

Khulna University of Engineering & Technology
Department of Biomedical Engineering (BME)
Undergraduate Syllabus (Approved)

Summary of Courses

First Year First Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 1101	Basic Biomedical Engineering	3.00	
02	EEE 1115	Electrical Circuits	3.00	
03	EEE 1116	Electrical Circuits Laboratory	1.50	
04	ME 1116	Engineering Drawing and Design	1.50	
05	Ph 1115	Physics	3.00	
06	Ph 1116	Physics Laboratory	0.75	
07	Ch 1115	Chemistry	3.00	
08	Ch 1116	Chemistry Laboratory	0.75	
09	Math 1115	Differential and Integral Calculus	3.00	
Total			19.50	

First Year First Term Load = **15L + 9.0P = 24.0** Hrs/week = **19.50** Credit

First Year Second Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 1201	Biochemistry	3.00	
02	BME 1202	Biochemistry Laboratory	0.75	
03	EEE 1215	Analog Electronics	3.00	
04	EEE 1216	Analog Electronics Laboratory	1.50	
05	CSE 1215	Computer Programming	3.00	
06	CSE 1216	Computer Programming Laboratory	1.50	
07	Hum 1215	Technical English	3.00	
08	Hum 1216	Technical English Laboratory	0.75	
09	Math 1215	Coordinate Geometry and Differential Equations	3.00	
Total			19.50	

First Year Second Term Load = **15L + 9P = 24.0** Hrs/week = **19.50** Credit

Yearly Total Credit = **19.50 + 19.50 = 39.00**

Second Year First Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 2101	Human Anatomy	3.00	
02	BME 2151	Numerical Methods and Statistics	4.00	
03	BME 2152	Numerical Methods and Statistics Laboratory	1.50	
04	ECE 2115	Digital Electronics and Logic Design	3.00	
05	ECE 2116	Digital Electronics and Logic Design Laboratory	1.50	
06	ME 2115	Basic Mechanics and Thermodynamics	3.00	
07	ME 2116	Basic Mechanics and Thermodynamics Laboratory	1.50	
08	Math 2115	Transforms Analysis	3.00	
Total			20.50	

Second Year First Term Load = **16L + 9.0P = 25.0** Hrs/week = **20.50** Credit

Second Year Second Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 2201	Human Physiology	3.00	
02	BME 2202	Human Physiology Laboratory	1.50	
03	BME 2211	Signals and Systems	3.00	
04	BME 2212	Signals and Systems Laboratory	1.50	
05	BME 2231	Biomedical Instrumentation	3.00	
06	BME 2232	Biomedical Instrumentation Laboratory	1.50	
07	Hum 2215	Economics and Sociology	3.00	
08	Math 2215	Linear Algebra, Complex Variable and Vector Analysis	4.00	
Total			20.50	

Second Year Second Term Load = **16L + 9.0P = 25.0** Hrs/week = **20.50** Credit

Yearly Total Credit = **20.50 + 20.50 = 41.00**

Third Year First Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 3101	Cell Biology	3.00	
02	BME 3111	Biomedical Signal Processing	3.00	
03	BME 3112	Biomedical Signal Processing Laboratory	1.50	
04	BME 3114	Biomedical Modeling and Simulation Laboratory	1.50	
05	BME 3141	Radiation and Ultrasound Imaging	3.00	
06	BME 3142	Radiation and Ultrasound Imaging Laboratory	1.50	
07	CSE 3115	Microprocessors and Microcontrollers	3.00	
08	CSE 3116	Microprocessors and Microcontrollers Laboratory	1.50	
09	Hum 3115	Occupational Psychology	2.00	
Total			20.00	

Third Year First Term Load = **14L + 12.0P = 26.0** Hrs/week = **20.00** Credit

Third Year Second Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 3200	Biomedical Systems Design Project	1.50	
02	BME 3211	Biomaterials	3.00	
03	BME 3213	Biomechanics	3.00	
04	BME 3231	Biomedical Devices and Control	3.00	
05	BME 3214	Biomedical Devices and Control Laboratory	1.50	
06	BME 3241	Magnetic and Nuclear Imaging	3.00	
07	BME 3242	Magnetic and Nuclear Imaging Laboratory	1.50	
08	ECE 3215	Body Sensor Networks	3.00	
09	ECE 3216	Body Sensor Networks Laboratory	1.50	
Total			21.00	

Third Year Second Term Load = **15L + 12.0P = 27.0** Hrs/week = **21.00** Credit

Yearly Total Credit = **20.00 + 21.00 = 41.00**

Fourth Year First Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 4000	Final Year Project/Thesis*	3.00	
02	BME 4111	Biomedical Image Processing	3.00	
03	BME 4112	Biomedical Image Processing Laboratory	0.75	
04	BME 4131	Bio-optics	3.00	
05	BME 4141	Brain and Neuro engineering	3.00	
06	BME 4142	Brain and Neuro engineering Laboratory	0.75	
07	BME 4170	Seminar	0.75	
08	BME 41**	Optional I	3.00	
09	BME 41**	Optional II	3.00	
Total			20.25	

