THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

CURRICULUM & SCHEME OF COURSES

Biomedical Engineering

Electrical and Instrumentation Engineering Department

5th July 2019

B.Eng. Bio Medical Engineering

Following is the proposed course scheme for the students to be enrolled during the session 2019/20. In the tables below

- **L stands for number of Lecture hours per week**
- **T stands for number of Tutorial hours per week**
- **P stands for number of Laboratory hours per week**

Each semester is 15 weeks of teaching, with 3 additional week for a mid-semester test and end semester examinations.

SEMESTER-I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA010	MATHEMATICS-I	3	1	0	3.5
2	UTA017	COMPUTER PROGRAMMING	3	0	2	4.0
3	UPH004	APPLIED PHYSICS	3	1	2	4.5
4	UTA013	ENGINEERING DESIGN PROJECT-I	1	0	2	4.0
5	UHU003	PROFESSIONAL COMMUNICATION	2	0	2	3.0
6	UBM001	ORIENTATION AND INTRODUCTION TO BIOMEDICAL ENGINEERING	3	1	0	3.5
		TOTAL	**15**	**3**	**8**	**22.5**

SEMESTER-II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	UMA004	MATHEMATICS-II	3	1	0	3.5
2	UCB028	GENERAL CHEMISTRY-I	3	1	2	4.5
3	UBM031	ELECTRICAL CIRCUITS	3	1	2	4.5
4	UBMXXX	STATICS	3	1	0	3.5
5	UEN002	ENERGY& ENVIRONMENT	3	0	0	3.0
6	UBM002	COMPUTER PROGRAMMING FOR BIOMEDICAL ENGINEERS	2	0	4	4.0
		TOTAL	**17**	**4**	**8**	**23**

UMA010-Mathematics - I

L	T	P	Cr
3	1	0	3.5

Course Objectives: To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

Partial Differentiation: Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives

Multiple Integrals: : Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, evaluation of triple integral (Cartesian).

Sequences and Series: Introduction to sequences and Infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence and conditional convergence.

Series Expansions: Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration.

Complex analysis: Introduction to complex numbers, geometrical interpretation, functions of complex variables, examples of elementary functions like exponential, trigonometric and hyperbolic functions, elementary calculus on the complex plane (limits, continuity, and differentiability), Cauchy-Riemann equations, analytic functions, harmonic functions.

Course Learning Outcomes: Upon completion of this course, the students will be able to

1) Examine functions of several variables, define and compute partial derivatives, directional derivatives and their use in finding maxima and minima in some engineering problems.
2) Evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
3) Determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.
4) Represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy-Riemann equations.
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Text Books:

1) Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.
2) Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.
3) Kasana, H.S., *Complex Variables: Theory and Applications*, Prentice Hall India, 2005 (2nd edition).

Reference Books:

1) Wider David V, Advanced Calculus: Early Transcendental, Cengage Learning (2007).
2) Apostol Tom M, Calculus, Vol I and II, John Wiley (2003).
3) Brown J.W and Churchill R.V, Complex variables and applications, McGraw Hill, (7th edition)

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	30
2.	EST	45
3.	Sessionals (May include assignments/quizzes)	25

UTA007 COMPUTER PROGRAMMING-I

L   T   P   Cr

3   0   2   4.0

Course Objectives: This fundamental course will enable the students to learn the concepts of Programming Language and design principles along with understanding of C Language.

Detailed Contents:

Preliminary Concepts: Introduction-Programming language design- programming language processing- Machine Language-Low level language- High Level Language-Syntax Specification-Regular Expressions- Formal Parameters-Classification of Grammars-Syntax Tree- Ambiguity.

Imperative Languages & Object-Oriented Languages: Imperative programming languages – Design Principles-control flow-execution steps-desirable & undesirable characteristics -General Characteristics of Object Based programming – Design Principles for Object oriented programming, Implementing Object oriented programming.

Control Structure and Looping: Introduction to the C Language-Structure of C Program-Expressions – type conversion-selection making Decisions-Two-way selection – Multi way selection- Repetition –Initialization and updating – loops in C –looping Applications- Library functions – Input, Output statements.

