Course Structure for 4 yrs. B. Sc. in Energy Science and Engineering

FIRST YEAR FIRST TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	Ch 1113	Chemistry I	3	3.00	-	-	3.00
02	Ch 1114	Sessional on Ch 1113	-	-	3/2	0.75	0.75
03	Hum 1113	Sociology and Behavioral Science	3	3.00	-	-	3.00
04	Math 1113	Differential and Integral Calculus	3	3.00	-	-	3.00
05	Ph 1113	Physics	4	4.00	-	-	4.00
06	Ph 1114	Sessional on Ph 1113	-	-	3/2	0.75	0.75
07	MES 1114	Workshop Practice	-	-	3/2	0.75	0.75
08	ESE 1100	Engineering Drawing I	-	-	3	1.50	1.50
09	ESE 1101	Fundamentals of Energy Resources	3	3.00	-	-	3.00
10	ESE 1102	Sessional on ESE 1101	-	-	3/2	0.75	0.75

No. of Theory Courses: 5 Total Contact hours: T16 + S9.0= 25.0hrs

No. of Sessional Courses: 5 Total Credit:20.50

FIRST YEAR SECOND TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	Ch 1213	Chemistry II	3	3.00	-	-	3.00
02	EE 1213	Electrical Circuits and Electronics	4	4.00	-	-	4.00
03	EE 1214	Sessional on EE 1213	-	-	3/2	0.75	0.75
04	Hum 1213	Technical English	3	3.00	-	-	3.00
05	Hum 1214	Sessional on Hum 1213	-	-	3/2	0.75	0.75
06	Math 1213	Differential Equation and Co-ordinate Geometry	3	3.00	-	-	3.00
07	ESE 1205	Thermodynamics for Energy Engineering	4	4.00	-	-	4.00
08	ESE 1206	Sessional on ESE 1205	-	-	3/2	0.75	0.75
09	ESE 1200	Engineering Drawing II	-	-	3	1.50	1.50

No. of Theory Courses: 5 Total Contact hours: T17 + S7.5 = 24.5 hrs

No. of Sessional Courses: 4 Total Credit:20.75

SECOND YEAR FIRST TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	CSE 2113	Computer Programming	3	3.00	-	-	3.00
02	CSE 2114	Sessional on CSE 2113	-	-	3	1.50	1.50
03	EE 2113	Electrical Machines	3	3.00	-	-	3.00
04	EE 2114	Sessional on EE 2113	-	-	3/2	0.75	0.75
05	Math 2113	Linear Algebra and Vector Analysis	4	4.00	-	-	4.00
06	ME 2113	Statics and Solid Mechanics	3	3.00	-	-	3.00
07	ME 2114	Sessional on ME 2113	-	-	3/2	0.75	0.75
08	ME 2115	Fluid Mechanics	3	3.00	-	-	3.00
09	ME 2116	Sessional on ME 2115	-	-	3/2	0.75	0.75

No. of Theory Courses: 5 Total Contact hours: T16 + S7.5 = 23.5

No. of Sessional Courses: 4 Total Credit:19.75

SECOND YEAR SECOND TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	EE 2213	Power Electronics	4	4.00	-	-	4.00
02	EE 2214	Sessional on EE 2213	-	-	3/2	0.75	0.75
03	Hum 2213	Economics and Accounting	3	3.00	-	-	3.00
04	Math 2213	Complex Variables and Fourier Analysis	3	3.00	-	-	3.00
05	ME 2213	Dynamics and Kinematics of Machineries	3	3.00	-	-	3.00
06	ME 2214	Sessional on ME 2213	-	-	3/2	0.75	0.75
07	ESE 2209	Bio and Wind Energy Engineering	3	3.00	-		3.00
08	ESE 2210	Sessional on ESE 2209	-	-	3/2	0.75	0.75
09	ESE 2230	Energy Engineering Simulation I	-	-	3/2	0.75	0.75

No. of Theory Courses: 5 Total Contact hours: T16 + S6.0 = 22.0 hrs

No. of Sessional Courses: 4 Total Credit: 19.00

THIRD YEAR FIRST TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	Math 3113	Statistics and Numerical Methods	3	3.00	-	-	3.00
02	Math 3114	Sessional on Math 3113	-	-	3	1.50	1.50
03	EE 3113	Power System Engineering	3	3.00	-	-	3.00
04	EE 3114	Sessional on EE 3113	-	-	3/2	0.75	0.75
05	ESE 3105	Heat and Mass Transfer	4	4.00	-	-	4.00
06	ESE 3106	Sessional on ESE 3105	-	-	3/2	0.75	0.75
07	ESE 3107	Solar Thermal Engineering	3	3.00	-	-	3.00
08	ESE 3108	Sessional on ESE 3107	-	-	3/2	0.75	0.75
09	ESE 3123	Thermo-Fluid Devices	3	3.00	-	-	3.00
10	ESE 3124	Sessional on ESE 3124	-	-	3/2	0.75	0.75

No. of Theory Courses: 5 Total Contact hours: T16 + S9.0 = 25.0 hrs

No. of Sessional Courses: 5 Total Credit: 20.50

THIRD YEAR SECOND TERM*

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	ESE 3200	Seminar on Special Topics	-	-	3/2	0.75	0.75
02	ESE 3202	Energy Innovation Lab	-	-	3/2	0.75	0.75
03	ESE 3203	Petroleum and Natural Gas Processing	3	3.00	-	-	3.00
04	ESE 3204	Sessional on ESE 3203	-	-	3/2	0.75	0.75
05	ESE 3207	Solar Photovoltaic Systems	3	3.00	-	-	3.00
06	ESE 3208	Sessional on ESE 3107	-	-	3/2	0.75	0.75
07	ESE 3211	Coal Power Generation	4	4.00	-	-	4.00
08	ESE 3217	Instrumentation and Control	3	3.00	-	-	3.00
09	ESE 3218	Sessional on ESE 3217	-	-	3/2	0.75	0.75
10	ESE 3221	Energy Storage Systems	3	3.00	-	-	3.00
11	ESE 3222	Sessional on ESE 3221	-	-	3/2	0.75	0.75
12	ESE 3250	Industrial Attachment	-	-	-	-	0.00

No. of Theory Courses: 5 Total Contact hours: T16 + S9.0 = 25.0 hrs

No. of Sessional Courses: 6 Total Credit: 20.50

FOURTH YEAR FIRST TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	ESE 4000	Project & Thesis	-	-	3	1.50	1.50
02	ESE 4105	Fuels and Engine Combustion	3	3.00	-	-	3.00
03	ESE 4106	Sessional on ESE 4105	-	-	3/2	0.75	0.75
04	ESE 4115	Power Plant Engineering	3	3.00	-	-	3.00
05	ESE 4116	Sessional on ESE 4115	-	-	3/2	0.75	0.75
06	ESE 4125	Safety and Environmental Aspects of Energy Projects	3	3.00	-	-	3.00
07	ESE 4126	Sessional on ESE 4125	-	-	3/2	0.75	0.75
08	ESE 4130	Energy Engineering Simulation II	-	-	3/2	0.75	0.75
09	ESE 40--	Optional I	3	3.00	-	-	3.00
10	ESE 40--	Optional II	3	3.00	-	-	3.00

No. of Theory Courses: 5 Total Contact hours: T15 + S9 = 24 hrs

No. of Sessional Courses: 4 Total Credit: 19.50

FOURTH YEAR SECOND TERM

Sl. No.	Course No.	Course Title	Theory		Sessional		Total Credit
			Contact Hours	Credit	Contact Hours	Credit	
01	ESE 4000	Project & Thesis	-	-	6	3.00	3.00
04	ESE 4213	Nuclear Power Engineering	3	3.00	-	-	3.00
	ESE 4214	Sessional on ESE 4213	-	-	3/2	0.75	0.75
05	ESE 4219	Energy Audit and Management	3	3.00	-	-	3.00
06	ESE 4220	Sessional on ESE 4219	-	-	3/2	0.75	0.75
07	ESE 40--	Optional III	3	3.00	-	-	3.00
08	ESE 40--	Optional IV	3	3.00	-	-	3.00
	ESE 40--	Optional V	3	3.00	-	-	3.00