*Continued to the second term

Fourth Year First Term Load = **15L + 10.5P = 25.5** Hrs/week = **20.25** Credit

Fourth Year Second Term

Si. No.	Course No.	Course Title	Credit	Remarks
01	BME 4000	Final Year Project/Thesis	3.00	
02	BME 4231	Telemedicine and Health Care	3.00	
03	BME 4232	Telemedicine and Health Care Laboratory	1.50	
04	BME 4251	Biomedical Ethics, Safety and Practice	3.00	
05	BME 4253	Hospital Management	3.00	
06	BME 42**	Optional III	3.00	
07	BME 42**	Optional IV	3.00	
Total			19.50	

N.B.: The course BME 4000 will be evaluated at the end of 4th year 2nd term

Forth Year Second Term Load = **15L + 9.0P = 24.0** Hrs/week = **19.50** Credit

Yearly Total Credit = **20.25 + 19.50 = 39.75**

Total = **39.00 + 41.00 + 41.00 + 39.75 = 160.75**

Optional Courses

Optional I (BME 41**)	BME 4101 Cell and Tissue Engineering BME 4103 Genetic Engineering BME 4105 Protein Engineering BME 4107 Genes and Human Disease
Optional II (BME 41**)	BME 4113 Bio MEMS BME 4115 Medical Robotics BME 4123 Molecular Modelling BME 4133 Biosensors and Biochips
Optional III (BME 42**)	BME 4213 Prosthetics and Artificial Organs BME 4217 Rehabilitation Engineering BME 4219 Brain Computer Interfaces BME 4255 Bio-Analytical Methods
Optional IV (BME 42**)	BME 4215 Bio-Nanotechnology BME 4221 Bioinformatics BME 4233 Clinical Engineering BME 4235 Bio-photonics

Contents of Biomedical Engineering Courses

First Year First Term

BME 1101 Basic Biomedical Engineering

Credit: 3.00

Contact Hours: 3 Hrs/week

Introduction: Definition, basic principles and problems in biomedical engineering, biomedical engineers, main fields of biomedical engineering, familiarization with the enabling technologies for biomedical engineering.

Electrophysiology: Concepts of cell, cell membrane, ion channel, resting and action potentials.

Biomaterials: Definition, properties, examples, biocompatibility, practical applications of biomaterials.

Bio-signals and bio-signal processing: Definition, classification, and origin of bio-signals, Overview of ECG, EEG and EMG signals, introduction to bio-signal processing, steps of bio-signal processing, applications of bio-signals and bio-processing.

Bioinstrumentation: Concepts of biosensors and transducers, bio-electrodes, medical instrumentation system, basic medical instruments and their applications.

Biomechanics: Definition, subfields of biomechanics, applications of biomechanics.

Medical imaging: Definition, Imaging modalities and their applications.

Overview of various topics: Molecular engineering, tissue engineering, rehabilitation engineering, biotechnology, bio-nanotechnology, etc.

Applications: Applications of engineering principles to selected medical and biological problems, Contemporary issues and roles of biomedical engineering.

EEE 1115 Electrical Circuits

Credit: 3.00

Contact Hours: 3 Hrs/week

Fundamental concepts: Voltage, current, power, energy, independent and dependent sources, sources of E.M.F., primary and secondary cells, resistance and impedance.

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

Basic circuit laws: Ohm's law, Kirchhoff's current and voltage laws, series and parallel circuits, voltage and current division, Wye-Delta transformation.

Circuit analysis: Nodal and mesh analysis, source transformation, Thevenin's, Norton's and Superposition theorems with applications, Millman's theorem, Compensation theorem, Maximum power transfer theorem and Reciprocity theorem.

Magnetic circuits: Flux, permeability and reluctance, magnetic potential, flux density, magnetization curve; Laws of magnetic circuits: Ohm's law and Ampere's circuital law, different combination of magnetic circuits, magnetic resonance.

Alternating current circuits: Introduction to alternating current circuits, use of phasor and phasor algebra, instantaneous, average and R.M.S values, complex impedance; Power relations in A/C circuits: real, reactive and apparent power, power factor, power factor improvement.

Single-phase AC circuits: Series and parallel RL, RC and RLC circuits, series and parallel resonance.

Introduction to filter: Definition, types and its applications.

Measuring instruments: Introduction to ammeter, voltmeter, ohmmeter, multi meter, galvanometer and wattmeter.

EEE 1116 Electrical Circuits Laboratory

Credit: 1.50

Contact Hours: 3 Hrs/week

Experiments based on EEE 1115 Electrical Circuits

ME 1116 Engineering Drawing and Design

Credit: 1.50

Contact Hours: 3 Hrs/week

Fundamental concepts: Principles and applications of orthogonal projection; Visibility, Angle problem; Oblique projection; Isometric projection; Auxiliary projection, Orthographic and auxiliary projection from pictorial views; Pictorial projection from orthogonal views; Development of objects.

Descriptive geometry: Projection, Methods of transferring projection, Practical application of descriptive geometry.

Drawing: Drawing of different machine elements with sectional views.

Design: Idea visualization; Flow-charting; Design optimization; Scientific instrument design; Manufacturing technology; Product design; Solid design; Design analysis.

Ph 1115 Physics

Credit: 3.00

Contact Hours: 3 Hrs/week

Wave and oscillations: Wave and composition of simple harmonic motion, simple harmonic motion, average value of kinetic and potential energies of a harmonic oscillation, superposition of simple harmonic motions, uses of Lissajous figure, damped oscillatory system, damped harmonic oscillation, the RLC circuit, forced vibration, quality factor of forced oscillator, sharpness of resonance, phase of driven oscillator, power absorption, types of waves, progressive and stationary wave, energy distribution due to progressive and stationary wave.

