Department of Materials Science and Engineering (MSE)

Khulna University of Engineering & Technology (KUET), Khulna-9203

Materials Science and Engineering (MSE) department at Khulna University of Engineering & Technology (KUET) has established in 2016 under the faculty of Electrical and Electronic Engineering. Currently, the department offers Bachelor of Science (B.Sc.) in engineering degree and intakes 60 students. MSE is the study of the structure—processing—properties relationships of engineering materials. Modern MSE encompasses a broad range of materials, from traditional metallurgy to biological materials, polymers, ceramics, semiconductors, composites, and optical and magnetic materials, as well as numerous nanotechnology materials. There is no engineering without materials. MSE graduates can be found employed in almost all fields of human endeavor. Followings are the vision and mission of the department:

Our Vision:

The vision of the Materials Science and Engineering (MSE) department is to provide education in MSE to meet national needs, to conduct interdisciplinary research that creates materials for tomorrow's innovative technologies, to be at the forefront of the international materials community in developing strategies to overcome evolving material challenges and to be the leading MSE department worldwide.

Our Mission:

- Create a stimulating and nurturing educational environment broadly preparing students at all levels for successful careers;
- Advance a fundamental understanding of materials properties, processing, and applications by performing leading edge, world class research;
- Train the most highly valued materials science and engineering students in the nation;
- Lead the advanced materials effort at Khulna University of Engineering & Technology;
- Professionalism and leadership in contemporary, interdisciplinary engineering practice based on materials, while accounting for the impact of their profession on an evolving, global society;
- Promote a greater understanding of the role of materials science in society; and actively participate in national and international professional societies.

1st Year, 1st Term					
Course Code	Course Tittle	L	P	C	PRE
Theory					
Ch 1127	Inorganic and Physical Chemistry	3	0	3	
EEE 1127	Electrical Engineering Fundamentals	4	0	4	
Math 1127	Differential and Integral Calculus	3	0	3	
MSE 1101	Introduction to Materials Science and Engineering	3	0	3	
Ph 1127	Optics and Waves	3	0	3	
Sessional					
Ch 1128	Sessional on Inorganic and Physical Chemistry	0	3	1.5	
EEE 1128	Sessional on Electrical Engineering Fundamentals	0	3	1.5	
Ph 1128	Sessional on Optics and Waves	0	3/2	0.75	
	Total				**19.75**

L = Lecture, T = Tutorial, P = Practical and C = Credit hours

Distribution of Marks

i. Theory Courses:

Class participation, attendance and assignments	10 %
Class tests, Quizzes, Spot tests etc.	20%
Term Final Examination	70%
Total	100%

N.B. Students fail to attend 60% of the class will not allow to sit in the final exam in any circumstance.

ii. Independent laboratory/design/field work courses:

Class participation and attendance	10 %
Quizzes, Viva-Voce conducted in lab class	20%
Viva-Voce conducted centrally	20%
Performance and reports	50%
Total	100%

iii. Project/thesis (Continued for two terms):

a) *At the end of 4th year 1st Term*: 30% of the total marks to be evaluated as follows:

Presentation and (Viva-Voce conducted by a Viva-Voce committee)	10%
Supervisor	20%
Total	30%

b) *At the end of 4th year 2nd Term*: 70% of the total marks to be evaluated as follows:

Presentation and Viva-Voce (conducted by a Viva-Voce committee)	20%
Supervisor	40%
External examiner (any other teacher of the department/ a member of examination committee	10%
Total	70%

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Khulna-9203, Bangladesh

Detailed Course Content
1st Year, 1st Term

Ch 1127 Inorganic and Physical Chemistry

Credits hour: **3**

Course description: The introductory inorganic and physical chemistry will provide basic principles of chemistry and their application in engineering systems, atomic configuration, electronic configuration, bonding and molecules, ionic and covalent bonds, solution chemistry and electrochemistry to undergraduate materials science and engineering students.

Referred textbooks:

- "Physical Chemistry of Ionic Materials" by Joachim Maier.
- ''Essentials of Physical Chemistry'' by Arun Bahl, B.S. Bahl and G.D. Tuli
- ''Physical Chemistry'' by Peter Atkins.
- ''Basic Solid State Chemistry'' by Anthony R. West.
- ''Solid State Chemistry'' by Lesley E. Smart, Elaine A. Moore.

