending and shear; and torsion (calculation of shafts).

MEN305: STRENGTH OF MATERIAL II (1 CREDIT)

Thick Cylinders: Lane's Theory: Open and close conditions for cylinder under internal pressure; compound cylinders. Bars of small initial curvature: Bending moment; shear force and normal force diagrams; leaf springs. Bars of large initial curvature: Theory and simplifying assumptions; crane hooks. Fatigue of materials; Forms of stress cycle; N-N Curves; smith and height graphs safety factor.

MEEN306:DYNAMICS OF MACHINERY II (2 CREDITS)

Kinematics of mechanisms; in a rotating reference frame; coriolis component of acceleration. Kinematics of simple, compound and epicyclical gear trains. Balancing of rotating masses. Crank effort and crank effort diagrams; Flywheels. Friction: Friction clutches; belt drives and band brakes.

MEEN307:DYNAMICS OF MACHINERY I (2 CREDIT)

Force analysis of machinery: Inertia force, inertia torque methods of linkage force analysis, engine force analysis. Kinematics of the hook's joint. Kinematics and Kinetics of centrifugal and inertia types governors
Balancing of reciprocating masses: Primary and secondary forces and moments; in-line engines; veer and radials engines; method of direct and reverse cranks. An introduction to the kinematics and kinetics of Cam mechanisms.

MEEN308: INTERNAL COMBUSTION (2 CREDITS)

Various types of internal combustion engines (spark ignition compression ignition, two stroke, four stroke and Wankel Engine). Various cycles of internal combustion engines (the air standard cycle. Otto, diesel, Joule and dual cycles). Rating of fuels for internal combustion engines (detonation, knocking and misfiring). Engine performance parameters (compression ratio, indicated pressure and power, engine capacity, mean effective pressure). Relationship between factors affecting performance of engines (torque, power, fuel consumption versus speed, efficiency versus compression ratio)

MEEN309: APPLIED THERMODYNAMICS (2 CREDITS)

Reciprocating Compressors: Brief mention of need for economic delivery pressures of reciprocating compressors. Distinction between reciprocating and rotary compressors and applications including advantages and disadvantages of each. Compressor cycle (including clearance volume and effect of clearance). Staging of compressors and efficiency (isothermal and isentropic). Inter-cooling, after cooling and optimum interstage pressure. Mixtures of perfect gases. Dalton's and Avogadro's Laws. Gibbs-Dalton Law. Properties of mixtures. Humid air (Psychrometric) the Psychrometric chart. Application to air conditioning cooling towers and steam condensers. Combustion Processes: Fuels. Calorific value of fuels. Reaction equation (air fuel ratio). Analysis of products of combustion. First law applied to combustion processes. Boiler and power plant efficiency.

MEEN310: DYNAMICS OF COMPRESSIBLE FLOW – (2 CREDITS)

Compressibility: First and second laws of thermodynamics; ideal gas relationships conservation of mass. Dynamics equation of motion. Energy equation. Speed of sound in a medium, Mach number; compressible flow regimes; concept of static and total conditions. Isentropic flow through ducts of varying area. Nozzles and diffusers. Effect of back pressure on nozzle flow. Choked flow. Flow through Laval nozzle, shock waves (normal and oblique). Prandtl-Meyer flows; attached and detached shock waves. Reflection and intersection of oblique shock waves; flow measurements

MEEN311: HYDRODYNAMICS: (2 CREDITS)

Vector concepts: Fields; continuum concepts; material derivative; gradient of a scalar field: curl of a vector field. Gauss divergence theorem; Stokes theorem; Green's theorem. Streamline and stream function: Definitions and physical meanings; equation of a streamline (Cartesian and cylindrical

coordinates); relationship between velocity and stream function (Cartesian and cylindrical coordinates); conditions for the existence of a stream function. Vortices and circulation. Definitions and physical meanings; Expressions for vortices and circulation. Definitions of potential function: relationship between potential function and stream function; Principle flow pattern: Uniform flow: Source; sink; free vortex ; doublet of superposition. Simple flow pattern: Uniform flow: Source; sink; free vortex; doublet, Rankin Oval, flow round a cylinder, D' Lambert paradox, Kutta-Joukowski theorem; Magnus effect. Euler equations.