Sound wave and acoustics: Audible, ultrasonic, infrasonic and supersonic waves, Doppler's effects and its application, applications of ultrasonic sound, intensity of sound, Bel, sound pressure level, phonon, acoustic intensity, architectural acoustic, diffraction of sound, musical sound, and noises, speech, characteristic's of musical sound, interference of sound wave, phase velocity and group velocity.

Electroacoustics (acoustical engineering): Electroacoustic phenomena, Electroacoustic music, Electroacoustic modulator.

Interference: Nature of light, interference of light, coherent source, young double slit experiment, energy distribution, condition for interference, production of interference fingers, Fresnel Bi-prism, Newton's ring.

Optical instrument: Photographic camera, simple microscope, compound microscope, telescope, astronomical telescope, spectrometer.

Radiation and nuclear physics: Black body radiation, Planck's quantum hypothesis, Photo electric effect, Compton effect, quantum state of energy, Dual character of light, X-ray diffraction, formulation of Bragg and Von Laue, application of x-ray, nuclear radiation, radioactivity, radioactive disintegration, artificial radioactivity, natural radioactivity, application of radioactivity, nuclear reactors.

Ph 1116 Physics Laboratory
Contact Hours: 3/2 Hrs/week

Credit: 0.75

Experiments based on Ph 1115 Physics

Ch 1115 Chemistry
Contact Hours: 3 Hrs/week

Credit: 3.00

Crystal: Crystal and X-ray, crystal growth, crystal lattices and lattice symmetry, seven crystal systems, unit cell, defects in crystal.

Photochemistry: Definition, Beer-Lambert law, Luminescence, Fluorescence, Phosphorescence, Laws of photochemistry, Quantum yield, Photosensitized reaction.

Nuclear chemistry: Basic concepts of nuclear chemistry, Radiochemistry, Nuclear force, Nuclear reactions, Nuclear reactor, Application of nuclear chemistry.

Electro-chemistry: Electrolytes, Conductance, Origin of EMF, Nernst theory, Type of electrodes and electrode potentials, Transport number, Free energy and EMF, Electrical double layer, Factors affecting electrode reaction, Battery, Fuel cell, pH and its determination.

Chemistry of polymer: Polymer and polymerization, Co-polymerization, Living polymer, Structure and properties of polymer, conducting polymer.

Polarographic analysis: Current-voltage relationship, Mass and transport processes, Direct current (DC) polarography, Principles, advantages and applications of DC polarography, cyclic voltametry.

Ch 1116 Chemistry Laboratory
Contact Hours: 3/2 Hrs/week

Credit: 0.75

Experiments based on Ch 1115 Chemistry

Math 1115 Differential and Integral Calculus
Contact Hours: 3 Hrs/week

Credit: 3.00

Differential calculus: Limit, continuity and differentiability; Differentiation: application of differentiation; Successive differentiation: Successive differentiation of different types of functions; Leibnitz's theorem; Expansion of functions: Rolle's theorem, Mean value theorem, Taylor's theorem in finite and infinite forms, Maclaurin's theorem in finite and infinite forms, Expansion of functions by differentiation; Indeterminate forms, L' hospitals Rule; Partial differentiation: Differentiation of multi-variable functions, Euler's theorem; Maximum and minimum: Maxima and minima of functions of one and two independent variables, Physical applications; Tangent and normal: Tangents and normals, Subtangent and subnormal in Cartesian and polar co-ordinates; Asymptotes; Curvatures: Curvature, Radius of curvature, Circle and centre of curvature, Chord of curvature in cartesian and polar co-ordinates.

Integral calculus: Definition of integration; Integration by the method of substitution; Integration by parts; Standard integrals; Integration by the method of successive reduction; Definite integrals, its properties and uses in summation of series; Wallis's formula; Improper integrals: Improper integrals, Differentiation under the sign of integration, Integration under the sign of integration; Beta and gamma functions; Double integration and triple integration for finding area and volume, Jacobian of the transformation.

First Year Second Term

BME 1201 Biochemistry
Contact Hours: 3 Hrs/week

Credit: 3.00

Introduction: The molecular logic of life, Biomacromolecules- compositions and principles of organization, Energy and principles of bioenergetics.

Carbohydrate: Definition, Classification, Structure, properties and reactions of carbohydrates, Biological importance of carbohydrates, Uses of carbohydrates.

Protein: Classification, Amino acids, Structure, properties and chemical reactions, Electrophoresis and architecture of protein molecules, Functions of protein.

Enzymes: Chemical nature, General properties, Spectro-photometric measurement of enzymes, Isolation techniques, Enzyme biotechnology.

Lipids: Classification, Metabolism of lipids, Cholesterol, Bile acids, Transport of lipid metabolism, Chemical nature of lipid types: fatty acids, TAG, phospholipids, sphingolipids, glycolipids.

Nucleic acids: Definition, Chemical composition and function, Nucleosides and nucleotides, DNA and RNA, Recombinant DNA and its applications.