Topic covers:

Chemical Bonding: Structure of atom, different types of bonding (ionic, covalent, hydrogen and metallic bond); Born-Haber-Cycle, ionic crystals, Lewis structure, molecular orbital theory, solid state reaction.

Electro-Chemistry: Electrolytic process, galvanic and voltaic process, electrochemical cell (working, reference, counter electrode, half-cell), EMF, standard electrode potential, transport number, polarization, Faraday's law, Nernst diffusion layer, conductance, corrosion.

Reaction and Kinetics: Oxidation and reduction, Balancing reaction Monitoring the progress of a reaction, rate laws and rate constants; experimental determination of rate law, order and molecularity of a chemical reaction, rate laws for reaction approaching equilibrium, temperature dependence of reaction of reaction rates; elementary reaction, steady state approximation, solid state reactions.

Solution Chemistry: Introduction to aqueous solution, acid and base, colligative properties of dilute solution, Raoult's law (ideal mixture, non-ideal mixture, positive and negative deviation), lowering of vapor pressure in solution, boiling point elevation.

Phase Rule: Definition of phases, components, and degrees of freedom; the phase rule, phase diagram study of one and two component systems; liquid-liquid phase diagram, liquid-solid phase diagram, cooling curves, congruent and incongruent melting point.

The Colloids: Introduction to colloids; different types of colloidal systems and their preparation, purification, properties, protective action and application; Tyndall effect, Brownian motion; electric double layer, zeta potential, Micelle

Module learning outcomes:

After successful completion of the subject students should be able to:

1) Explain the periodic table and the properties of elements from same group.
2) Calculate the molecular mass of a compound and calculate the number of moles in a substance.
3) Describe the differences between covalent and ionic bonding.
4) State the factors that contribute to the stability of ionic compounds.
5) Explain how interatomic bonding in ionic, molecular, and covalent solids influences their melting points.
6) Understand the chemical reactions and balancing of the reaction.
7) Explain the chemical solutions and different kinds of aqueous solution.
8) Interpretation of solution based on the vapor pressure based on Roult's law.
9) Obtain adequate knowledge on the electrochemistry, emf, and electrode potential.

10) Clearly identify and define the colloidal system and their preparation.
11) Elucidate the Brownian motion and electric double layer.

EEE 1127 Electrical Engineering Fundamentals

Credit hours: **4**

Course description:

Undergraduate students deal with basic of electrical engineering such as electrical units and standards, electrical networks and circuit theorems, DC Circuits, AC current, introduction to measuring instruments, and electrical machineries. This course is designed in such a way so that students can gain basic electrical knowledge, which will be useful in selecting materials for electrical applications.

Referred textbooks:

- ''A Textbook of Electrical Technology (Volume-I)'' by B.L Theraja and A.K Theraja
- ''Introductory Circuit Analysis'' by Robert Boylestad
- ''Fundamentals of Electric Circuits by Charles'' K. Alexander and Sadiku
- ''Alternating Current Circuits'' by Corcoran
- ''A Textbook of Electrical Technology (Volume-II)'' by B.L Theraja and A.K Theraja
- ''Electrical Machines 3rd Edition'' by S. K. Bhattacharya
- ''Direct and Alternating Current Machinery'' by Rosenblatt & Friedman
- ''Fundamentals of Electrical Drives'' by Gopal K. Dubey
- ''A Course in Electrical and Electronic Measurements and Instrumentation'' by AK Sawhney.

Topic covers:

Introduction to Electrical Engineering: Essence of electricity, electric current, potential and potential difference, electromotive force, electric power, ohm's law, basic circuit components, types of induced EMF's, Kirchhoff's laws, Joule's law, series parallel circuits, voltage and current division, star-delta transformation , simple problems.

Network Analysis: Branch current analysis, loop analysis, Nodal and Mesh analysis, Network theorems- Norton, Superposition, Thevenin's, Maximum power transfer theorems and simple problems.

Single-phase AC circuits: Principle of ac voltages, waveforms and basic definitions, average value, root mean square value, form factor and peak factor of sinusoidally varying quantities, phasor representation of alternating quantities , the J operator and phasor algebra. Analysis, with phasor diagrams, of R, L, C, RL, RC and RLC circuits, parallel and series- parallel circuits. power in ac circuits- real power, reactive power, apparent power and power factor, resonance in ac circuits, simple problem.