Functions and Arrays: Functions — calling Functions – Passing arguments- Arrays – Defining and processing an array – Array Functions-Passing arrays to Functions – Multidimensional Arrays – Strings-arrays of Strings- String Manipulation functions

Structures and Pointers: Structures & Unions- definition – Processing structures – Passing structures to a function – User defined data types – Pointers: Operations on Pointers – Pointers and Multidimensional Arrays - Arrays of pointers- bitwise operators- Files: File creation – File processing – Opening and closing a file.

LIST OF EXPERIMENTS:

1. Program to understand the basic data types.
2. Program for looping and decision statements.
3. Program for finding Fibonacci series.
4. Finding a factorial for a given number.
5. Programs using library functions.
6. Programs using built-in math functions.
7. Programs on functions.
8. Programs on arrays.
9. Programs on string manipulations.
10. Programs on structures and unions.
11. Programs on pointers.

12. Programs on basic file operations.

Course Learning Outcomes (CLO):

Upon completion of this module, Students will be able to:

1. To understand the concepts of Programming language.
2. To learn the basics of C declarations, operators and expressions.
3. Ability to define and manage data structures based on problem subject domain.
4. Ability to work with textual information, characters and strings.
5. Ability to work with arrays of complex objects.
6. To learn on the manipulation of strings, functions and pointers.
7. To apply concepts and techniques for implementation.

TEXT BOOKS:

1. Seyed H Roosta," Foundations of programming languages design & implementation", Cengage Learning. 2009. (For Unit 1 &2 Refer Chapter No. 1 -9).

2. Behrouz A.Forouzan and Richard F.Gilberg," Computer Science, A structured programming Approach Using C.", third edition, Cengage learning, 2008. (For Unit 3-5 Refer Chapter No. 4 – 10).

REFERENCE BOOKS:

1. Ravi Sethi, "Programming Language Concepts and Constructs", Pearson Education, 2006.

2. Ashok N. Kamthane, "Programming with ANSI and Turbo C", Pearson Education, 2007

3. Pradip Dey, Manas Ghosh, "Programming in C", second edition, Oxford University Press, 2011.

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	20
2.	EST	40
3.	Sessional (May include assignments/quizzes)	40

UPH004: APPLIED PHYSICS

	L	T	P	Cr
	3	1	2	4.5

Course Objectives: Introduce the laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. Student will learn measurement principles and their applications in investigating physical phenomenon.

Oscillations and Waves: Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; *Acoustics:* Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera;

Ultrasonics: Production and Detection of Ultrasonic waves, Applications - green energy, sound signaling, dispersion of fog, remote sensing, Car's airbag sensor.

Electromagnetic Waves: Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth.

Optics: *Interference:* Parallel and wedge-shape thin films, Newton rings, Applications as Non-reflecting coatings, Measurement of wavelength and refractive index.

Diffraction: Single and double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers.

Polarization: Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows.

Lasers: Basic concepts, Laser properties, Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment.

Quantum Mechanics: Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunneling effect (Qualitative idea), Application - Quantum computing.

Laboratory Work:
1   Determination of damping effect on oscillatory motion due to various media.
2   Determination of velocity of ultrasonic waves in liquids by stationary wave method.
3   Determination of wavelength of sodium light using Newton's rings method.
4   Determination of dispersive power of sodium-D lines using diffraction grating.
5   Determination of specific rotation of cane sugar solution.
6   Study and proof of Malus' law in polarization.
7   Determination of beam divergence and beam intensity of a given laser.
8   Determination of displacement and conducting currents through a dielectric.
9   Determination of Planck's constant.

Micro Project: Students will be asked to solve physics-based problems/assignments analytically or using computer simulations, etc.