BME 1202 Biochemistry Laboratory
Contact Hours: 3/2 Hrs/week

Credit: 0.75

Experiments based on BME 1215 Biochemistry

EEE 1215 Analog Electronics
Contact Hours: 3 Hrs/week

Credit: 3.00

Semiconductor devices: Review of semiconductor, p-n junction diode characteristics, and different types of diode with their applications.

Power supply: Rectifier- half and full wave rectifier, regulated power supply, controlled and uncontrolled rectification.

Transistors: Transistor and its current components, transistor as an amplifier, BJT, different transistor configurations and their equivalent circuits, study of load lines, transistor switching times, detailed study of transistor biasing and thermal stabilization.

FET: Introduction, construction and characteristics, transfer characteristics, MOSFET, FET biasing, FET amplifier, NMOS, PMOS and CMOS.

Operational amplifier: Definition, applications, characteristics of Op-Amp, frequency response and noise, instrumentation amplifiers, active filters.

Small signal amplifiers: Analysis of low, medium and high frequencies.

Breakdown devices: Characteristics and applications of SCR, TRIAC, DIAC and UJT.

Power amplifiers: Definition, classification and applications of power amplifiers, push-pull power amplifier, and transistor amplifier with complementary symmetry, Tuned potential amplifier- single, double and cascaded.

Introduction to negative feedback amplifiers and oscillators: Basic concept of negative feedback, Negative feedback amplifier, Basic concept of oscillator, sinusoidal oscillator.

EEE 1216 Analog Electronics Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on EEE 1215 Analog Electronics

CSE 1215 Computer Programming
Contact Hours: 3 Hrs/week

Credit: 3.00

Programming language: Definition, Types of programming language, Program editor, Concepts of high level and low level language.

C fundamentals: The C character set, Identifiers and keywords, Data types, Constants, Variables, Arrays, Declaration, Expressions, Statements, Symbolic constants, Operators & Expressions, Arithmetic operators, Unary operators, Relational & logical operators, Assignment operator, Conditional operators, Library functions, Data input & output functions.

Control statements: While statement, Do while statement, For-Nested loops, if else, Switch, Break, Continue, comma operator, go to statement, programs.

Functions: Defining a function, Accessing a function, Passing arguments to functions, Specifying arguments data types, Function prototypes, Storage classes, auto, Static, Extern and register variables.

Arrays: Defining an array, Processing array, passing array to a function, Multi dimensional array, Array & strings.

Pointers: Declarations, Pointers to a function, pointer and one dimensional array, operating a pointer Pointers and multi dimensional arrays, arrays of pointers, passing functions to other functions.

Structures and unions: Definitions-Processing a structure-User defined data types-Structures and pointers-passing structure to functions-self referential structures.

Files: Open, close, Process, Operations on a file.

Preprocessor directives: Preprocessor Directives, Command Line Arguments.

C++ fundamentals: Introduction.

CSE 1216 Computer Programming Laboratory

Credit: 1.50

Contact Hours: 3 Hrs/week

Experiments based on CSE 1215 Computer Programming

Hum 1215 Technical English

Credit: 3.00

Contact Hours: 3 Hrs/week

Grammar: Tense, article, preposition, subject-verb agreement, clause, conditional and sentence structure.

Vocabulary building: Correct and precise diction, affixes, level of appropriateness, Colloquial and standard, informal and formal.

Structure and written expression: The noun-phrase, the verb phrase, subject verb agreement, pronouns; verb as complements; questions; affirmative agreement (too/so); negative agreement (either/neither); negation; commands; modal auxiliaries; adjectives and adverbs; comparison; nouns functioning as adjective; enough with adjective, adverbs and nouns; cause connectors; passive voice ; causative verbs; relative clauses; that-other uses; subjunctive; inclusive; use of know/know how; clause of concession; problem verbs; style in written English; problem with vocabulary and prepositions; verbal idioms.

Scientific terminology: Construction of sentences and paragraphs; phrases and idioms; proverbs; punctuation; commercial correspondence and tender notice, amplification and description; Comprehension, précis, abstract; Technical report writing; standard forms of term papers, thesis, etc.

Skill developing: Developing reading skill, writing skill, listening skill and note taking, speaking skill, technical speech.

Hum 1216 Technical English Laboratory

Credit: 0.75

Contact Hours: 3/2 Hrs/week

Experiments based on Hum 1215 English

Math 1215 Coordinate Geometry and Differential Equations

Credit: 3.00

Contact Hours: 3 Hrs/week

Coordinate Geometry of Two Dimensions: Translation and rotation of axes; Identification of conics with their properties.

Coordinate Geometry of Three Dimensions: Cartesian, Cylindrical polar and Spherical polar coordinates; distance of two points; Section formula; Projection; direction cosines and direction ratios; angle between two lines; distance of a point from a line; Planes: different forms of the equation of a plane, distance of a point from a plane, equations of bisector of planes; Straight line: different forms of equations of straight line, angle between a line and plane, coplanar lines, shortest distance between two lines; Sphere: General equation of the sphere, tangent plane, angle of intersection of two spheres; Cone: equation with vertex at origin; Standard equations of central conicoids.

Ordinary Differential Equations: Order and degree of ordinary differential equations; Formation of differential equations; Solutions of first order first degree differential equations by various

methods; Solutions of general linear equations of second and higher orders with constant coefficients; Solution of linear homogeneous equations.