MEEN401: MACHINE DESIGN III (2 CREDITS)

Power Transmission: Direct Friction Drives: Wire rope drives: Rope types sheaves and groove shapes; application in lifts; cranes and aerial ropeways. Efficiency. Gear Drives: Bevel, worm and helical gears. Geometry and representation in engineering drawing. Reduction gears and variable speed drives. Planetary (epicyclic) gears. Chain Drives: Springs: Classification; materials used. Disc: (Delleville) ring volute and rubber springs. Fatigue. Energy storage capacity. Teting. Dimensioning. Bearings: Classification: Fundamentals of theory of friction: sliding and rolling bearing calculation and selection of bearings; standard for rolling contact bearing; lubrication; service life, mounting and fits required: applications; Couplings and clutches: Classification: rigid and flexible couplings – toothed, Oldham, universal and elastic. Clutches; toothed, friction, electromagnetic, fluid and power. Clutches as transmitting and safety devices. Brakes: Classification: friction materials; single and double shoe brakes; disc brakes; band brakes (Agriculturally and electrically operated). Machine Frames: Classification; optimum shape; welded and cast frames; fundamentals of calculation. Fundamentals of computer-Aided Machine Design: Basic concepts: computer languages used; optimization, computer graphics. Short Design Assignments: (a) Reduction gear box; (b) Computer aided design of toothed gears.

MEEN 403: METROLOGY (2 CREDITS)

Standards of Measurement: Past and present standards of measurement; and standards; line and wave length standards, and bars and slip gauges. Grades of slip gauges, uses, care; manufacture and calibration of slip gauges. Interferometer: Theory of interference of light. Optical flats; uses of optical flats interferometer. Errors in Measurement: Linear Measurement: Measuring instruments and comparators. Design and operation of measuring instruments and comparators. Design and operation of measuring instruments. Principles of kinematics, Angular Measurements and circular division: Protractors; sidebars; angle gauges; level; clinometers, autocollimators and angle dekkors; reflectors and optical square. Calibrating circular divided scales and indexing equipment. Precision Polygons and their calibration. Testing straightness, flatness and squareness. Taper measurement. Screw thread measurement: Types of thread. Thread measurement. Errors in thread. Thread gauges. Gear Measurement: The involutes shape. Tooth thickness measurement. Pitch measurement, etc. Measurement of surface Finish: Importance; Meaning of surface texture. Methods of measurement. Effects of sampling length. Measuring instruments.

MEEN 405: EXPERIMENTAL STRESS ANALYSIS (1 CREDIT)

Strain gauges: Electrical resistance and semiconductor strain gauges; strain gauge circuits; applications of strain gauges to uneasily, two-dimensional surface strain analysis; mismatch techniques; Large strains. Holographic and other methods: Agricultural gauges; ultrasonic for residual stresses; use of lasers

MEEN 407: THEORY OF VIBRATIONS (3 CREDITS)

Free undamped and free damped vibrations of single degree of freedom systems, forced damped and undamped vibrations. Longitudinal, Transverse and torsion modes. Effect of movement of supporting structure. Power absorbed in vibration. Vibration absorbers. Vibration measurement. Free and forced undamped linear vibrations with two or more degree of freedom. Vibration isolation. Dynamic absorbers. The centrifugal pendulums. Natural frequencies of systems in transverse vibration. Whirling of shafts. Free and forced undamped torsional oscillations of systems with several d.o.f. ESE illation of geared systems. Reduction to simpler systems. Determination of the fundamental natural frequency by exact and approximate methods.