Course Learning Outcomes (CLO):

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

1. demonstrate a detailed knowledge of oscillations, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics;
2. discuss how the laws of physics have been exploited and applied in the development and design of simple engineering systems;
3. collate, analyse and formulate an experimental report with error analysis and conclusions;

Text Books:

1. *Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001).*
2. *Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007).*
3. *Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999).*

Reference Books:

1. *Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice Hall^{TM} (2008).*
2. *Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990).*
3. *Verma, N.K., Physics for Engineers, Prentice Hall of India (2014)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

UTA013: ENGINEERING DESIGN PROJECT-I

	L	T	P	Cr
	1	0	2	5.0

Course Objectives: To develop design skills according to a Conceive-Design-Implement-Operate (CDIO) compliant methodology. To apply engineering sciences through learning-by-doing project work. To provide a framework to encourage creativity and innovation. To develop team work and communication skills through group-based activity. To foster self-directed learning and critical evaluation.

To provide a basis for the technical aspects of the project a small number of lectures are incorporated into the module. As the students would have received little in the way of formal engineering instruction at this early stage in the degree course, the level of the lectures is to be introductory with an emphasis on the physical aspects of the subject matter as applied to the 'Mangonel' project. The lecture series include subject areas such as Materials, Structures, Dynamics and Digital Electronics delivered by experts in the field.

This module is delivered using a combination of introductory lectures and participation by the students in 15 "activities". The activities are executed to support the syllabus of the course and might take place in specialised laboratories or on the open ground used for firing the Mangonel. Students work in groups throughout the semester to encourage teamwork, cooperation and to avail of the different skills of its members. In the end the students work in sub-groups to do the Mangonel throwing arm redesign project. They assemble and operate a Mangonel, based on the lectures and tutorials assignments of mechanical engineering they experiment with the working, critically analyse the effect of design changes and implement the final project in a competition. Presentation of the group assembly, redesign and individual reflection of the project is assessed in the end.

Breakup of lecture details to be taken up by MED:		
Lec No.	**Topic**	**Contents**
Lec 1	Introduction	The Mangonel Project. History. Spreadsheet.
Lec 2	PROJECTILE MOTION	no DRAG, Design spread sheet simulator for it.

Lec 3	PROJECTILE MOTION	With DRAG, Design spread sheet simulator for it.
Lec 4	STRUCTURES FAILURE	STATIC LOADS
Lec 5	STRUCTURES FAILURE	DYNAMIC LOADS
Lec 6	REDESIGNING THE MANGONEL	Design constraints and limitations of materials for redesigning the Mangonel for competition as a group.
Lec 7	MANUFACTURING	Manufacturing and assembling the Mangonel.
Lec 8	SIMULATION IN ENGINEERING DESIGN	Simulation as an Analysis Tool in Engineering Design.
Lec 9	ROLE OF MODELLING & PROTOTYPING	The Role of Modelling in Engineering Design.

Breakup of lecture details to be taken up by ECED:

Lec No.	Topic	Contents
Lec 1-5	Digital Electronics	Prototype, Architecture, Using the Integrated Development Environment (IDE) to Prepare an Arduino Sketch, structuring an Arduino Program, Using Simple Primitive Types (Variables), Simple programming examples. Definition of a sensor and actuator.

Tutorial Assignment / Laboratory Work:

Associated Laboratory/Project Program: T- Mechanical Tutorial, L- Electronics Laboratory, W- Mechanical Workshop of "Mangonel" assembly, redesign, operation and reflection.

Title for the weekly work in 15 weeks	Code
Using a spread sheet to develop a simulator	T1
Dynamics of projectile launched by a Mangonel - No Drag	T2
Dynamics of projectile launched by a Mangonel - With Drag	T3
Design against failure under static actions	T4
Design against failure under dynamic actions	T5
Electronics hardware and Arduino controller	L1
Electronics hardware and Arduino controller	L2
Programming the Arduino Controller	L3
Programming the Arduino Controller	L4
Final project of sensors, electronics hardware and programmed Arduino controller based measurement of angular velocity of the "Mangonel" throwing arm.	L5
Assembly of the Mangonel by group	W1
Assembly of the Mangonel by group	W2
Innovative redesign of the Mangonel and its testing by group	W3
Innovative redesign of the Mangonel and its testing by group	W4
Final inter group competition to assess best redesign and understanding of the "Mangonel".	W5

Project: The Project will facilitate the design, construction and analysis of a "Mangonel". In addition to some introductory lectures, the content of the students' work during the semester will consist of:

1. the assembly of a Mangonel from a Bill Of Materials (BOM), detailed engineering drawings of parts, assembly instructions, and few prefabricated parts ;
2. the development of a software tool to allow the trajectory of a "missile" to be studied as a function of various operating parameters in conditions of no-drag and drag due to air;
3. a structural analysis of certain key components of the Mangonel for static and dynamic stresses using values of material properties which will be experimentally determined;
4. the development of a micro-electronic system to allow the angular velocity of the throwing arm to be determined;
5. testing the Mangonel;
6. redesigning the throwing arm of the Mangonel to optimise for distance without compromising its structural integrity;
7. an inter-group competition at the end of the semester with evaluation of the group redesign strategies.

Course Learning Outcomes (CLO):

Upon completion of this module, students will be able to:

1. simulate trajectories of a mass with and without aerodynamic drag using a spreadsheet based software tool to allow trajectories be optimized;
2. perform a test to acquire an engineering material property of strength in bending and analyze the throwing arm of the "Mangonel" under conditions of static and dynamic loading;
3. develop and test software code to process sensor data;
4. design, construct and test an electronic hardware solution to process sensor data;
5. construct and operate a Roman catapult "Mangonel" using tools, materials and assembly instructions, in a group, for a competition;
6. operate and evaluate the innovative redesign of elements of the "Mangonel" for functional and structural performance;

Text Books:

1. *Michael McRoberts, Beginning Arduino, Technology in action publications.*
2. *Alan G. Smith, Introduction to Arduino: A piece of cake, CreateSpace Independent Publishing Platform (2011)*

Reference Book:

1. *John Boxall, Arduino Workshop - A Hands-On Introduction with 65 Projects, No Starch Press (2013)*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	-
2	EST	-
3	Sessional: (may include the following)	
	Mechanical Tutorial Assignments	30
	Electronics Hardware and software Practical work in Laboratory	30
	Assessment of Mechanical contents in Lectures and Tutorials and Electronics contents in Lectures and Practical.	10
	Project (Assembly of the "Mangonel", innovative redesign with reflection, prototype competition, Final Presentation and viva-voce	30

UHU003: PROFESSIONAL COMMUNICATION

	L	T	P	Cr
	2	0	2	3.0

Course Objective: To introduce the students to effective professional communication. The student will be exposed to effective communication strategies and different modes of communication. The student will be able to analyze his/ her communication behavior and that of the others. By learning and adopting the right strategies, the student will be able to apply effective communication skills, professionally and socially.

Effective Communication: Meaning, Barriers, Types of communication and Essentials. Interpersonal Communication skills.

Effective Spoken Communication: Understanding essentials of spoken communication, Public speaking, Discussion Techniques, Presentation strategies.

Effective Professional and Technical writing: Paragraph development, Forms of writing, Abstraction and Summarization of a text; Technicalities of letter writing, internal and external organizational communication. Technical reports, proposals and papers.

Effective non-verbal communication: Knowledge and adoption of the right non-verbal cues of body language, interpretation of the body language in professional context. Understanding Proxemics and other forms of non-verbal communication.

Communicating for Employment: Designing Effective Job Application letter and resumes; Success strategies for Group discussions and Interviews.

Communication Networks in Organizations: Types, barriers and overcoming the barriers.

Laboratory Work:
1. Pre -assessment of spoken and written communication and feedback.
2. Training for Group Discussions through simulations and role plays.
3. Training for effective presentations.
4. Project based team presentations.
5. Proposals and papers-review and suggestions.

Minor Project (if any): Team projects on technical report writing and presentations.

Course Learning Outcomes (CLO):
1. Understand and appreciate the need of communication training.
2. Use different strategies of effective communication.
3. Select the most appropriate mode of communication for a given situation.
4. Speak assertively and effectively.
5. Correspond effectively through different modes of written communication.
6. Write effective reports, proposals and papers.
7. Present himself/herself professionally through effective resumes and interviews.