Partial Differential Equations (PDE): Linear PDE with constant coefficients; Solution by separation of variables.

Series Solution: Solution of differential equations in series by the method of Frobenius, Bessel's and Legendre's differential equations and their solutions.

Second Year First Term

BME 2101 Human Anatomy

Credit: 3.00

Contact Hours: 3 Hrs/week

Lower limb: Bones of lower limb; Front of thigh; Medial side of thigh; Gluteal region; Popliteal fossa; Back of thigh; Front, lateral and medial side of leg; Back of leg; Sole of foot; Joints of lower limb; Venous and lymphatic drainage; Arches of foot.

Abdomen: Introduction to abdomen and osteology; Anterior abdominal wall; Male external genital organ; Abdominal cavity and peritoneum; Abdominal part of oesophagus and stomach; Small and large intestine; Large blood vessel of gut; Extrahepatic biliary apparatus; Spleen, Pancreas and liver; Kidney and ureter; Diaphragm; Posterior abdominal wall; Suprarenal gland and chromaffin system; Perineum; Urinary bladder and urethra; Boundary and contents of pelvis; Female reproductive system; Male reproductive organ; Rectum and anal canal; Wall of pelvis.

Upper limb: Bones of upper limb; Pectoral region; Axilla; Back; Cutaneous nerves, superficial veins and lymphatic drainage; Scapular region; Arm; Forearm and hand; Joints of upper limb.

Thorax: Bones and joints of thorax, wall of thorax, thoracic cavity and pleurae; Lungs; Mediastinum; Pericardium and heart; Superior vena cava, aorta and pulmonary trunk; Trachea, oesophagus and thoracic duct.

Head and neck: Osteology head and neck; Scalp, temple and face; Side of neck; Back of neck; Contents of vertebral canal; Cranial cavity; Contents of orbit; Anterior triangle of neck; Parotid region; Temporal and infratemporal region; Submandibular region; Deep structure in neck; Prevertebral region; Mouth and pharynx; Nose and paranasal sinuses; Larynx; Ear; Eye ball.

Brain: Introduction; Meaning of the brain and spinal cord; Spinal cord; Cranial nerves; Brainstem; Cerebellum; Fourth ventricle; Cerebrum; Third ventricle, lateral ventricle and limbic system; Neural pathways and reticular formation; Blood supply of brain and spinal cord.

Histology: Histology of all human organs.

Embryology: Introduction to embryology.

BME 2151 Numerical Methods and Statistics

Credit: 4.00

Contact Hours: 4 Hrs/week

Numerical Errors: Different types of error, Error in functional evaluation, Propagation of error in arithmetic process and Truncation errors.

Single Non-linear Equation: Method of iteration, Bisection method, False Position method, Secant method, fixed point method, Newton Raphson method and its convergence.

Interpolation: Difference tables, Newton interpolation formula and error, Divided difference and central difference formula, Lagrange's Interpolation formula.

Solution of Systems of Linear Equations: Gaussian elimination, Gauss elimination with Pivoting, Gauss-Jordan method.

Numerical Differentiation and Integration: Trapezoidal rule, Simpson's rule, Romberg rule with error and Weddle's method.

Solution of Ordinary and Partial Differential Equations: Modified Euler method, Euler's method; Runge-Kutta method, linear algebraic systems; Introduction to partial differential equation, Geometric interpretation, Elliptic, parabolic and hyperbolic partial differential equation.

Probability: Introduction, sets and probability, random variable and its probability distributions, treatment of grouped sampled data, some discrete probability distributions, normal distribution.

Statistical Analyses: Frequency distribution, Measure of central tendency: Mean median, mode, index number, variance, mean deviation, standard deviation, quartile deviation, time series analysis.

Curve fitting: Relationship between variables, Equations of approximating curves, Straight line, Method of least squares, least square parabola, Problem involving two or more variable.

Correlation and regression: Linear correlation, Measures of correlation, least square regression lines, Standard error of estimate, Coefficient of correlation, Remarks concerning the correlation

coefficient, Rank correlation formula, Regression lines and the linear correlation coefficient, Regression application to time series, sampling theory of correlation and regression.

Hypothesis testing: Test of independence and goodness of fit, Statistical significance, t test, Chi-square test.

BME 2152 Numerical Methods and Statistics Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on BME 2117 Numerical Methods and Statistics

ECE 2115 Digital Electronics and Logic Design
Contact Hours: 3 Hrs/week

Credit: 3.00

Number systems and Boolean algebra: Review of binary, octal and hexadecimal number systems; Conversion methods; Number representation; Signed, unsigned, fixed point, floating point numbers; Addition and subtraction in different bases; Complement, subtraction using complements; Binary multiplication & division; Different coding system; Boolean algebra, various gates, sum of products and product of sums, standard and canonical forms and other logical operations; Simplification of Boolean function using Karnaugh map methods, tabular method, implementation of logic circuit using various gates, universal gates.

Combinational logic design: Design procedure of Adder, subtractor, code converters, parity bit checker and magnitude comparator; Analysis of different combination circuits, encoder, decoder, multiplexer, demultiplexer, ROM, PLA and their applications.