No. of Theory Courses: 5 Total Contact hours: T15 + S9 = 24 hrs

No. of Sessional Courses: 3 Total Credit: 19.50

Total credit = (20.50 + 20.75 + 19.75 + 19.00 + 20.50 + 20.50 + 19.50 + 19.50) = 160.00

List of Optional Courses:

Course No.	Course Name	Contact Hour	Credit
ESE 4001	Modern Fuel Technology	3	3.0
ESE 4003	Hydrogen and Fuel Cells	3	3.0
ESE 4005	Hybrid and Electric Vehicles	3	3.0
ESE 4007	Smart Grid Technology	3	3.0
ESE 4011	Material for Energy Engineering Applications	3	3.0
ESE 4013	Energy Systems in Buildings	3	3.0
ESE 4015	Energy System Design and Optimization	3	3.0
ESE 4021	Process Equipment Design	3	3.0
ESE 4023	Computational Fluid Dynamics	3	3.0
ESE 4025	HVAC&R System Design	3	3.0
ESE 4027	Energy and Process Integration	3	3.0
ESE 4029	Piping Systems Design	3	3.0
ESE 4031	Power Plant Instrumentation and Control	3	3.0
ESE 4033	Nuclear Thermal Hydraulics	3	3.0
ESE 4035	Industrial Hazard and Safety Management	3	3.0
ESE 4041	Fundamentals of Mechatronics	3	3.0
ESE 4043	Electro-Mechanical Energy Conversion	3	3.0
ESE 4045	Engineering System Dynamics and Simulation	3	3.0
ESE 4051	Fundamentals of Cryogenic Engineering	3	3.0
ESE 4061	Computational Engineering and Data Science	3	3.0
ESE 4071	Natural Gas Processing Technology	3	3.0
ESE 4073	Natural Gas Transmission and Distribution	3	3.0
ESE 4081	Introduction to Petroleum Engineering	3	3.0
ESE 4083	Petroleum Refining Technology	3	3.0
ESE 4085	Mineral Energy Resources	3	3.0
ESE 4091	Safety and Reliability Analysis	3	3.0
ESE 4093	Atmosphere Ocean and Climate dynamics	3	3.0

Approval:

1. Detailed outline of first year first term was approved in the 54th meeting of the academic council.
2. Detailed outline of first year second term was approved in the 55th meeting of the academic council.
3. Detailed outline of 2nd year first and second term was approved in the 57th meeting of the academic council.
4. Course structure was approved in the 57th meeting of the academic council.
5. Detailed outline of 3rd year and second first term was approved in the 61st meeting of the academic council.

Detailed Outline of Undergraduate Courses

FIRST YEAR FIRST TERM

Ch 1113 Chemistry I

Credit: 3.0 **Contact hour: 3 hrs/week**

Chemical Equilibrium: Law of mass action, equilibrium constant, magnitude of equilibrium constant and the direction of reaction, factors affecting equilibrium constant, Le Chatelier's principle. Numerical values of equilibrium constant.

Electro-Chemistry: Electrolytes; Nernst theory of electrode potential, type of electrodes and electrode potentials, EMF measurement, polarization and over potentials; Origin of EMF, free energy and EMF, electrical double layer, factor affecting electrode reaction and current, Modes of mass transfer, Lithium and lithium ion battery, Transport number; pH value and its determination; Electrode potentials, electroplating and galvanizing; Fuel cell, Voltammetry.

Nuclear Chemistry: Nuclear binding energy, Radioactivity and nuclear reactions, patterns of nuclear stability; Nuclear transmutations, nuclear model, energy changes in nuclear reactions; Nuclear fission, nuclear fusion; Nuclear reactor, nuclear force, methods of separation of isotopes, applications of isotopes.

Chemistry of polymer: Basic concepts of polymer and polymerization, co-polymerization, ionic polymerization, living polymer and their structures; Concepts of plastics, rubbers and fibers; glass transition temperature, average molecular weight and molecular weight distribution; Properties of macromolecules, conducting polymer, optical fiber.

Industrial chemistry: Solid, liquid and gaseous fuels; Coal and its constituents, calorific value of coal and other fuels, refining and distillation of crude oil, motor and aviation fuels, thermal and catalytic cracking, petroleum and petrochemicals, natural gas and its composition, purification and utilization, LPG gas,.

Environmental chemistry: Environment and its characteristics, Heavy metal contamination, Chemistry of toxic metal and non-metal pollutants, Quality of natural water, classes of polluted water, DO, BOD, COD, hydrocarbons, ozone and ozone layer depletion, environmental effects of the oxides of carbon, nitrogen and sulfur.

Ch 1114 Sessional on Ch 1113

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Hum 1113 Sociology and Behavioral Science

Credit: 3.0 **Contact hour: 3 hrs/week**

Sociology

Introduction: Definition, origin and development of Sociology and its perspectives; Impact of Sociology on engineering.

Fundamental concepts: Society, Group, Socialization and Personality development, Family, Marriage, Social structure, Social stratifications; Community and Association; Mob property.

Culture: Culture and civilization, culture and biology, Cultural diffusion, cultural lag, elements of culture.

Industrialization and Urbanization: Industrial revolution and its impact, Urbanization and its consequences, urban ecology, urban social problems; Industrialization in Bangladesh.

Social and Environmental Issues: Pre-industrial and industrial society; Deviance and social control, Population and environment; Social change and its agents; Poverty, Beggary, Crime, Immoral income and Juvenile delinquency.

Ethics: Meaning of ethics, professional ethics and codes, its positive and negative faces, psychological basis of ethics.

Behavioral Science

Organizational Behavior and Health: Training and development in organizations; training needs analysis; models of training evaluation; Employee relations; psychological contract at work; motivation theories: models and applications; job satisfaction and performance; quality of working life; counseling and age at work; impact of unemployment.

Assessing People for Work: Organization design; organization structure and performance; organization development and change; psychological basis of resistance to change; culture and climate in organizations; leadership styles and models; work groups and team effectiveness at work; team building models and validation evidence; inter-group cooperation and conflict in organizations; business strategy at work; organizations and their environments.

Math 1113 Differential and Integral Calculus

Credit: 3.0 **Contact hour: 3 hrs/week**

Differential Calculus

Basics: Function and its representations; its domain and range; graph of common function families: power function, exponential and logarithmic function, sine and cosine function; Basic concepts of limit, continuity of a function with emphasis on piecewise defined functions from geometric and algebraic point of view; Derivative of function from geometric, algebraic and physical point of view, Review of differentiation techniques: power function, exponential and logarithmic functions, trigonometric and inverse trigonometric functions, differentiation of products and quotients and chain rule of differentiation; Differential calculus of hyperbolic and inverse hyperbolic functions.

Application and Existence theorems: Implicit differentiation; Related Rates problems; Differentials, linear approximation (tangent line approximation), and error propagation; Maxima, minima, and optimization problems; Rolle's Theorem, Mean Value Theorem, Corollaries of Mean Value Theorem, Taylor's Theorem, approximation of functions using Taylor's polynomials, and Maclaurin Series.

Partial Differentiation and Curvature: Functions of two or more variables, level curves, and contour plots; Partial differentiation and its geometrical, analytic, and physical interpretation; Chain rule of partial differentiation, equation of tangent plane, and total differential; Curvature, radius of curvature, and center of curvature.

Integral Calculus

Basics: Review of indefinite integration rules for power, exponential, logarithmic, trigonometric, inverse trigonometric, hyperbolic and inverse hyperbolic functions; Definite integrals, its properties; Riemann Sum and its interpretation in definite integrals; Fundamental theorems of calculus; Mean value theorem for integrals and average value of a continues function.

Techniques of Integration: Integration by substitution; Integration by parts; Integration of rational function by partial fractions; Integration by trigonometric substitutions; Integration by successive reduction; Differentiation under the sign of integration, Integration under the sign of integration; Gamma and beta functions.

Application of Integration: Area between two curves; Volume by Slicing (disks and washer technique), volume by revolution about x and y asis, volume by cylindrical shells; Length of a plane curve; Area of a surface of revolution.

Ph 1113 Physics

Credit: 4.0 Contact hour: 4 hrs/week

Wave and Oscillations: Wave and composition of simple harmonic motion, average value of kinetic and potential energies of a harmonic oscillation, superposition of simple harmonic motions; Types of wave: progressive and stationary wave, energy distribution due to progressive and stationary wave, interference of sound wave.