Text Books:

1. *Lesikar R.V and Flately M.E., Basic Business Communication Skills for the Empowering the Internet Generation. Tata Mc Graw Hill. New Delhi (2006).*
2. *Raman,M & Sharma, S., Technical Communication Principles and Practice, Oxford University Press New Delhi.(2011).*
3. *Mukherjee H.S., Business Communication-Connecting at Work, Oxford University Press New Delhi, (2013).*

Reference Books:

1. *Butterfield, Jeff.,Soft Skills for everyone,Cengage Learning New Delhi,(2013).*
2. *Robbins, S.P., & Hunsaker, P.L.,Training in Interpersonal Skills,Prentice Hall of India   New Delhi,(2008).*
3. *DiSianza,J.J & Legge,N.J.,Business and Prfofessional Communication,Pearson Education India New Delhi,(2009).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	25
2	EST	45
3	Sessionals (Group Discussions; professional presentations; panel discussions; public speaking; projects, quizzes)	30

UBM001 ORIENTATION AND INTRODUCTION TO BIOMEDICAL ENGINEERING

	L	T	P	Cr
	3	1	0	3.0

Course objective: The students will learn that engineering principles can be applied to living systems and to demonstrate key principles and engineering concepts taught in various courses throughout the Biomedical Engineering

Detail contents:

Basic Concepts: Numbers, Units and Consistency Checks: Introduction, Numbers and significant figures, Scientific Notation, Accuracy and Precision, Dimensions and units, SI Units, Keeping Track of Units in Equations, English and Other Units, Conversion factors, The Use of Weight to Describe Mass, Consistency checks, Reality Check, Units Check, Ranging Check

Darcy's Law: Pressure-Driven Transport through Membranes: Introduction – Biological and Man-Made Membranes, Darcy's Law, Ideal and Non ideal Materials, Mechanical Filtration (Sieving)

Poiseuille's Law: Pressure-Driven Flow Through Tubes: Introduction – Biological Transport, Poiseuille's Law, Simplified Version of Poiseuille's Law, Assumptions for Poiseuille's Law, Power Expended in the Flow, Series and Parallel Combinations of Resistive Elements, Series, Parallel

Hooke's Law: Elasticity of Tissues and Compliant Vessels: Introduction, The Action of Forces to Deform Tissue, HOOKE'S Law and Elastic Tissues, Compliant Vessels, Incompressible Flow of Compliant Vessels

Starling's Law of the Heart, Windkessel Elements and Conservation of Volume: Introduction – Compliance of the Ventricles, Pressure-Volume Plots: the pv Loop, STARLING'S LAWOF THE HEART, Windkessel Elements, Conservation of Volume in Incompressible Fluids

Euler's Method and First-Order Time Constants: Introduction: Differential Equations, Euler's Method, Waveforms of Pressure and Volume, First-Order Time Constants

Muscle, Leverage, Work, Energy and Power: Introduction: Muscle, Levers and Moments, Work, Energy, Power, Power in Fluid Flow

Ohm's Law: Current, Voltage and Resistance: Introduction, Charge, Electric Field, Current, Voltage, Ohm's Law, Fluid Analogies, Sign Conventions for Voltage and Current, Resistivity of Bulk Materials, Diodes and Other Non-Ohmic Circuit Elements, Power Loss in Resistors

Kirchhoff's Voltage and Current Laws: Circuit Analysis: Introduction, Kirchhoff's Voltage Law (KVL), Kirchhoff's Current Law (KCL), Resistive Circuit Analysis Using the Branch Current Method

Series and Parallel Combinations of Resistors and Capacitors: Introduction, Resistors in Series, Resistors in Parallel, Capacitors in Series, Capacitors in Parallel, Voltage Divider, Current Divider

Course learning Outcomes (CLO)

Student will be able to:

1. Understand the basic concepts of numbers, units and consistency checks
2. apply Darcy's Law, Poiseuille's Law, Hooke's Law, Starling's Law and Euler's Method on physiological system
3. comprehend the Muscle, Leverage, Work, Energy and Power for the system
4. apply Ohm's Law, Kirchhoff's Voltage and Current Laws, Series and Parallel Combinations of Resistors and Capacitors for solving circuits.