Sequential logic design: Introduction to sequential circuits, analysis and synthesis of synchronous and asynchronous sequential circuits; SR, JK, Master slave, T and D type flip-flops, their characteristics and triggering; Binary counter, classification, Synchronous and asynchronous counter design and analysis, ring counter, Johnson counters, ripple counter and counter with parallel load; Concept of state, state diagram, state table; Serial adder; Sequence detector.

Digital integrated circuits: Characteristics of digital ICs, voltage and current ratings, noise margin, propagation delay, power dissipation; Brief description of TTL, DTL, RTL, ECL, IL, MOS and CMOS logic and their characteristics, principles of operation and application; Comparison of performance of various logic families; Various memory devices and their interfacing; A/D & D/A converters and their applications.

ECE 2116 Digital Electronics and Logic Design Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on ECE 2115 Digital Electronics and Logic Design

ME 2115 Basic Mechanics and Thermodynamics
Contact Hours: 3 Hrs/week

Credit: 3.00

Engineering mechanics: Fundamental concepts and principles of mechanics, Free body diagram, Principles of transmissibility of forces and force couple system, Centroides and center of gravity of area and volume.

Fluid mechanics: Concepts of fluids, Nature and classification of fluids, Basic flow concepts, Fluid statics, Hydrostatic forces on surfaces, Rigid body motion, Pressure measurements, Bernoulli's equation, Flow metering, Introduction to compressible and incompressible flow, Isentropic flows, Fluid dynamic principles and their application in natural organs and substitutes, Flow consideration in their design.

Thermodynamics: Zeroth law of thermodynamics and its significance, Energy and First law, Different thermodynamic processes, Work done during adiabatic and isothermal processes, Energy transfer as heat for a control volume, Second law of thermodynamics, Entropy and heat conduction in human body.

Introduction to heat transfer: Concepts of conduction, convection and radiation.

ME 2116 Basic Mechanics and Thermodynamics Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on ME 2115 Basic Mechanics and Thermodynamics

Math 2115 Transforms Analysis
Contact Hours: 3 Hrs/week

Credit: 3.00

Transform methods: Concept of transformation, Examples for transformation.

Laplace transform: Definition; Existence conditions; Properties of Laplace transforms; Transforms of standard functions, Unit step function, Dirac delta function and Periodic functions; Transforms of derivatives and integrals; Inverse Laplace transform; Convolution theorem.

Fourier analysis: Fourier series and Fourier co-efficient, Dirichlet's condition and Fourier expansion, Convergence of Fourier series, Exponential form of Fourier series, Change of interval, Half range series, Parseval's identity.

Fourier transform: Fourier integrals: Fourier sine, cosine and general integrals; Fourier transform: Finite and infinite Fourier sine and cosine transform, Transforms of standard functions, Properties, Convolution theorem; Discrete and Fast Fourier Transforms: Discrete Fourier Transforms; Discrete convolution, Periodic sequence and circular convolution; Decimation, In-time algorithm; Computation of inverse DFT.

Z-transform: Z-transform of standard functions, Inverse Z-transform (Partial fraction expansions), Properties of Z-transform, Solution of difference equation.

Wavelet transform: Introduction and application in biomedical engineering.

Second Year Second Term

BME 2211 Signals and Systems
Contact Hours: 3 Hrs/week

Credit: 3.00

Introduction: Definition, representation and classification continuous time (CT) and discrete time (DT) signals; Basic CT and DT signals; Basic operations on CT and DT signals; Definition and classification of system.

Continuous time signal and system: Linear time invariant (LTI) systems; Convolution integral; Linearity, causality, time invariance, memory, stability, invertibility; CT system representation by different equations.

Discrete time signal and system: Linear shift invariant (LSI) systems; Convolution sum; Causality and stability; DT system representation by difference equations.

Fourier analysis of CT signals and systems: Continuous Time Fourier Series (CTFS) and Fourier Transforms (CTFT), Properties, Inverse CTFT, Frequency domain characterization of LTI systems.

Sampling: Representing a CT signal by samples, Shannon's Sampling Theorem, Effect of under sampling, Aliasing, Reconstruction of CT signal from samples, Discrete time processing of CT signals.

Fourier analysis of DT signals and systems: Fourier series representation of DT periodic signals, Properties, Representation of DT periodic signals by Discrete time Fourier transform (DTFT), Properties, Inverse DTFT, Frequency response of systems characterized by difference equations.

Transform operations on CT signals and systems: Laplace transform, properties, inverse transform, solution of system equations, system transfer function, system stability and frequency response and applications, convolution integral and its application, superposition integral.

Transform operations on DT signals and systems: Z-transforms and its properties, inverse Z-transform, analysis of LSI systems using Z-transform, stability and causality, solution of difference equation.

BME 2212 Signals and Systems Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on BME 2215 Signals and Systems

BME 2201 Human Physiology
Contact Hours: 3 Hrs/week

Credit: 3.00

Basic concepts of human physiology: Structure of the cell and cell membrane, Function of each component of the cell, Cell reproduction, Membrane potential, Action potential, Secondary messengers.

Blood and immunity: Blood cells and their function, Blood clotting, Blood groups, Estimation of RBC, WBC and PLATELET, Immunity and immunodeficiency, Transplantation, Graft rejection and graft versus host reaction.