Damped and Forced Harmonic Oscillator: Damped oscillatory system, damped harmonic oscillation, the LCR circuit, forced vibration, quality factor of forced oscillator, sharpness of resonance, phase of driven oscillator, power absorption.

Particle Properties of Waves: Photoelectric effect, Quantum theory of light, Compton Effect.

Wave Properties of Particles: De Broglie hypothesis, nature of De Broglie waves, phase velocity and group velocity.

Atomic Structure: Bohr's atom model, Nature of electron orbits, Orbital energy, origin of spectral lines, different series of spectral lines of Hydrogen, Orbital energy level diagram of hydrogen atom, Correspondence principle, Vector atom model, Orbital states, space quantization, span quantization, Magnetic moment of orbital electron, Quantization of magnetic moment, Electron shell.

Solid State Physics: Structure of crystals, Classification of solids, Einstein's model of the lattice, specific heat of the solids, Debye's model of the lattice heat capacity. Debye's approximation of high temperature and low temperature; Outstanding properties of metals, Thermal conductivity, Momentum space, Fermi-Dirac distribution, Quantum theory of Free electron, escape of electron from a metal, Importance of Hall effect, Hall Voltage, and Hall coefficient, Mobility, Hall angle and drift velocity, velocity of electron according to Band theory.

Nuclear Physics: Introduction, nuclear constituents, nuclear properties, binding energy, packing fraction, nuclear force, fission and fusion process.

Radioactivity: Introduction to radioactivity, Laws of radioactive disintegration, half-life, Mean life, Laws of successive disintegration, Detection of radioactivity, Practical application of radioactivity, Biological effects of radiation, Safety measures in radioactivity.

Ph 1114 Sessional on Ph 1113

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of Ph 1113.

MES 1114 Workshop Practices

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Acquaintance with tools and equipment used in machine shop; Practice of different operations on Lathe, Shaper, Drilling and Grinding machines.

Acquaintance with tools and machines used in welding shop, practices on Arc and Gas welding.

ESE 1100 Engineering Drawing I

Credit: 1.50 **Contact hour: 3 hrs/week**

Fundamental principles and applications of Orthogonal projection; Oblique projection; Isometric projection; Auxiliary projection; Orthographic and auxiliary projection from pictorial views; pictorial projection from orthographic views, Development of objects.

Fundamentals of building drawings, plan, elevation and sectional drawing.

Reference Book:

1. *Mechanical Drawing by T. E. French, C. L. Svensen, J. D. Helsel and B. Urbanick, 10th Edition.*
2. *Eng. Drawing and Graphic Technology by T. E. French, C. J. Vierck and R. J. Foster, 14th Edition.*

FIRST YEAR SECOND TERM

Ch 1213 Chemistry II

Credit: 3.0 **Contact hour: 3 hrs/week**

Chemical Kinetics: Order and molecularity of reaction, rate equations, for zero, first, second and third order reaction. Theories of reaction rates. reaction in solutions, kinetic model for non-elementary reactions.

Photochemistry: Photon, law of photo chemistry, absorption law and mechanism of photochemical reaction, fluorescence, phosphorescence and chemiluminescence.

Organic chemistry: Hybridization of orbitals, electrophiles, nucleophiles and free radicles, isomerism, geometrical and optical isomers, polymerization, introduction to biochemical engineering and concept of biological catalysis, nature of microorganisms, their requirements and classification, industrially important microorganisms. Kinetics of enzyme catalyzed reactions. Batch fermentation: yield coefficients for biomass and product formation, rates of reaction, growth, limiting substrate concentrations.

Corrosion: Introduction to corrosion, chemical corrosion, electrochemical corrosion of metals, corrosion rates, types of corrosion with properties and phenomenon, Factor affecting corrosion, corrosion in contact to soil, prevention of corrosion.

Adsorption and Catalysis: Adsorption, types of adsorption, Adsorption isotherms; Fruendlich, Langmuir, and BET isotherms, Catalysis.

Spectroscopy: Basic concept of Spectroscopy, Electronic, vibrational and rotational spectroscopy.

EE 1213 Electrical Circuits and Electronics

Credit: 4.00 **Contact hour: 4 hrs/week**

Electrical Circuits

Introduction: Voltage, current, power, energy, independent and dependent sources, resistance. Basic laws: Ohm's law, Kirchhoff's current and voltage laws, Joule's law. Simple resistive circuits: Series and parallel circuits, voltage and current division, Wye-Delta transformation.

Techniques of circuit analysis: Nodal and mesh analysis. Network theorems: Source transformation, Thevenin's and superposition theorems with applications in circuits having independent and dependent sources, Maximum power transfer.

Energy storage elements: Inductors and capacitors, series & parallel combination of inductors and capacitors.

Alternating Current circuits: Instantaneous, average and R.M.S values, complex impedance and phasor algebra. Real, reactive and apparent power, power factor. Series and parallel RL, RC and RLC circuits. Series and parallel resonance, energy analysis at resonance.

Electronics

Semiconductors: Intrinsic Semiconductors: Crystal and energy band diagram, conduction in semiconductors, Electron and hole concentration. Extrinsic semiconductors: n-type doping, p-type doping, and compensation doping. Drift and diffusion current, Mobility and Conductivity. The potential barrier; work function; contact potential.

Semiconductor diode characteristics: Qualitative and Quantitative theory of the p-n junction as a diode; Ideal pn junction, pn junction band diagram, current components in p-n diode; Volt-ampere characteristics; Reverse breakdown; Avalanche and Zener breakdown; Zener diode, Special-Purpose Diodes: Schottky diode, Current regulator diode.

Introduction to Logic and Digital Circuits: Logic operations, Basic gates; OR, AND, NOT, NAND, NOR, X-OR; Flip-Flops; Shift registers; Counter; Binary and BCD code, Comparators.

EE 1214 Sessional on EE 1213

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of EE 1213.

Hum 1213 **Technical English**

Credit: 3.00 **Contact hour: 3 hrs/week**

Vocabulary and Structure: Better reading skills, better writing skills, better speaking skills, word formation; roots, prefixes, suffixes, phrases and idioms; synonyms and antonyms; simple structures, complex and compound structure; Clauses, Identification and analysis of clauses, Notional language, Grammatical problems.

Comprehension and Composition: Paragraph writing technique, formal and informal report writing, commercial correspondence; Memo, Letter; Application writing; Tender writing; Free composition writing; Précis writing; Term paper and Thesis/project report writing technique.

Hum 1214 **Sessional on Hum 1213**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Practical learning based on Hum 1213.

Math 1213 **Differential Equation and Co-ordinate Geometry**

Credit: 3.00 **Contact hour: 3 hrs/week**

Differential Equations

First-order ODEs: Introduction, Definition of differential equation, Classification based on type, order and linearity; General solution, initial and boundary value problem; Solution methods for Fist-order differential equations: Separable differential equations, Linear differential equations; Solution using integrating factors; Exact differential equations; Homogeneous differential equations; Modeling using first-order equations: Electric circuits, Newton's law of cooling, Radioactive decay.

Second-order ODEs: Solutions of linear homogeneous equations with constant coefficients; Solution of linear non-homogeneous equations by various methods (general method, method of variation of parameters, and short method); Modeling using second-order equations: Free oscillation, Forced oscillations, RLC-circuits.

Laplace Analysis: Definition and existence condition of Laplace transform. Properties of Laplace transform; Transform of elementary functions; Inverse Laplace transform and its properties; Convolution; Solution of ordinary and Laplace transform.

Co-ordinate Geometry

Two-dimensional geometry: Review of Cartesian and Polar co-ordinate systems, Transformation of co-ordinates: translation and rotation; General Equation of second degree; Identification of conics with their properties.

Vector geometry: Study of Cartesian, Cylindrical polar and Spherical polar coordinate systems, their mutual conversion; Review of vector algebra, dot product, cross product; Distance between two points; Equation of line in three-dimensions using vectors, symmetrical form of a straight line, equation of plane using vectors; Angle between line and plane, shortest distance between two lines, perpendicular distance of a point from a plane, angle between two planes.