Text Book:
1. Introduction to Biomedical Engineering: Biomechanics and Bioelectricity Part I & II," D.A. Christensen, Synthesis Lectures on Biomedical Engineering, Morgan & Claypool (2009).
2. Introduction to Biomedical Engineering 2nd Edition, by John Enderle, Joseph Bronzino, Susan M. Blanchard, Elsevier Academic Press (2005)

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	35
2.	EST	45
3.	Sessional (Assignments/Quizes)	20

UMA004: MATHEMATICS – II

L T P Cr
3 1 0 3.5

Course Objectives: To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.

Linear Algebra: Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.

Ordinary Differential Equations: Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.

Laplace Transform: Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.

Fourier Series: Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation.

Course Learning Outcomes (CLO):
Upon completion of this course, the students will be able to:
1. Solve differential equations of first and 2nd order using various analytical methods.
2. apply methods of Laplace transform and Fourier series to solve initial and boundary value problems, respectively.
3. Solve systems of linear equations using row reduction method
4. analyze vectors algebraically and geometrically in R^n

Text Books:
1. *Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).*
2. *Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).*

Reference Books:
1. *Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley (2006).*
2. *Jain, R.K. and Iyenger, S.R.K, Advanced Engineering Mathematics, Narosa Publishing House(2011).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1	MST	30
2	EST	45
3	Sessionals (May include assignments/quizzes)	25

UCB028: GENERAL CHEMISTRY I

	L	T	P	Cr
	3	1	2	4.5

Course Objective: The course aims at understanding the physical and chemical properties of atoms, molecules and ions.

Detail Contents:

Chemical Tools: Experimentation and Measurements: Significant figures, Rounding Numbers, Accuracy and precision, Mean and median, Average deviation, Standard deviation, Relative standard deviation, Sample mean and population mean, Q-test, F-test, T-test.

Atoms, Molecules and Ions: Recapitulation of basic concepts, An introduction to atomic and molecular spectroscopy, Beer-Lambert's Law.

Mass Relationships in Chemical Reactions: Representation of chemical reactions, Balancing chemical equations: Oxidation number and ion electron methods, Stoichiometric calculations: Amounts of reactants and products.

Reactions in Aqueous Solution: Recapitulation of basic concepts, Measuring the concentration in solutions: Volumetric titration (acid-base, redox and complexometric), Instrument based titrations (conductometry, potentiometry and pH-metry).

Periodicity and Electronic Structure of Atoms: Electromagnetic radiations, Particle like behavior, Photoelectric effect, Black-body radiation, Plank's Postulate, Wave-particle duality, de Broglie's hypothesis, Heisenberg uncertainty principle, Quantum mechanical model of atom, Concepts of orbital and quantum numbers, Pauli's exclusion principle, Periodic trends: Electronic configuration, Atomic radii.

Ionic Compounds: Periodic Trends and Bonding Theory: Electronic configuration of ions, Periodic trends: Electronegativity and Electron affinity, Ionization energy, Formation of ionic bonds, Lattice energy of solids.

Covalent Bonding and Electron-Dot structures: Covalent bonding, Formation of covalent bond, Electron-dot structure, Concept of polarity and dipole moment.

Covalent Bonding: Bonding Theories and Molecular Structure: VSEPR model, Valence bond theory, Concept of hybridization, Molecular Orbital Theory, MO diagrams of diatomic molecules, MO diagrams of π-bonded systems, Conjugated systems, Huckel's rule.

Thermochemistry: Changes in internal energy, enthalpy in chemical reactions, Exothermic and Endothermic reactions, Concept of heat capacity, Kirchhoff's Equation, Hess's Law.

Gases: Their Properties and Behavior: Kinetic theory of gas, Collision and Mean free path, Maxwell-Boltzmann Distribution Law of Molecular Velocities, Concept of ideal and real gases, Behavior of real gases: van der Waal's equation.

Course Learning Outcomes: The students will be able to reflect on:
1. Concepts of analytical tools of experimentation and measurements; atoms, molecules and ions.
2. Periodicity, electronic structure and behavior of atoms.
3. Mass relationships and chemical reactions in aqueous solution.
4. Concepts of ionic and covalent bondings, VSEPR Model, valence bond theory and molecular orbital theory.
5. Thermochemistry, properties of gases and their behavior.
6. Laboratory techniques like pH metry, potentiometry, colourimetry, conductometry and volumetry .