Cardiovascular system: Properties of heart muscle, Conductive system of heart, Cardiac cycle, Conduction of cardiac impulse, Electrocardiography, Standard leads of ECG, Regulation of heart rate, Regulation of blood pressure, Fetal circulation.

Nervous system: Structure, Properties and function of neuron, Synapses and synaptic transmission, Concept of sensory receptor and sense organ, Neurotransmitters and their classification, Neuromuscular junction and nerve impulse transmission, Reflexes with their classification and reflex arc, Velocity of conduction of nerve impulse, Autonomic nervous system.

Respiratory system: Pulmonary ventilation, Physical principles of gas exchanges, Pulmonary volume and capacities, Transport of oxygen and carbondioxide in the blood and tissue, Regulations of respiration, Pulmonary function tests.

Digestive and excretory systems: Local hormone of GIT, Digestive enzymes, Mechanism of HCL secretion, Digestion and absorption of GIT, Mechanism of urine formation and acidification of urine, Renal function test, Skin and sweat gland, Secretion of exocrine and endocrine glands, Temperature regulation.

Special senses: Optics of vision, Receptor and neural function of retina, Photochemistry of vision, Central neurophysiology of vision, EOG, Mechanism of hearing, Hearing loss, Audiograms, Hearing tests, Taste and smell sensors.

BME 2202 Human Physiology Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on BME 2217 Human Physiology

BME 2231 Biomedical Instrumentation
Contact Hours: 3 Hrs/week

Credit: 3.00

Introduction: Basic concepts of instrumentation, biomedical instrumentation, biomedical instrumentation system, applications of biomedical instrumentation.

Biomedical amplifiers: Bio-potential amplifiers, instrumentation amplifiers, preamplifiers, their characteristics, limitations and applications.

Sensors and transducers : Historical perspective, signal transduction; sensor and transducer types and technologies, terminology and working principles; Main technical definitions, calibration, selectivity, sensitivity, reproducibility, detection limits, response time, problems and trade-offs.

Physico-chemical transducer: Electrochemical transducers; Semiconductor transducers; Optical transducers; Thermal transducers; piezoelectric and acoustic-wave transducer; Limitations and problems to be addressed, overview of performance and applications.

Biosensors: Catalytic biosensors, mono-enzyme electrodes, bi-enzyme electrodes, enzyme sequence electrodes and enzyme competition electrodes, Affinity based biosensors, Inhibition-based biosensors, Cell-based biosensors, Blood-gas monitoring and blood glucose sensors, Biochips and biosensor arrays, Problems and limitations.

Biomedical instruments: Introduction to diagnostic instruments: ECG, EEG, EMG; Therapeutic instruments: pacemaker, defibrillator, incubator; Life support systems: heart lung machine, haemodialyzer and ventilator; Clinical laboratory instruments: spectrophotometer, automated chemical analyzers.

Biomeasurement: Measurement of bioelectric potential; Blood flow, pressure and volume; Cardiac output; Heart sound of blood;

Electrical safety: Physiological effects of electrical current, Shock hazards from electric equipments, Methods of accident prevention.

BME 2232 Biomedical Instrumentation Laboratory
Contact Hours: 3 Hrs/week

Credit: 1.50

Experiments based on BME 2219 Biomedical Instrumentation

Hum 2215 Economics and Sociology
Contact Hours: 3 Hrs/week

Credit: 3.00

Economics: Definition, scope and methods, Demand, supply and their elasticity's equilibrium analysis partial and general; Consumer behavior, marginal utility, indifference curve, consumer's surplus; producer behavior; iso-quant, iso-cost line. Factors of production function; production possibility curve; fixed cost and variable cost; short run and long run costs, total, average and marginal cost; laws of returns; internal and external economics and diseconomies; market, E-marketing and market forms; perfect and imperfect competition; price output determinations, Introductory ideas on GNP, GDP, perceptual income, interest, rent, saving, investment, inflation; project approval, NPV, IRR & their application, cost benefit analysis, customer to business and business to customer analysis.

Sociology: Definition and importance of sociology; Social structure of Bangladesh; Society, community, association, institution, group; Stages in the evolution of human civilization; Definition and characteristics of culture, culture contents, cultural lag, culture and civilization; The growth of capitalism, features and social consequences, socialism; Family, forms and functions of family, functions of family in modern industrial society, marriage, forms of marriage, functions of marriage, urbanization and industrialization; Change-evolution-progress-development, factors in social change; Human migration, population and resources; Crime, deviance, juvenile delinquency, youth unrest; Effects of technological factors on social life.

Math 2215 Linear Algebra, Complex Variables and Vector Analysis
Contact Hours: 4 Hrs/week

Credit: 4.00

Linear Algebra: Matrix Operations: Field and Matrices over a field, Product of matrices by partitioning, Symmetric, Diagonal and other special types of matrices with their properties, Elementary transformations and equivalent matrices, Rank, Inverse of a square matrix by elementary row operation; Systems of Linear Equations: Solutions of systems of homogeneous linear equations, Existence of nontrivial solutions of set of homogeneous linear equations, Consistency of system of linear equations, Solution of non-homogenous equations using matrix; Vector Spaces: General vector spaces, Column, Row and Null Spaces, Basis and Dimension; Eigen Systems: Eigen values and Eigen vectors; Estimation of the size of Eigen values; Inner-Product Vector Spaces: Inner-product spaces, Orthogonality.