MEEN 409: VISCOUS INCOMPRESSIBLE FLOW (2 CREDITS)

Properties of real fluids: Surface tension: vaporization; elasticity and compressibility; viscosity; stresses in a viscous fluid flow; relationship between stress and state of strain, Navier-stoke's equations of motion. Viscous Incompressible Flow: Newton's definition of viscosity; Newtonian and non-Newtonian fluids; effects of viscosity on fluid motion. Viscosity measurement. Reynolds's modification of Nervier-Stokes equaqtions. Turbulent mixing process. Pipe Flow: Pipe flow for a laminar viscous flow. Pre;ssure drop. Friction factor for laminar flow. Turbulent flow. Friction factor for turbulent flow. Pressure losses and minor losses in pipe system.

MEEN 411: HEAT TRANSFER (2 CREDITS)

Introduction: Modes of heat transfer; basic laws of heat transfer, analogy between heat flow and electrical flow. Conduction: general conduction equation in rectangular and cylindrical coordinates; one – and two dimensional steady-state conduction; conduction in series and parallel; unsteady state conduction; extended surface. Convection: Dimensional and analytical analysis leading to Reynolds's Prattle, Nussle and Gash of numbers for free and forced convection: Laminar, forced convection over a flat plate and in a tubne; Reynolds Analogy; examples of correlations of dimensionless parameters leading to the convective heat transfer co-efficient. Radiation: Thermal radiation, absorption: Reflection and transmission of radiation; black-body emissive power; radiation excfhange between black surfaces; radiation exchange between black surfaces; radiation exchange between gray surfaces. Heat Exchangers: Basic types of heat exchangers; logarithmic mean temperature difference; heat exchanger effectiveness; heat exchanger design by LMTD and effectiveness approaches.

MEEN 501: INTRODUCTION TO CONTROL THEORY (3 CREDITS)

Feedback control systems, Representation of control components and systems. Linearization and response to test inputs. Block diagram Algebra. Steady state Analysis. Proportional, Integral and Proportional Plus Integral Control System. Laplace Transform and Control System Analysis. Frequency Analysis. Bode, Nicols and Nyquist diagrams. Stability Analysis. Routh-Hurwitz Criterion. Root-locus Method, Nyquist Stability Criterion, Control system Design and compensation using various Stability Methods. Non-Linear Control Systems.

MEEN 503: PRODUCTION MANAGEMENT I (2 CREDITS)

Investment Analysis: Relevant costs: Break even analysis; Compound interest factors: Economic Alternatives. Production: Planning; Sales Forecasting Techniques: Determination of Factor-of-Production requirements.

Factory Design: Sitting of Factory; Space requirements; Development of Departmental arrangements; Plant Layout; Materials handling. Production Control: Production Control in Intermittent Manufacture and Continuous Manufacture; Linear Programming; Critical Path Scheduling. Factory Organisation: Types of Organisation; Personnel Functions Sales Organisation; Purchasing; Welfare and Financial Control.

MEEN 502: PRODUCTION MANAGEMENT II (2CREDITS)

Work Study: Motion Study: Method Study Objectives; Basic Procedure; Process Charts; Activity Chart; Motion Study. Time Study: Stop Watch Time Study; Standard Data Method; and Waiting Line Analysis. Inventory Control: Relevant Factors; Economic Lot Sizes; Inventory Decision Rules and Simulation. Statistical Quality Control; Control Charts for Variables; Defectives and Defects; Acceptance Sampling; Design of Acceptance Sampling Plans. Job Evaluation: Job Specification; Quantitative and Non-quantitative System of Job Evaluation. Wage Incentives: Incentive Plans; Day Rate Plan; Full Participation Plan; Less than Full Participation Plan; Step Plan.

MTEN 523: CASTING AND JOINING (2 CREDITS)

Types of Foundries and Casting Processes; Sand Casting, Sand Moulds and Cores; Properties of Sand and Sand Casting. Risering and Gating. Casting Defects. Casting Design. Die Casting, Shell Mould Casting, Investment Casting, co2 Casting, Centrifugal Casting etc. Welding: Fusion Welding and Pressure Welding, Gas Welding, Resistance Welding and different types of arc, Gas and Resistance Welding Processes. Thermit Welding. Other Welding Processes. Welding different metals. Metallurgical considerations. Welding Defects. Weld Inspection and Testing. Torch and arc Cutting; Brazing and Soldering. Riveting and Adhesive Bonding.