Recommended Books
1. Lee, J.D., Concise Inorganic Chemistry, ELBS, (2008) 5th ed.
2. Sharpe, E., Inorganic Chemistry, Pearson Education (2003) 3rd ed.
3. Skoog, D.A., West, D.M., Holler, F.J., and Crouch, S.R., Fundamentals of Analytical Chemistry, Brooks/Cole (2003) 8th ed.
4. Atkins, P.W., Physical Chemistry, W.H. Freeman (2018) 11th ed.
5. Castellan, G. W., Physical Chemistry, Narosa (2004) 4th ed.
6. Zumdahl, S. S.; Chemistry Concepts and Applications, Cengage Learning, (2009),1st ed.

List of Experiments

1. To determine the amount of NaOH and Na_2CO_3 present in the same solution.

2. To find the temporary and permanent hardness of water sample by complexometric titration using standard EDTA solution.

3. To determine the copper content of a given sample solution of copper ore using 0.1 N sodium thiosulphate solution iodometrically.

4. To estimate the available chlorine in bleaching powder.

5. To determine the amount of Fe^{+2} and Fe^{+3} ions by permanganometry.

6. To find out the total alkalinity and sulphate content in a water sample.

7. To determine the strength of given sodium hydroxide solution by titration with standardhydrochloric acid conductometrically.

8. Determine pKa value of acetic acid by pH-metric titration.

9. Spectrophotometric determination of Fe^{2+} with 1,10-phenanthroline.

10. To titrate potentiometrically FAS solution against potassium permanganate and to determine the standard electrode potential of Fe^{2+} / Fe^{3+} system.

Evaluated Scheme

MST	EST	Sessional (May include Quizzes/Assignments/Lab Evaluation)
25	40	35

UBM031: ELECTRICAL CIRCUITS

	L	T	P	Cr
	3	1	2	4.5

Elementary Concepts: Concept of Potential difference and emf. Ohm's law, circuit elements, effect of temperature on resistance.

D. C. Circuits: Kirchhoff's law, ideal and practical voltage and current sources. Mesh and Nodal analysis. Source transformation. Star delta transformation. Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem.

Transient and steady state analysis of DC Circuits: The ideal capacitor, permittivity, parallel plate capacitor, variable capacitor; charging and discharging characterization, time-constant, rise-time, fall-time; inductor energization and de-energization, inductance current-voltage relationship, time-constant; Transient response of RL, and RC circuits.

A.C. Fundamentals: Sinusoidal voltage and currents, their mathematical and graphical representation, concept of cycle period, frequency, instantaneous, peak, average, rms values, peak factor, and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Series and parallel circuits, fundamentals of resonance in AC circuits

Electromagnetism: Concepts of Magnetic circuits, Analogy between electrical and magnetic circuits, Electromagnetic induction, Dot convention, Equivalent inductance, Analysis of Magnetic circuits, AC excitation of magnetic circuit, Iron Losses, Fringing and stacking, applications: solenoids and relays.

Laboratory Work:

Verification of KVL and KCL, Superposition, Thevenin's and Norton's theorems, Measurement of R, L, C parameters, A.C. series and parallel circuits, Computer aided analysis of RL and RC circuits, Magnetic circuits.

Course Learning Outcomes (CLO):

After the completion of the course the students will be able to:

1. Apply network laws and theorems to solve electric circuits.
2. Analyze transient and steady state response of DC circuits.
3. Signify AC quantities through phasor and analyze AC circuit behavior.
4. Apply the basic concepts of electro magnetism.

Text Books:

1. Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, PHI (2008).
2. Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).
3. Engineering Circuits Analysis, W. H. Hayt and Jr J. E. Kemmerly,, 2nd Edition, Mc GrawHill.

Reference Books:

1. Chakraborti, A., Basic Electrical Engineering, Tata McGraw–Hill (2008).
2. Del Toro, V., Electrical Engineering Fundamentals, Prentice–Hall of India Private Limited (2004).
3. Mac Elwyn Van Valkenburg. Network analysis. Prentice-Hall; 1964.