Reference Books:

1. Advanced Engineering Mathematics by Erwin Kreyszig
2. Advanced Modern Engineering Mathematics – by Glyn James
3.Thomas' Calculus – by George B. Thomas, Maurice D. Weir, Joel Hass, and Frank R. Giordano

ESE 1205 **Thermodynamics for Energy Engineering**

Credit: 4.0 **Contact hour: 4 hrs/week**

Introduction and Basics: Macroscopic and microscopic viewpoints of thermodynamics; Definition of thermodynamic terms; Thermodynamic system; Heat and work and their path dependence; Pure substance and phase, property and phase diagrams, p-V-T surface; Ideal gas, its equation of state, law of corresponding states.

Laws of thermodynamics: Zeroth law; First law and its mathematical forms, its application in closed and open system for different processes; Second law and its mathematical forms, heat engine and Carnot's principles, Clausius inequality, application of second law in closed and open systems.

Exergy Analysis: Definition and basic concepts of exergy, specific exergy; Exergy analysis of closed systems; Exergy analysis of open systems; Exergetic (second law) efficiency.

Thermodynamic Relations: Virial, Van Der Waals, Redlich-Kwong (RK), and Soave-Redlich-Kwong (SRK) equation of state; Exact differentials and their properties, Maxwell relations; Volume expansivety, isothermal compressibility, isentropic compressibility, velocity of sound, Joule-Thomson coefficient.

Thermodynamic Cycles Analysis: Carnot cycle; Rankine cycle, improving performance by superheat and reheat; Regenerative cycle; Air-standard Otto, Diesel cycle, Dual cycle, and Brayton cycle; Vapor compressional refrigeration cycle; Absorption refrigeration cycle.

Mixture of Gases and Vapors: Mixture of ideal gases, gravimetric and volumetric analysis; Dalton's law of partial pressure, volume and enthalpy of gaseous mixture; Isentropic process with gaseous mixtures; Adiabatic saturation process; Psychrometry: dry and wet bulb temperatures, specific humidity, relative humidity, dew point temperature, degree of saturation; Psychometric chart and its uses.

Reference Books:

1. Fundamentals of Engineering Thermodynamics – by Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey
2. Thermodynamics an Engineering Approach – by Yunus A. Cengel and Michael A. Boles
3. Thermodynamics – by Gregory Nellis and Sanford Klein
4. Basic and Applied Thermodynamics – by P.K. Nag

ESE 1206 **Sessional on ESE 1205**

Credit: 0.75 **Contact hours: 3/2 hrs/week**

Experiments based on the theory of ESE 1205.

ESE 1200 **Engineering Drawing II**

Credit: 1.50 **Contact hour: 3 hrs/week**

Working Drawing of machine elements with sectional views, Sub-assembly and assembly drawing; Pipes and pipe fittings; Electrical circuit diagrams. These will be implemented using CAD Software.

SECOND YEAR FIRST TERM

EE 2113 **Electrical Machines**

Credit: 3.0 **Contact hour: 3 hrs/week**

Magnetic circuits: Flux, permeability and reluctance, magnetic field strength, magnetic potential, flux density, magnetization curve. Laws of magnetic circuits: Ohm's law and Ampere's circuital law.

DC Generators: EMF equation, Principle of DC generators, description of different parts of DC generators, classification, Different types of winding, Armature reaction, losses and efficiency, parallel operation of DC generators.

DC Motor: Principle of operation, classification, losses and efficiency, Starting, Separately excited DC motor, Permanent magnet DC motor, speed control of DC motor.

Transformer: Constructional features and principles of operation, equivalent circuit, losses and efficiency. Three phase transformer: Construction and operation, 3-phase connection of transformers. Short circuit test and open circuit test.

Induction Motor: Rotating magnetic field, general principles, construction, equivalent circuits, squirrel cage and slip ring motors, torque developed, applications of single phase induction motor.

Alternators: Construction, theory of operation, armature windings, voltage regulation, armature reaction and reactance, control of excitation, losses and efficiency, synchronizing and load sharing, parallel operation, low power single-phase alternator.

EE 2114 **Sessional on EE 2113**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of EE 2113.

Math 2113 **Linear Algebra and Vector Analysis**

Credit: 4.0 **Contact hour: 4 hrs/week**

Linear Algebra

Basics: System of linear equations; matrix equation, vector equation; Gaussian elimination; row reduction and echelon forms; Matrices (rectangular, square, row, column, diagonal, triangular, symmetric, skew-symmetric) and Matrix Operations (equality, arithmetic product, transpose, trace); Determinants by cofactor expansion; Inverse of a matrix and inverse using adjoins.

Vectors and Vector Spaces: Representation of vectors: tuple, column matrix, row matrix; Definition of vector space and its axioms; Subspaces; Linear dependency and independency, Basis and dimension of a vector space, Row space, column space and nullspace; Rank and nullity; Euclidian n-space and its properties, Euclidian inner product and norm, Cauchy-Schwarz inequality in $\mathbb{R}^n$; Linear transformations and it's properties; Application of Linear transformation in reflection, projection, rotation, dilation and contraction.

Eigenvalues and Eigenvectors: Definition of eigenvalue and eigenvectors; Characteristic equation and characteristic polynomial, Evaluation of eigenvectors and bases for eigenspace; Diagonalization; Orthogonal diagonalization.

Vector Analysis

Vector-valued functions: Definition of vector-valued functions, their geometrical representation-space curves; Differentiation rules for vector-valued functions; Integration rules for vector-valued functions. Space curve analysis: unit tangent vector, unit normal vector, unit binormal vector.

Gradient, Divergence, Curl: Definition, graphical representation of functions with two and three variables, level curves, level surface, contour curves, contour surfaces; Definition of scalar field with examples; Review of partial differentiation; Directional derivative and its geometrical interpretation, Gradient of a function of several variables, Geometrical interpretation of gradient and gradient field; Equation of tangent plane, Vector fields: Definition and examples, Partial derivatives of vector fields, Divergence and curl of vector fields.

Vector Integration: Line integrals, surface integrals, volume integrals, double integration and triple integration; Jacobean of the transformation; Stokes' theorem, Greens' theorem, divergence theorem of Gauss and problems related to them.

Reference Books:
1. Elementary Linear Algebra by Howard Anton, Chris Rorres.
2. Linear Algebra and Its Applications by David C. Lay
3. Vector Analysis – by Murray R. Spiegel, Seymour Lipschutz, and Dennis Spellman
4. Thomas' Calculus – by George B. Thomas, Maurice D. Weir, Joel Hass, and Frank R. Giordano

ME 2113 **Statics and Solid Mechanics**

Credit: 3.0 **Contact hour: 3 hrs/week**

Statics:

Introduction: Fundamental concepts and principle of transmissibility; Resolution of force into components; Resultant of concurrent force systems; Free body diagram, Equilibrium of a particle.

Equilibrium of rigid bodies: Non-concurrent force system, Moment of a force, equilibrium of non-concurrent and parallel force systems; Moment of a couple; equivalent couple; force couple systems; reduction of forces system to force couple system; Analysis of structure: Trusses.

Center of gravity: Centroid of area and volume, Pappus-Guldinus theorem.

Moment of inertia: Inertia of area and mass; radius of gyration; parallel axes theorem; product of inertia.

Law of friction: Equilibrium under frictional resistance, sliding friction; Wedges, belt frictions.

Solid Mechanics:

Stress and Strain: Introduction; Analysis of internal forces; Tensile, compressive, bearing and shearing stresses; Stresses in thin-walled pressure cylinder; Stress-strain diagram; Axial and biaxial deformations; Thermal stresses.

Statically Determinate Beams: Different types of loading and supports; Shear force and bending moment diagrams; Stresses in beams, flexure formula, economic sections, shearing stresses in beams, general shear formula; variation of shearing stresses in beams; Deflection of beams, double integration.

Torsion: Introduction; Torsion formula; Angle of twist; Shaft couplings and helical springs; Analysis and design of circular shaft.

Columns: Introduction; Critical load, slenderness ratio and classification of columns; Euler's formula.

Reference. Books:
1. Vector Mechanics for Engineers: Statics – by Ferdinand P. Beer & E. Russell Johnston, Jr.
2. Mechanics of Materials – by R.C. Hibbeler
3. Strength of Materials – by Andew Pytel and Ferdinad L. Singer

ME 2114 **Sessional on ME 2113**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ME 2113.