MEEN 504: FORMING AND FINISHING (2 CREDITS)

Rolling: Steel making. Rolling Theory. Hot and Cold Rolling. Defects in rolled metals. Forging: Forging Operations and Processes. Fibrous Structure of Forgings. Smith Forging, Drop Forging, Press Forging and Gorging Machines or Upsetters. Extrusion and Wire, Rod and Tube Drawing: Direct and Indirect Extrusion. Alloys suitable for extrusion. Wire drawing, Rod drawing and Tube drawing. Deep drawing; Drawing and redrawing. Machines and Tools. Lubrication. Defects. Force required. Allied processes. Miscellaneous Cold Working Processes: Shearing Bending, Spinning, Stretching, Coining, Enbossing, etc. *Powder Metallurgy: Metal Powders; Mixing and Blowing; Pressing; Sintering; Sizing and Impregnation. Applications. New developments and special machining processes. Surface Treatment: Different techniques for Surface treatment. Metal Cleaning Techniques. Electro-plating: Principles and Standards; Plating metals, preparation and maintenance of plating solutions. Quality control, stripping of faulty deposits. Design of the process chart. Other metallic coatings.

MEEN 506: ADVANCED STRENGTH OF MATERIALS I (2 CREDITS)

Three-dimensional stress analysis: Principle stresses and principle axes. Shear stresses. Analysis of three-dimensional state of strain. Stress-strain relations: Generalized Hooke's Law. Change in volume and distortion. Strain-displacement relations: Equations of equilibrium. Compatibility equations. Airy's stress function and its application to the cases of rectangular and polar coordinates. Torsion of elements of non-circular cross-section; prandtl's stress function. Membrane analogy. Solutions for bars of rectangular and triangular cross-sections. Torsion of thin-walled sections. Rotating discs and cylinders: Discs of uniform thickness. Axially thin and thick discs. Plates and shells: Bending of rectangular plates under a single, and mutually perpendicular moments. Bending of circular plates. Finite element and finite difference methods.

MEEN 507: ADVANCED STRENGTH OF MATERIALS II (1 CREDIT)

Terms and Assumptions in the Theory of Plasticity: Bodies; strain; Bauschinger Effect; dilatation in Plastic of flow. Yield Criteria: Coulomb-Tresca-Guest Yield Criteria; Huber-Mises-Hencky yield criterion. Theories of Plastic Flow: Levy-Mises flow rule; Prandtl-Reuss flow rule; Hencky-Ilyushin flow rule. Elastic-Plastic Torsion and Bending of Metals: Fully plastic moment; plastic moment; plastic hinge; deflection in plastic bending; collapse load for statically determinate and indeterminate cases; Nadai's Sand-Hill Analogy. Selected Analytical Solutions to Metal Forming Problems: Wire-drawing; sheet and plate bending rolling of sheets. Upper Bound Solutions: Uppen Bond Theorem; Extrusion through symmetrical wedge-shaped dies; compression between rigid plates.

MEEN 508: LUBRICATION THEORY (1 CREDIT)

Introduction to friction and wear: Types and classification of lubricants: Types and classification of bearings, Basic principles of lubrication. Newtonian fluids. One-dimensional viscous flow. Hydrostatic

squeeze films. Hydrostatic bearings, Principles of hydrodynamic lubrication. Boundary lubrication. Pressure distribution in bearings. Grading, selection and testing of lubricants and bearings.

MEEN509: AERODYNAMICS (2 CREDITS)

Conformal transformation: Kutta-Joukowski transformation; aerofoil characteristic parameters; Kelvin's Theorem; Blasius Theorem, Helmholtz Theorem; Kutta condition and starting vortex; Bound vortex; Vortex sheet; symmetrical and cambered aerofoils. Aerofoils of infinite lengths; circulation distribution round aerofoil; aerodynamic force and moment coefficients; Finite aerofoils; stalling; Horse shoe vortex; Downwash and induced drag; practical aerofoils; shape, data and performance.