Magnetic Circuits: Basic definitions, analogy between electric and magnetic circuits, Ampere circuital law, self and mutual inductance.

Basic Instruments: Introduction, classification of instruments, operating principles, essential features of measuring instruments, operating principles of Moving coil and moving iron instruments (Ammeters and Voltmeters), Watt meters and energy meters.

DC Generators: Construction of DC generators, emf equation, Principle of operation, classification, Characteristics of different types of DC generator, Voltage build up and armature reaction.

DC Motors: Principle of operation, speed equation, classification, Characteristics of different types of DC motors, Starting of DC motors and methods for speed control.

Transformers: Working principle, Construction and Cooling, emf equation, Equivalent circuits, Losses and efficiency.

Induction Motors: General principles, Rotating magnetic field, Production of torque, Speed- torque characteristics, starting and speed control.

Alternators: Construction and theory of operation.

Module learning Outcome:

After finishing of the course students learn about the following:-

1. Clear and sound knowledge on electrical units and standards.
2. Implement their knowledge on solving DC circuits and get an introduction to AC circuit
3. Can efficiently use the general laws and the type of electrical connection.
4. Should able to calculate the electrical parameters in different types of connections and the load distribution.
5. Become adept at using various methods of circuit analysis, including simplified methods such as series-parallel reductions, voltage and current dividers, and the node method;
6. Appreciate the consequences of linearity, in particular the principle of superposition and Thevenin Norton equivalent circuits;
7. Be introduced to the concept of singularity functions and learn how to analyze simple circuits containing step and impulse sources;
8. Gain insight into the behavior of a physical system driven near resonance, in particular the relationship to the transient response and the significance of the quality factor Q;
9. Learn how operational amplifiers are modeled and analyzed, and to design Op-Amp circuits to perform operations such as integration, differentiation and filtering on electronic signals;
10. Learn how negative feedback is used to stabilize the gain of an Op-Amp-based amplifier and how positive feedback can be used to design an oscillator;
11. Understand the operating principles of the electrical measuring instruments;
12. Identify the electrical machineries and basic working principles of these electrical machines.

Math 1127 Differential and Integral Calculus

Credit hour: **3**

Course description: Calculus was first invented to meet the mathematical needs of scientists of the sixteenth and seventeenth centuries, needs that mainly mechanical in nature. Nowadays it is a tool used almost everywhere in the modern world to describe change and motion. Its use is widespread in science, engineering, medicine, business, industry, and many other fields. Calculus also provides important tools in understanding functions and has led to the development of new areas of mathematics including real and complex analysis, topology, and non-Euclidean geometry.

Referred textbooks:

- "Differential and Integral Calculus Vol. 1" by Richard Courant;
- "Differential and Integral Calculus Vol. 2" By Richard Courant;
- "Skills in Mathematics Integral Calculus for JEE Main & Advanced 7th Edition" by Amit M Agarwal;
- " Elements of the Differential and Integral Calculus" by William Anthony Granville, edited by Percey F. Smith

Topic covers:

Differential Calculus: Limit, Continuity; differentiability; Differentiation review: reviews of various differentiation of various types of functions, application of differentiation, Successive differentiation; successive differentiation of different types of functions, Leibnitz's theorem; Expansion of functions: Rolle's theorem; Cauchy's mean value theorem; Taylor's theorem (finite and infinite form); Maclaurin's theorem in finite and infinite forms; Cauchy's forms of remainder and Lagrange's form of remainder. Expansion of function by differentiation; indeterminate forms; L'hospital rule; partial differentiation, Euler's theorem. Maxima and minima (multiple variables); Tangent and normal, Sub tangent and subnormal in Cartesian and polar coordinates; Asymptotes. Curvature, Radius of curvature, Circle and center of curvature.

Integral Calculus: Definition of integration, Integration by the substitution method, Integration by parts, Standard integrals, Integration by the method of successive reduction; Definite integrals, its properties and uses in summation of series; Walli's formula, improper integral; Differentiation

under the sign of integration, integration under the sign of integration, Beta and gamma functions; Multiple Integrals: Change of order of Integration, Jacobian of transformation, Double Integrals, Triple Integrals. Area under a plane curves in Cartesian and polar coordinates; Volume of solid revolution, volume of hollow solids of revolutions by shell method; Area of surface of revolution.