ME 2115 **Fluid Mechanics**

Credit: 3.0 **Contact hour: 3 hrs/week**

Introduction and Basics: Definition of a fluid and fluid mechanics, fluid as a continuum, Fundamental concepts: Stress and rate of strain, Viscosity and Newton's law of viscosity, No-slip and no-temperature jump condition, scalar and vector fields; Important Fluid properties; Fluid forces: body and surface forces, their mathematical representation.

Fluid Statics: Condition for fluid statics, pressure at a point, basic equation for pressure field, pressure variation in fluid at rest; Manometers: U-tube, inclined-tube, Bourdon pressure gage; Buoyancy.

Fluid Dynamics and Bernoulli Equation: Lagrangian and Eulerian view of fluid flow, Velocity field, Acceleration field, Material derivative; Classification of fluid motion; Concept of streamlines and streamtubes, Pathlines, Streaklines, and timelines; Deformation of fluid elements, Vorticity, and Rotationality; Continuity equation, Euler equation; Navier-Stokes equation; Bernoulli's equation: derivation, application along and across streamlines, its limitations; Static, dynamic, and stagnation pressures; Energy grade line and Hydraulic grade line.

Control Volume Analysis: Reynolds transport theorem: derivation and interpretation; Concept of systems and control volumes, Derivational and application of integral forms of conservation laws for mass, energy, linear momentum, and angular momentum.

External Viscous Flow: General characteristics of flow past an object and concept of boundary-layer, boundary-layer thicknesses; Momentum integral equation boundary-layer analysis: flow with zero pressure gradient, flow with pressure gradient; Concept drag and drag coefficient, friction drag, pressure drag, streamlining; Concept of circulation, lift, and lift coefficient.

Reference Books:
1. Fluid Mechanics by Yunus A. Cengel and John M. Cimbala. 3rd Edition
2. Fundamentals of Fluid Mechanics by Bruce R. Munson, Donald F. Young, Theodore H. Okiisi, and Wade W. Huebsch, 6th Edition
3. Introduction to Fluid Mechanics by Robert W. Fox, Philip J. Pritchard, and Alan T. McDonald. 8th Edition

ME 2116 **Sessional on ME 2115**
Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ME 2115.

CSE 2113 **Computer Programming**
Credit: 3.0 **Contact hour: 3 hrs/week**

*Out of two only one programming language will be adopted based on department's decision during a particular term

Programming with C
Introduction: Programming languages, compilers, and pseudo-compilers.
Programming paradigm: Structured, object oriented programming, structure of C++ programming.
Data Types and Operator: Declaring variables of different data types and doing different types of operations on them, facing problems when internal result of calculation crosses the boundary of a data type.
Data Input/Output: Variation and formats of getting input and giving output.
Debugging: Program debugging and testing.
Control Statements: Implementation of all types of control statement structures such as if, else-if, nested else-if, switch, goto, while, do-while, for, etc.
Arrays: single and multi- dimensional arrays and their applications: matrix manipulation, sorting of data; **String:** finding vowel and consonant from a given string, detecting palindrome, counting words of a string, reversing each words of a sentence, using different functions of string.h library.
Functions: Doing some previous problems using function, passing arguments by value and by reference.
Recursion: Find Greatest Common Divisor, Fibonacci, Factorial, and Tower of Hanoi.
Program Structure: Use static and global variable.
Pointers: Dynamic memory allocation, arrays of pointers, passing pointers to a function;
Structures and Unions: Data processing using structures and union, linked lists;
File: Opening, closing, creating and processing data files. Introduction to low-level programming

Or

Programming with Octave
Introduction: Programming languages, compilers vs. pseudo-compilers, octave as programming language.
Octave environment: named variables, numbers and formatting, number representation and accuracy, loading and saving data, repeating previous commands, getting help, cancelling a command, semicolons and hiding answers.
Arrays and vectors: building vectors, colon notation, displaying large vectors and matrices, vector creation functions, extracting elements from a vector, vector math.
Plotting graphs: single graph, multiple graphs, multiple figures, manual scaling, saving and printing figures.
Script files: creating and editing a script, running and debugging scripts, remembering previous scripts.
Control statements: if...else selection, switch selection, for loops, while loops, accuracy and precision.
Functions: creating and using functions.

Matrices and vectors: matrix multiplication, the transpose operator, matrix creation functions, building composite matrices, matrices as tables, extracting bits of matrices.
Solving Ax = b: Solution when A is invertible, Gaussian elimination and LU factorization, Matrix division and the slash operator, Singular matrices and rank, Ill-conditioning, Over-determined systems: Least squares, Triangulation.
Eigenvectors and the Singular Value Decomposition: The eig function, The Singular Value Decomposition; Approximating matrices: Changing rank, the SVD function, Economy SVD.
Complex numbers: Plotting complex numbers, finding roots of polynomials.

CSE 2114 **Sessional on CSE 2113**

Credit: 1.50 **Contact hour: 3 hrs/week**

Experiments based on the theory of CSE 2113.

SECOND YEAR SECOND TERM

EE 2213 **Power Electronics**

Credit: 4.0 **Contact hour: 4 hrs/week**

Transistor: Transistor and its current components, BJT characteristics and different regions of operation, different transistor configurations, transistor as a switch and amplifier, transistor biasing, DC and AC load lines, thermal stabilization.

FET: Introduction, Construction and characteristics, MOSFET: depletion type and enhancement type, biasing.

Semiconductor power devices: SCRs, TRIACS, power MOSFET and IGBT, DIAC.

AC to DC controlled converter: Single phase and three phase half wave, full wave and semi-converter, phase control, characteristics, harmonics, power factor control and converter triggering circuits.

AC to AC controlled converter: On-off and phase control, single phase and three phase power controllers and cycloconverter.

DC to DC converter: Chopper, characteristics and operation of step up and step down choppers, switching converter and power regulators.

Inverter: Three phase and single phase voltage source and current source inverters, modulation techniques, voltage, frequency and harmonic control, PWM inverters, resonant converter, space vector modulation in three phase inverters.

EE 2214 **Sessional on EE 2213**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of EE 2213.

Hum2213 **Economics and Accounting**

Credit: 3.0 **Contact hour: 3 hrs/week**

Economics

Micro Economics: Definition and principle of economics; Basic economic ideas and resources allocation in different economic systems; Production possibility curves; Elasticity of demand and supply analysis; Price system and micro economy; Price determination, cost of production and market behavior analysis; Government microeconomic intervention; production, production function, types of productivity; Internal and external economics and diseconomies.

Macro Economics: National income analysis, savings and investment; inflation and monetary policy; Fiscal policy and trade policy with reference to Bangladesh; NPV, IRR, payback period, cost benefit ratio and their application.

Energy Project Appraisal: Causes and analysis; Social and environmental cost and benefit analysis of energy projects and their impact analysis.

Accounting

Introduction: Meaning and Importance of Accounting.

Accounting Equations: Some relevant accounting principles;

Accounting Cycle: Journal–Ledger, Trial balance, Final Financial Accounts (Income statement and balance sheet), Considering adjustment of entries.

Depreciation: Methods of depreciation, straight line and reducing balance method.

Costing: Concept and classification of costs; Labor, overhead and job costing; Marginal costing; Operating costing; Salaries and wages.

Math 2213 **Complex Variables and Fourier Analysis**

Credit: 3.0 **Contact hours: 3 hrs/week**

Complex Analysis: Functions; limits; continuity; complex differentiation, analytic function, Cauchy Riemann equation, harmonic function, orthogonal family of curves; Singular points, Complex integration, Cauchy's theorem, Cauchy's integral formula.

Bessel's Function: Bessel's differential equation; Bessel's function of first kind, its properties and recurrence relations.

Fourier Analysis: Euler Fourier series representation of function, Condition for existence of Fourier Series, Fourier series of different periods, Fourier series for even and odd functions, half range Fourier Series, complex form of Fourier series, Parseval's theorem

Partial Differential Equations: Formation and classification of PDEs; Solution of one dimensional heat equations; Solution of Laplace's equation in 2-dimensional Cartesian and polar coordinates with their application in heat distribution.

Reference Books:

1. *Advanced Modern Engineering Mathematics – by Glyn James*
2. *Advanced Engineering Mathematics – by Erwin Kreyszig*

ME 2213 **Dynamics and Kinematics of Machineries**

Credit: 3.00 **Contact hour: 3 hrs/week**

Kinematics of particles: Motion of particle, rectilinear and curvilinear motion; motion of several particles, rectangular components of velocity and acceleration; Motion relative to frame in translation; tangential, normal, radial and transverse components.