MEEN 510: THERMAL POWER GENERATION (2 CREDITS)

Vapour Power Plant: Rankine cycle; superheat and reheat cycles. Regenerative cycles and analysis of feed heater train. Plant optimization – binary cycles, process turbines, improving boiler efficiency. Vapour Power Plant Units: Boiler: Water steam generation, types of boiler (water tube, fire tube); treatment of boiler water. Turbines, Single stage impulse; multistage (Pressure compounding, velocity compounding); blade velocity diagrams; losses in turbines; materials for turbine construction. Gas Turbine Power Plant: Ideal Joule cycle: Intercooling; reheating; regeneration; Ericsson Cycle. Practical cycles. Application of gas turbine for electricity generation, aircraft propulsion, transport (road, rail, marine). Simple turbo jet. Turbo compressors. Nuclear Power Plant: Nuclear physics; Nuclear reactors (Boiling Water, Pressurized light/heavy water, sodium graphite gas cooled). Properties of light/heavy water, gases, liquid metals, fused salt or organic fluids as coolants. Single/double pressure cycles. Plant siting and waste disposal. Internal Combustion Engines: Fundamentals of two/diesel engines. In-line, vee and opposed piston arrangements. Piston cooling, scavenging, super charging, fuel injection and governing. Miscellaneous Power Systems: Hydro power, solar power, wind, geothermal, wave, etc. Economics of Power Supply: Definition of utilization factor, capacity factor, load factor. Economic comparison of plants.

MEEN 511: ENERGY CONVERSION SYSTEMS (1 CREDIT)

Energy resources; energy usage and supplies; analysis of thermoelectric, thermionic and magnetohydrodynamic conversion processes and fuel cells. Discussion of solar, geothermal and nuclear energy sources.

MEEN 512: TURBOMACHINERY (2 CREDITS)

Application of the impulse-momentum principle (Jet propulsion propellers, windmills, deflectors and blades, rocket propulsion) relation between torque and change in angular momentum. Flow through rotating passages. Euler's equation of lift. Construction of velocity vector diagrams. Practical impellers. Centrifugal machines. Action (impulse turbines; reaction turbines; Axial flow machines). Examples of

performance curves. Specific speed and wheel jet diameter relationships. Turbine selection and design. Cavitation.

MEEN 514: BOUNDARY LAYER THEORY (1 CREDIT)

Review of Navier-Stokes equations. Definitions: Boundary layer thickness; displacement thickness, momentum thickness, energy thickness and shape factor, Laminar boundary layer equations (incompressible flow): Derivation using the order of magnitude technique. Laminar boundary layer on flat plate (incompressible flow): Derivation of equations, exact solutions, approximate solutions; Determination of boundary layer, displacement, momentum and energy thickness and shape factor. Turbulent boundary layer on flat plate: Approximate solution using Blasius friction factor and Nikuradse velocity distribution. Boundary layer separation: Causes and effects, prevention. Thermal boundary layer.

MEEN 516: ADVANCED STRENGTH OF MATERIALS III (1 CREDIT)

Energy Methods: Theorem of virtual work. Castigliano's Theorem. Theorem of least work. Applications. Axially Uniform Disc: Temperature stresses in uniform discs; discs of variable thickness. Thermal stresses in plates and shells. Metal forming processes. Application of plastic flow theories to some problems Application of slip-line field theory to select metal forming processes.

MEEN 518: REFRIGERATION AND AIR CONDITIONING (1 CREDIT)

Refrigeration: Carnot refrigeration cycle; vapour compression refrigeration; multiple compression with flash chamber. Absorption refrigeration. Miscellaneous refrigeration methods. Air Conditioning: Psychometry; duct design; load estimation, selection of components.