Module learning outcomes:
After accomplishment of the course students should be able to-
1) Handle the differentiation in effective way to engineering application;
2) Determine the area and volume by integration;
3) Clarify their understanding of the different formula and techniques of differentiation and integration;
4) Use the algebra of limits, and L'Hôpital's rule to determine limits of simple expressions;
5) Apply the procedures of differentiation accurately, including implicit and logarithmic differentiation;
6) Apply the differentiation procedures to solve related rates and extreme value problems;
7) Obtain the linear approximations of functions and to approximate the values of functions;
8) Perform accurately definite and indefinite integration, using parts, substitution, inverse substitution;
9) Understand and apply the procedures for integrating rational functions;
10) Perform accurately improper integrals;
11) Calculate the volumes of solid objects, the length of arcs and the surface area.

MSE 1101 Introduction to Materials Science and Engineering

Credits: **3**
Reference books:

- "Engineering Materials 1": An introduction to properties, applications and design, 4th edition." By M. Ashby, D. Jones;
- "Engineering Materials 2": An introduction to microstructures and processing, 4th edition" by M. Ashby, D. Jones;
- **"Materials Science and Engineering: An Introduction, 9th Edition." By William D. Callister, David G. Rethwisch**

Course description:
This course is designed for undergraduate students to introduce with the materials science and engineering. The focus of the subject is to familiarize the students with Geological and archeometallurgical understanding, introduction to crystal structure, the structure of crystalline solids, imperfections in solids, physical, mechanical and chemical properties of materials, strengthening mechanism, selection of materials in view of service and fabrication requirements, and economics, Factors influencing properties, introduction to different examination process of materials service condition.
Topic Covers:

History: Stone age to Modern age, Examples of different types of materials, Classification of materials, Advanced materials.

Atomic Structure and Bonding: Fundamental concepts, Electrons in materials, Periodic table, Bonding Forces and Energies, Primary Interatomic Bonds, Secondary Bonding, the structure of crystalline solids, Unit Cells, Metallic crystal structure, Miller indices, Density computation, Crystallographic directions, Crystallographic planes, Introduction to X ray diffraction.

Imperfection in solids: Point defects (Vacancies, Interstitials), line defects (Dislocations, area defects (Grain boundary defects), Dislocations and its interactions.

Mechanical Properties: Concepts of stress strain, True stress, True strain, Stress strain behaviour, Elastic properties of materials, Elastic Modulus, Deformation, Tensile strength and Yield strength, Elongation, Hardness, Ductile fracture, Brittle fracture, Toughness, High temperature properties and application, Creep, fatigue.

Strengthening mechanism: Strengthening by Grain Size Reduction, Solid-Solution Strengthening, Strain Hardening, Precipitation hardening and other hardening techniques.

Composite: Dispersion-Strengthened Composites, Calculation of strength of composite materials, Polymer-Matrix Composites, Metal-Matrix Composites, Ceramic-Matrix Composites, Carbon–Carbon Composites, Processing of Fiber-Reinforced Composites.

Materials Properties: Electrical Properties (Electrical Conductivity, Electronic and Ionic Conduction, Energy Band Structures in Solids, Electron Mobility, Electrical Resistivity of Metals, Electrical Characteristics of Commercial Alloys), Semiconductor, Superconductor Magnetic Properties , Optical Properties, aspects of Materials in design.

Nondestructive testing: Introduction to basic principle of dye penetration testing, Magnetic particle testing, Ultrasound tests, Radiography and Eddy current testing.

Module learning outcomes:
After successful completion of this course, students are able to
1) Obtain a clear idea about the history of evolution of materials.
2) Describe the basic principles underlying the behavior of materials.
3) Provide the scientific foundation for understanding of the relations among material properties and their application.
4) Estimate the number of atom in a unit cell, closed packed planes and density of unit cells.
5) Differentiate different types cubic and other types of crystal structure
6) Determine the tensile, yield strength, and elongation from stress-strain curve.
7) Choose the materials based on the mechanical properties.
8) Develop a vocabulary for the description of the empirical facts and theoretical ideas about the various levels of stricture, from atoms, through defects in crystals, to larger scale morphology of practical engineering materials.
9) Demonstrate about basic of nondestructive testing techniques.
10) Get a clear idea about the strengthening mechanism and applied to the industry.
11) Sort out the difference between Metals, Polymers, Ceramics and Composite.
12) Develop a preliminary concept in broadly distinguishing different types of materials.
13) Understand mechanical properties of materials and apparently choose the right materials for application.