Kinetics of particles: Newton's second law of motion, linear and angular momentum, radial and transverse components of motion.

Kinematics of rigid bodies: Translation; rotation about a fixed axis; general plane motion, motion about a fixed point and general motion; Absolute velocity and acceleration, relative velocity and acceleration; Principle of work and energy and its application; Power and efficiency; Potential energy, conservative forces; Conservation of energy and its application; Principle of impulse and momentum; Direct and oblique central impact.

Kinetics of rigid bodies: Plane motion of rigid bodies; Equation of motion, angular momentum and D'Alembert principle, constrained plane motion; Work of forces acting on a rigid body, Kinetic energy of rigid body in plane motion; Principle of work and energy for the plane motion, principle of impulse and momentum for plane motion; Concentric impact.

Mechanics of Machinery: Inertia and kinetic energy of rotation and reciprocating parts; Turning moment diagram, fluctuation of energy and speed; Fly wheel; Balancing of stationary, rotating and reciprocating masses, balancing of In-line engines and V-engines; Law of gearing forms of tooth and types of gear; Gear trains and their arrangements; Types of governors and their control.

ME 2214 **Sessional on ME 2213**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ME 2213.

ESE 2209 **Bio and Wind Energy Engineering**

Credit: 3.0 **Contact hour: 3 hrs/week**

Bio-energy

Introduction: Concept of biomass and bio-fuel, its characteristics, heating value and composition, bio-energy, photosynthetic efficiency, potential of biomass sources, advantages and disadvantages, energy plantations; Types of sources.

Bio-chemical Conversion: Need of conversion and types; anaerobic digestion – BOD, COD, digester design, biogas production and its feedstock, microbial and biochemical aspects, operating parameters for biogas production, types of digesters, digesters for rural application, high rate digesters for industrial waste; Ethanol production by fermentation – cane molasses and other sources, dry fermentation.

Thermo-chemical Conversion: Pyrolysis: fixed and fluidized bed pyrolysis, reactor design, carbonization, densification, briquetting, preparation of feedstock, torrified product, bio-coal; Gasification and its types; Incineration.

Modern uses of Biomass: Processing for oils and fats, bio-diesel technology, transesterification, Gasohol as a substitute for petrol, chemical composition of bio-diesel; Cogeneration systems.

Wind Energy

Assessing Wind Resources: Basics of wind generation, air density as function of elevation and humidity; Study of Wind profiles - simple log profile, the power law, roughness length, roughness change model, displacement height, wind shear, Weibull distribution of wind speed; Basic terms and definitions related to wind measurement, wind speed measuring instruments and their principle.

Wind Energy Conversion Systems: Classification of wind turbines and their comparison; Horizontal axis wind turbine - major components and angles; Aerodynamic behavior of turbine blades - airfoil terminology, lift, drag, tip speed ratio, flow over airfoil; Vertical axis turbines; Turbine design, One-dimensional momentum theory and Bitz limit, power coefficient, thrust coefficient, overall efficiency, overall power output.

Wind energy project and Environment: Major phases of a wind farm project, activities and cost associated with each phase; Impact of WEC projects on environment.

ESE 2210 **Sessional on ESE 2209**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ESE 2209.

ESE 2230 **Energy Engineering Simulation I**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Solution of Energy Science and Engineering problems using standard simulation software.

THIRD YEAR FIRST TERM

Math 3113 **Statistics and Numerical Methods**

Credit: 3.00 **Contact hour: 3hrs/week**

Statistics:

Basic Statistics: Review of data, Events, Variables; Population and Samples; Grouped data, Ungrouped data, Frequency distribution: Relative and cumulative; Average, Median, Mode, Standard deviation, Moment, Skewness, Peakedness and Coefficient of variation of grouped data.

Basic Probability: Brief overview of sets, Venn diagrams and set operations, Axioms of probability, Probability rules, Conditional probability and Independent events, Bayes formula. Statistical distributions and their uses: Introduction to probability density functions and their physical significance, Geometric, Binomial, Poisson, Normal, Uniform, Exponential distributions.

Numerical Methods:

Roots and Optimization: Bisection and Newton-Raphson method; Use of root finding functions in Octave – `fzero`, `roots`, `poly`, `polyval`; Basics of optimization and golden-search technique; Use of root optimization functions in Octave – `fminbnd`, `fminsearch`.

Solution of Linear Equation: Gaussian elimination and pivoting, LU decomposition; Diagonal dominance and condition number of a matrix, Gauss-Seidel and Jacobi method; Use of Octave functions for solution of linear systems.

Curve Fitting and Interpolation: Linear and polynomial regression; Newton's formulae for forward and backward interpolation, Lagrange's interpolation method; Use of curve-fitting functions in Octave – `interp`, `polyfit`, `spline`.

Numerical Calculus: Forward, backward and central difference formula for first and second order derivative; Trapezoidal rule, Simpson's rule for integration; Euler, Heun, and Runge-Kutta methods solving initial –value problems, basics of boundary vale problem and shooting method. Use Octave functions – `quad`, `ode45`, `ode15s`, and `bvp4c`; Application of numerical calculus to problems from fluid mechanics, heat transfer, and control engineering.

Reference Books –

1. Applied Statistics and Probability for Engineers, 6th Ed. – Douglas C. Montgomery and George C.
2. Applied Numerical Methods with MATLAB for Engineers and Scientists, 3rd Ed. – by Steven C. Chapra.
3. Numerical Methods for Engineers and Scientists, 3rd Ed. – Amos Gilat, Vish Subramaniam.

Math 3114 **Sessional on Math 3113**

Credit: 1.50 **Contact hour: 3 hrs/week**

Computer applications on the problems based on the theory of Math 3113.

EE 3113 **Power System Engineering**

Credit: 3.0 **Contact hour: 3 hrs/week**

Introduction to Power System: Basics of Power System Engineering, Electrical supply system, AC and DC power supply schemes.

Transmission lines: Flux linkages, inductance due to external flux, and inductance of single-phase two-wire line. Electric field, capacitance of two wire line, effect of earth, representation of lines: short, medium and long transmission lines, T and π representation. Sag and stress analysis, effect of wind and ice loading, supports at different elevation, conditions of erection, effects of temperature changes, corona & corona power loss.

Insulators for overhead lines: Types of insulators, potential distribution in a string of insulators, string efficiency, methods of equalizing potential distribution.

Load flow and fault analysis: P.U. method of performance calculation, P.U. impedance of three winding transformers, and Power flow in simple systems, voltage and frequency controls. Symmetrical three phase faults on synchronous machine, Unsymmetrical Faults: Single line to ground fault, line to line fault, double line to ground fault.

Circuit breakers and fuse: Circuit breakers' types, ratings, constructions, and selections. Arc extinction, recovery voltage. Constructions, characteristics, and applications of commercially available fuses. Types, construction, operating principle of over current relays. Lightning arrestors, surge absorbers, ground wire, generators grounding.

Introduction to Smart grid: Definition, key functions of smart grid, smart grid's control elements and their operations, smart grid's communications and cyber security.

Reference Books:

1. *Mehta. Principles of Power System- V.K.Mehta and Rohit Mehta*
2. *Elements of Power System Analysis, 4th Ed-William D. Stevenson*
3. *Electrical Power Systems- C.L. Wadhwa*

EE 3114 **Sessional on EE 3113**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of EE 3113.

ESE 3105 **Heat Transfer and Mass Transfer**

Credit: 4.00 **Contact hour: 4hrs/week**

Introduction: Basic modes of heat transfer; Thermal properties of materials.

Conduction: Law of conduction, Heat conduction equations in one, two and three dimensions; Solution of steady heat flow with and without heat generation, Consideration of variable thermal conductivity; Composite walls; Heat transfer augmentation, fins of uniform cross-sections, critical thickness of insulation; Unsteady heat conduction, Use of Heisler's chart.

Convection: Review of hydrodynamic equations for boundary layer theory, Analysis of thermal boundary layer by control volume method; Laminar heat transfer over flat plate; Fully developed flow heat transfer through smooth pipes, Cases of constant heat flux and constant wall temperature boundary conditions; Applications of dimensionless numbers; Correlation of heat transfer in turbulent flow; Use of hydraulic diameter. Correlations for free and forced convection heat transfer over horizontal and vertical plates, cylinders, spheres and inclined pipes; Horizontal and vertical tube bundles in cross flow.