Complex Variable: Complex number system; General functions of a complex variable; Limits and continuity of a function of complex variable and related theorems; Analytic functions, Complex differentiation, sufficient condition for analyticity and Cauchy-Riemann equations; Harmonic functions and conjugate harmonic functions, Construction of analytic functions when either part is given (Milne-Thomson method); Different types singularities; Line integral of a complex function; Cauchy's integral theorem and converse of Cauchy's theorem.

Vector Analysis: Transformation of vectors on a plane: scaling, rotation, translation; Linear dependence and independence of vectors; scalar and vector fields, Differentiation of vectors together with elementary applications; Gradient, divergence and curl of point functions and related forms; Green's, Stoke's and Gauss's theorem and their applications.

Basic Science and Humanities (Physics, Chemistry, Mathematics and Humanities)			
Course Type	Course Code	Course No.	Course Title
Theory	Ph **15	Ph 1115	Physics
	Ch **15	Ch 1115	Chemistry
	Math **15	Math 1115	Differential and Integral Calculus
		Math 1215	Coordinate Geometry and Differential Equations
		Math 2115	Transforms Analysis
		Math 2215	Linear Algebra, Complex Variable and Vector Analysis
	Hum **15	Hum 1215	Technical English
		Hum 2215	Economics and Sociology
		Hum 3115	Occupational Psychology
Laboratory	Ph **16	Ph 1116	Physics Laboratory
	Ch **16	Ch 1116	Chemistry Laboratory
	Hum **16	Hum 1216	Technical English Laboratory
Allied Engineering Courses (EEE, CSE, ECE and ME)			
Course Type	Course Code	Course No.	Course Title
Theory	EEE **15	EEE 1115	Electrical Circuits
		EEE 1215	Analog Electronics
	CSE **15	CSE 1215	Computer Programming
		CSE 3115	Microprocessors and Microcontrollers
	ECE **15	ECE 2115	Digital Electronics and Logic Design
		ECE 3215	Body Sensor Networks
	ME **15	ME 2115	Basic Mechanics and Thermodynamics
Laboratory	EEE **16	EEE 1116	Electrical Circuits Laboratory
		EEE 1216	Analog Electronics Laboratory
	CSE **16	CSE 1216	Computer Programming Laboratory
		CSE 3116	Microprocessors and Microcontrollers Laboratory
	ECE **16	ECE 2116	Digital Electronics and Logic Design Laboratory
		ECE 3216	Body Sensor Networks Laboratory
	ME **16	ME 1116	Engineering Drawing and Design
		ME 2116	Basic Mechanics and Thermodynamics Laboratory

Major Groups in Biomedical Engineering

Cluster Name	Course Code	Course Title
Cellular & Tissue	BME **01–BME**10	BME 1101 Basic Biomedical Engineering

		BME 1201 Biochemistry
		BME 1202 Biochemistry Laboratory
		BME 2101 Human Anatomy
		BME 2201 Human Physiology
		BME 2202 Human Physiology Laboratory
		BME 3101 Cell Biology
		BME 4101 Cell and Tissue Engineering
		BME 4103 Genetic Engineering
		BME 4105 Protein Engineering
		BME 4107 Genes and Human Disease
System Design & Control	BME **11–BME**30	BME 2211 Signals and Systems
		BME 2212 Signals and Systems Laboratory
		BME 3111 Biomedical Signal Processing
		BME 3112 Biomedical Signal Processing Laboratory
		BME 3114 Biomedical Modeling and Simulation Laboratory
		BME 3211 Biomaterials
		BME 3213 Biomechanics
		BME 4111 Biomedical Image Processing
		BME 4112 Biomedical Image Processing Laboratory
		BME 4113 BioMEMS
		BME 4115 Medical Robotics
		BME 4123 Molecular Modeling
		BME 4213 Prosthetics and Artificial Organs
		BME 4215 Bio-Nanotechnology
		BME 4217 Rehabilitation Engineering
Sensors & Devices	BME **31–BME**40	BME 4219 Brain Computer Interfaces
		BME 4221 Bioinformatics
		BME 2231 Biomedical Instrumentation
		BME 2232 Biomedical Instrumentation Laboratory
		BME 3231 Biomedical Devices and Control
		BME 3232 Biomedical Devices and Control Laboratory
		BME 4131 Bio-optics
		BME 4133 Biosensors and Biochips
		BME 4231 Telemedicine and Health Care
		BME 4232 Telemedicine and Health Care Laboratory
Imaging	BME **41–BME**50	BME 4233 Clinical Engineering
		BME 4235 Bio-photonics
		BME 3141 Radiation and Ultrasound Imaging
		BME 3142 Radiation and Ultrasound Imaging Laboratory
		BME 3241 Magnetic and Nuclear Imaging
		BME 3242 Magnetic and Nuclear Imaging Laboratory
Applied Engineering	BME **51–BME**60	BME 4141 Brain and Neuroengineering
		BME 4142 Brain and Neuroengineering Laboratory
		BME 2151 Numerical Methods and Statistics
		BME 2152 Numerical Methods and Statistics Laboratory
		BME 4251 Biomedical Ethics, Safety and Practice
		BME 4253 Hospital Management
		BME 4255 Bio-Analytical Methods