Ph 1127 Optics and Waves

Credit hours: 3
Referred Textbooks:

- "Vibrations and Waves" by P. French
- "Optics" 4th Edition by E. Hecht,
- "Physics of Light and Optics" by Justin Peatross and Michael Ware
- "Principles of Optics" by M. Born and E. Wolf
- "Principles of Physics" by David Halliday, Jearl Walker, Robert Resnick

Course description:
The physics of waves and oscillations including sound, elastic, and electromagnetic waves, Topics range from the theory of simple harmonic oscillators, transverse modes of a continuous string, and physical optics including interference, Fresnel and Fraunhofer diffraction, and resolution, diffraction of X-rays and electrons by crystals. The propagation of light, Geometrical optics, the superposition waves, Polarization, Modern optics (Laser and others), Geometrical optics to the level of simple optical systems, Huygens' principle, introduction to wave optics.
Topic covers:
Simple Harmonic Motion: Physical Characteristics of Simple Harmonic Oscillators, Displacement, velocity and acceleration, General solutions for simple harmonic motion and the phase angle, The energy of a simple harmonic oscillator, Numerical solution of simple harmonic oscillation.

The Damped Harmonic Oscillator: Physical Characteristics of the Damped Harmonic Oscillator, The Equation of Motion for a Damped Harmonic Oscillator, Light damping, Heavy damping, Critical damping, Rate of Energy Loss in a Damped Harmonic Oscillator.

Travelling Waves: Physical Characteristics of Waves, Travelling Waves, Travelling sinusoidal waves, The Wave Equation, The Equation of a Vibrating String, The Energy in a Wave, The Transport of Energy by a Wave, Waves at Discontinuities.

Standing Waves: Standing Waves on a String, Standing Waves as the Superposition of Two Travelling Waves, The Energy in a Standing Wave, The superposition principle, The superposition of normal modes, The amplitudes of normal modes and Fourier analysis.

Sound wave: Audible, ultrasonic, infrasonic and supersonic waves, Doppler's effects and its application, application of ultrasonic sound, Accoustics.

Geometrical Optics: Combination of lenses, Defects of images, Optical instruments (compound microscope, polarizing microscope, resolving power of a microscope, Electromagnetic lenses).

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

Diffraction of light: Fresnel and Fraunhoffer diffraction, diffraction by single slit, diffraction by double slit, diffraction gratings, Polarization, production and analysis of polarized light, optical activity, optics of crystals.

Module learning outcomes:

On successful completion of this module, students will be able to:

1) Analyze simple systems undergoing simple harmonic motion and be able to derive equations describing the motion and expressions for the oscillation frequency;
2) Understand the motion of a simple harmonic oscillator, including both its free response from starting conditions, and the response when driven at a single frequency;
3) Derive the wave equation for standing and travelling waves e.g. waves on a string;
4) Describe the behavior of a damped and driven harmonic oscillator in both time and frequency domains;
5) Explain the behavior of waves at interfaces (reflection, transmission, impedance) and their behavior in dissipative media (damping);
6) Demonstrate an intuitive feel for fundamental and basic properties such as the speed, frequency and wavelength of light;
7) Understand the basic operating principles of light sources, detectors and amplifiers
8) Calculate interference and diffraction patterns arising from , e.g. multiple point sources of light and slits of finite width;
9) Demonstrate an understanding of the working of selected optical instruments;
10) Properly use optical microscope and efficiently analyze the result obtained in microscope.

Ch 1128 Sessional on Inorganic and Physical Chemistry

Credit: **1.5**

Course description:

Volumetric analysis: acid-base titration, oxidation-reduction titrations, and determination of Fe, Cu, and Cr, Ni volumetrically, Chemical etching and Experiments based on ChY 1127.

Ph 1128 Sessional on Optics and Waves

Credit hours: **0.75**

Course description: Experiments based on Ph 1127.

EEE 1128 Sessional on Electrical Engineering Fundamentals

Credit hours: 1.5

Course description: Experiments based on EEE 1127.