Heat transfer with change of phase: Condensation. Drop-wise and film-wise condensation, their effect on heat transfer rate; Effect of film turbulence; Nusselt equations, condensation number; Melting and solidification; Boiling: Types of boiling; Processes of bubble growth and bubble dynamics; Pool and film boiling; boiling curve, boiling with vapor production, critical heat flux; Forced convection boiling in horizontal and vertical tubes; Heat transfer rate in different boiling phenomena.

Mass Transfer: Introduction, Fick's law of diffusion; Binary diffusion. Mass transfer coefficient; Basics of absorption, distillation and adsorption.

Reference Books:

1. Fundamentals of Heat and Mass Transfer, 7th Ed. – Frank P. Incropera, David P. DeWitt et al.
2. Heat and Mass Transfer, Fundamentals & Application, 5th Ed. – Yunus A. Cengel and Afshin J. Ghajar
3. Heat Transfer – Gregory Nellis and Sanford Klein
4. Heat Transfer – NecatiOzisik

ESE 3106 **Sessional on ESE 3105**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ESE 3105.

ESE 3107 **Solar Thermal Engineering**

Credit: 3.00 **Contact hour: 3 hrs/week**

Introduction: Review of sun-earth geometry, variation of extraterrestrial radiation, beam and diffuse radiation, direction of beam radiation, R_b factor, total radiation on horizontal and inclined surfaces, variation of radiation, monthly average values, estimation of daily average daily total radiation, KT method, hourly radiation from daily data.

Heat Transfer Concepts: Theory of thermal radiation, Radiation properties, Planck's law, Wien's displacement law, Stefan-Boltzmann equation; Concept of black body and gray body; Spectral dependence of radiation properties; Kirchhoff's law; Shape factor; Radiation exchange between surfaces, Re-radiating surfaces; Radiation shields.

Flat Plate Collectors: Introduction, construction methodology and classification; Critical radiation level; Mean fluid temperature; Overall heat loss coefficient; Energy balance equation of FPC; Effective transmittance-absorptance product; Testing of collector, collector efficiency factor; Heat removal factor and flow factor; Heat capacity factor in FPC; Optimum inclination of FPC. Evacuated tube cover collector, Evacuated-tubular collector, thermal efficiency, evacuated tube with heat pipe.

Concentrating Collectors: Introduction, characteristic parameters; Concentration ratio, optical efficiency; Classification of concentrators; Tracking of concentrators, tracking methods; Thermal analysis; Materials for concentrators.

Application: Solar water heating, heat collection in storage tank, effect of heat load; Solar air heating, room heating, crop heating; Solar distillation, working principle and thermal efficiency; Solar cooling; Solar thermal power generation schemes; Central receiver power plants; Dish Stirling systems; Solar ponds, Thermal analysis of solar power plants.

Reference Books:

1. Solar Engineering of Thermal Process - J. A. Duffie, W. A. Beckman, John Wiley & Sons Inc
2. Solar Energy: Fundamentals, Design, Modeling and Applications –G. N. Tiwari, Narosa Publishing House
3. Solar Energy Engineering,2nd Edition -Soteris A. Kalogirou, Academic Press

ESE 3108 **Sessional on ESE 3107**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ESE 3107.

ESE 3123 **Thermo-fluid Devices**

Credit: 3.00 **Contact hours: 3 hrs/week**

Pipe flow: Buckingham π theorem; Hydraulic diameter, flow regimes based on Reynolds number; Laminar flow in pipes, entrance region and velocity profile, fully developed flow and average velocity, pressure drop and head loss; Turbulent velocity profile in pipes, use of Moody Chart and Colebrook equation; Major and minor losses; Flow rate and velocity measurement – pitot tube, obstruction flow meters, rotameter, turbine flow meters.

Compressible flow: Distinction between compressible and incompressible flow**,** One-dimensional isentropic compressible flow; Variation of flow velocity with area, flow through converging-diverging nozzle and chocking; Shock wave.

Pump Compressor and Blowers: Classification of turbomachinery**;** Water horsepower, brake horsepower, efficiency for pumps; Pump performance curve, pump sizing for piping systems; Cavitation and NPSH; Pump Scaling laws, pump specific speed, affinity laws; Fans, blowers and compressors, compressor intercooling.

Heat Exchangers: Classification of heat exchangers, Overall heat transfer coefficient, fouling factor; Analysis using LMTD and NTU method, Design of double-pipe heat exchangers, shell-and-tube heat exchangers and TEMA standards; Plate heat exchangers.

Reference Books:

1. Fluid Mechanics Fundamentals and Applications, 3rd ED. – Yunus A. Cengel, John M. Cimbala.
2. Fox and McDonald's Introduction to Fluid Mechanics, 8th ED. – Philip J. Pritchard, John C. Leylegian.
3. Fundamentals of Heat and Mass Transfer, 7th ED. – Frank P. Incropera, David P. DeWitt et al.
4. Process Heat Transfer Principle, Application and Rules of Thumb, 2nd ED – Robert W. Serth, Thomas G. Lestine.

5. Heat Transfer in Process Engineering – Eduardo Cao.

ESE 3124 **Sessional on ESE 3123**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ESE 3123 and design problems related ESE 3123.

THIRD YEAR SECOND TERM

ESE 3200 **Seminar on Special Topics**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

The department will arrange special lectures on recent research and technology in the field of energy engineering by the expert from inside or outside of the university for the students. Students are required to perform case studies on topics pertaining to energy science and engineering. At the end of the semester, each student will hand in a report and give presentation of his or her study.

ESE 3202 **Energy Innovation Lab**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

The student will fabricate a model of a system using their innovative idea under guidance of a faculty. At the end of the semester, each student will hand in a report and give presentation of his or her project for evaluation.

ESE 3203 **Petroleum and Natural Gas Processing**

Credit: 3.00 **Contact hour: 3 hrs/week**

Petroleum: Composition of Petroleum; thermal properties of petroleum, important product properties and test methods; Dehydration of Crude Oil, Desalting of Crude Oil, Crude Oil Stabilization and Sweetening, distillation of petroleum, ADU, VDU, blending of gasoline; fraction-impurities, treatment of gasoline, treatment of kerosene, wax and purification; Cracking, catalytic cracking, catalytic reforming, naphtha cracking, cooking, hydrogen processes, and alkylation processes isomerization processes.

Natural Gas: Origin of natural gas, Properties of natural gas, overview of the natural gas industries in Bangladesh.

Gas and Liquid Separation: Separation Equipment, Types of separators, Separation principles, Factors affecting separation, Separator design, Low temperature separation, Two-phase Gas-Oil Separation, Three-Phase Oil-Water-Gas.

Dehydration Processes: Dehydration of natural gas, Gas hydrates, Hydrate inhibition, Absorption dehydration, Adsorption dehydration.

Desulfurization Processes: Sweetening of natural gas, Sour gas treating, Sulfur removal processes, Solid bed sweetening processes, Physical absorption and chemical absorption process.

Gas Flow Measurements and Control: Fundamentals of gas flow through conduits, orifice meter, Flow control and pressure regulating instruments.

LNG and LPG: Basics, Properties, Composition, Liquefaction technologies, Production processes, LNG carrier, LPG cylinders/tanks/vessels, Storage and handling, LPG cylinder sizing, Fire hazards, Safety legislation, Commercial and industrial uses.

Lube oil: Lube Oil Base Stocks, Lube oil processing, Propane de-asphalting, solvent extraction, De-waxing, Specifications of lube oil, Lube Additives.

Reference Books:

1.Modern Petroleum Refining Processes,5th Ed.- B. K. BhaskaraRao
2. Gas Production Engineering- Sanjay Kumar, Gulf Publishing Company
3. Petroleum Refining Technology- Ram Prasad , Khanna Publishers
4. Petroleum Refinery Engineering -Nelson, W. L.
5. Gas Conditioning and Processing- John M. Campbell

ESE 3204 **Sessional on ESE 3203**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ESE 3203.

ESE 3207 **Solar Photovoltaic System**

Credit: 3.00 **Contact hour: 3hrs/week**

Introduction: PV physics, band structure and Fermi level in semiconductors, pn-junctions, diode models, photon interactions with semiconductors.

PV Cell Fundamentals: Working principle, Computing PV cell power, equivalent circuit models, short- and open-circuit properties, fill factor, and parasitic resistances. PV cell external and internal quantum efficiency, and computing the spectral response. Theoretical cell efficiency, multi-junction devices, the Shockley-Queisser limit. Antireflection coatings, cell passivation, and cell optical properties.

PV Technology: PV cell architecture and fabrication steps, characterization techniques crystalline Si substrates, thin film deposition, amorphous Si, CIGS, and CdTe thin-film cells.

PV Systems: Introduction to PV systems, Location and orientation issues, factor affecting performance, PV cells wired in series and parallel, shaded and faulty cell effects, Components of PV systems, system integration- online and offline, inverters, design criteria, calculation, economics and ecology of PV system, load analysis, life cycle analysis and cost estimation.

Reference Books:

1., Solar Photovoltaic System Applications: A Guidebook for Off-Grid Electrification -Mohanty, Parimita, Muneer, Tariq, Kolhe. Mohan L.

2.. Solar Photovoltaic Technology And Systems - Chetan Singh Solanki

3. Photovoltaic Systems Engineering - Roger A. Messenger

ESE 3208 **Sessional on ESE 3207**

Credit: 0.75 **Contact hour: 3/2 hrs/week**

Experiments based on the theory of ESE 3207.

ESE 3211 **Coal Power Generation**

Credit: 4.00 **Contact hour: 4 hrs/week**

Introduction: Types of Coal and their Characteristics; Geology of coal; evaluation of coal for different uses; proximate and ultimate analysis of coal; Overview of coal power in Bangladesh and world; Role of coal in the overall energy situation.

Coal and Ash Handling: Necessity of coal handling system, Out-plant handling, Coal preparation, Coal Transfer, Coal storage, In-plant handling, Coal feeding arrangements; Bottom ash, Fly ash, Ash handling systems; Fundamental Concept of Control and Monitoring of Ash handling Plant; Dust collection and its disposal, Types of dust collectors and their working principle.

Coal Combustion: Coal burning furnaces, Firing Methods, Types of stokers and their working principle, Combustion Mechanism, Kinetics of Combustion Reactions, Combustion equipments for Burning of coal, Pulverized coal, Various pulverizing mills, screening, mechanical and thermal dewatering, Pulverized coal firing systems, Pulverized coal burners.

Clean Coal Technology: Introduction to clean coal technologies, Pre-Combustion Coal Cleaning and Capture of CO_2, Post-Combustion Capture of CO_2, Carbon Capture and Oxyfuel Combustion, CO_2 Compression, Transportation and Sequestration. Combustion Strategies to Reduce NO_X Production, Capture of SO_2 and NO_X, Combined SO_2 and NO_X Removal, Mercury Removal, International Regulations of Coal-Fired Emissions, Advanced Pulverized Coal-Fired Power Plants, Integrated Gasification Combined Cycle Systems.

Steam Generators: Introduction to Power Station Steam Generators, Boiler classification, general design considerations, boiler specifications, working principle of Fire tube and water tube boilers, high pressure and supercritical boilers, positive circulation boilers, fluidized bed boiler, waste heat recovery boiler, major boiler mountings and accessories, boiler efficiency.

Steam turbines: Types, Impulse and reaction turbine, convergent and divergent nozzles, Stage efficiency, Degree of reaction. Performance of steam turbines. Compounding of turbines, optimum velocity ratio, reheat factor and condition line, loses in steam turbine, Steam turbine governing,

Reference Books:
1. P. Breeze. 2015. Coal-Fired Generation, 1st Edition. Academic Press, USA.
2.P. Jayarama Reddy. 2013. Clean Coal Technologies for Power Generation. 1st edition, CRC Press.
3.B. Miller and B. Miller. 2010. Clean Coal Engineering Technology , 1st Edition, Butterworth-Heinemann
4. Thermal Engineering – P.L. Ballaney
5. Steam Turbine - Kearton

ESE 3217 Instrumentation and Control
Credit: 3.00 Contact hour: 3 hrs/week

Instrumentation: Functional elements of a measurement system; Sensors for temperature, flow, velocity, linear distance, level, pressure, force, pH measurement; Control valve sizing and selection**;** Control signal transmission and related industry standards; Study of piping instrument diagram (P&ID)**;** Basic components of Data acquisition system, Error analysis and calibrations.

Dynamic Modeling: Review of conservation and constitutive laws of energy systems and dynamic modeling; Linearization ODEs, Review of Laplace Transform, evaluate transfer function and input-output model; Analysis of first and second order systems – graphical and optimization fit, State-space modelling.

Controller Design: Basics of feedback control**;** P, PI, and PID controller design, tuning, and troubleshooting; Frequency response analysis and control system design, Stability analysis; Basics of cascade control; fuzzy logic, control structure.

Automation: Introduction of PLC, PLC Hardware, Definitions of Allen-Bradley conditional inputs and outputs, I/O configuration, Programming Terminals and Peripherals, Application of PLC in Automation, Automation system components, Industrial communications, Continuous control, overview of SCADA and DCS systems; Microcontroller basics, classification, basic Architecture, memory, registers, I/O ports.

Reference Books -
1. Process Dynamics and Control, 4th Ed. – Dale.E. Seborg, Thomas F. Edgar et al.
2. Process Control, 2nd Ed. – Thomas E. Marlin
3. Schaum's Outline of Feedback and Control Systems, 2nd Ed. - Allen J. Stubberud Ivan J. Williams Joseph J. DiStefano
4.Programmable Logic Controllers: Principles and Applications, 5th Ed.-John W. Webb, Ronald A. Reis
5.Programming and Customizing the AVR Microcontroller-Gadre, McGraw-Hill

ESE 3218 Sessional on ESE 3217
Credit: 0.75 Contact hour: 3/2 hrs/week

Experiments based on the theory of ESE 3217.

ESE 3221 Energy Storage Systems

Credit: 3.0 Contact hour: 3 hrs/week

Introduction: Need of energy storage; Different modes of Energy Storage; Comparative Ratings and Properties: System Ratings, Energy density, Power density and specific power.

Mechanical Energy Storage: Pumped hydro storage, Elastic energy storage, Energy storage in Advanced Flywheels, Compressed air energy storage

Thermal Energy Storage: Sensible heat storage system, Latent heat storage system, Solar energy storage systems.

Electrochemical Energy Storage: Structure, working principle, Classification of Batteries; Batteries with aqueous electrolyte: Lead-acid, Alkaline, Nickel-iron, Nickel-cadmium, Ni-MH; Batteries with nonaqueous electrolyte: Lithium-metal, Lithium-metal polymer, Lithium-ion, Lithium-iron phosphate, Lithium-ion polymer, Large size Batteries: Sodium-sulfur (NaS) Battery, Vanadium Redox flow battery; Modeling of batteries; Battery Management System; Aging of electrochemical batteries;

Electro-magnetic Energy Storage Superconducting Magnet Energy Storage (SMES) systems, Sizing of SMES; Capacitor and Batteries: Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor (EDLC), principle of working, structure performance and application.

Advanced Energy Storage Systems: Fuel cell: Principle of working, Basic thermodynamics and electrochemical principles, Classification, Electrolytes, Fuel types, Fuel cell electrodes; Applications for power and transportation. Hydrogen System: Its merit as a fuel; Production: from fossil fuels, electrolysis, thermal decomposition, photochemical, photocatalytic, hybrid; Storage: Metal hydrides, Metallic alloy hydrides, Sea as the source of Deuterium.

System Arrangement and application: Storage as grid component, storage with PV systems, Hybrid Power plant, Fast charging stations, Advanced System Architecture, Uninterruptible power supply (UPS).

Reference Books:

1. Energy Storage: Fundamentals, materials and applications - Robert A. Huggins
2. Energy Storage: Systems and components - Alfed Rufer
3. Energy Storage: Technologies and application - Ahmed Faheem Zobaa

ESE 3222 **Sessional on ESE 3221**

Credit: 0.75 **Contact hours: 3/2 hrs/week**

Experiments based on the theory of ESE 3221.

ME 3250 **Industrial Attachment**

Credit: 0.0

The student will participate in attachments (for one to two weeks) in relevant industries to get hands on working experiences. Time of the industrial attachment will be decided by the department. Student will submit a report after completion of their industrial attachment.