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	45
3.	Sessional (Assignments/Projects/Tutorials/Quizes/Lab Evaluations)	30

UBMXXX: STATICS

L	T	P	Cr
3	1	0	3.5

Description: This course covers the topics of the operations with free body concept, equilibrium of coplanar and non-coplanar force systems, analysis of trusses, friction and centroids, center of gravity and moment of inertia.

Unit 1: Introduction to statics: Introduction, Newtonian Mechanics, Fundamental Properties of Vectors, Representation of Vectors Using Rectangular Components, and Vector Multiplication

Unit 2: Basic Operation with Force Systems: Equivalence of Vectors, Force, Reduction of Concurrent Force Systems, Moment of a Force about a Point, Moment of a Force about an axis, Couples, Change the Line of Action of a Force.

Unit 3: Resultant of Force Systems: Reduction of Force System to a Force and a Couple, Definition of Resultant, Resultant of Coplanar Force Systems, Resultant of Three-Dimensional Systems, Introduction to Distributed Normal Loads.

Unit 4:Coplanar Equilibrium Analysis: Definition of Equilibrium, Free-Body Diagram of a body, Coplanar Equilibrium Equations, Writing and Solving Equilibrium Equations, Equilibrium Analysis for Single-Body Problems, Free-Body Diagrams involving Internal Reactions, Equilibrium Analysis of Composite bodies, Analysis of Trusses, Method of Joints, Method of Sections

Unit 5:Three-Dimensional Equilibrium: Free-body Diagrams, Independent Equilibrium equations, Improper Constraints, Writing and Solving Equilibrium equations, Equilibrium Analysis

Unit 6: Friction: Coulomb's theory of Friction, Problem Classification and Analysis, Impending Tipping Angle of Friction: Wedges and Screws, Ropes and Flat belts

Unit 7: Centroids and Center of Gravity: Centroids of Plane Areas and Curves, Centroids of Curved surfaces, Volumes, and Space curves, Theorem of Pappus- Guldinus

Unit 8: Moment of Inertia: Moment of Inertia of Areas, Moment of inertia about the centroidal axes

Course Learning Outcomes (CLO): The students will be able to:
1. Draw free body diagrams
2. Write and solve equilibrium equations for particles and rigid bodies
3. Find internal and external reactions for rigid bodies
4. Find centroids and moments of inertia for plane figures
5. Draw shear and bending moment diagrams for statically determinate structures.

Text Books:
1. *Shames, I. H. Engineering Mechanics: Dynamics, Pearson Education India (2006).*
2. *Beer, Johnston, Clausen and Staab, Vector Mechanics for Engineers, Dynamics, McGraw-Hill Higher Education (2003).*

Reference Books:
1. *Hibler, T.A., Engineering Mechanics: Statics and Dynamics, Prentice Hall (2012).*
2. *Timoshenko and Young, Engineering Mechanics, Tata McGraw Hill Education Private Limited, (2006).*
3. *J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II – Dynamics, 6th Ed, John Wiley, 2008.*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weights (%)
1.	MST	30
2.	EST	45
3.	Sessional (may include Assignments/Projects/Tutorials/Quiz	25

UEN002: ENERGY AND ENVIRONMENT

	L	T	P	Cr
	3	0	0	3.0

Course Objectives: The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the value of regional and global natural and energy resources; and emphasize on need for conservation of energy and environment.

Natural Resources: Human settlements and resource consumption; Biological, mineral and energy resources; Land, water and air; Natural resources vis-à-vis human resources and technological resources; Concept of sustainability; Sustainable use of natural resources

Ecology, Structure and Functioning of Natural Ecosystems: Ecology, ecosystems and their structure, functioning and dynamics; Energy flow in ecosystems; biogeochemical cycles and climate; Population and communities

Agricultural, Industrial Systems and Environment: Agricultural and industrial systems vis-à-vis natural ecosystems; Agricultural systems, and environment and natural resources; Industrial systems and environment

Environment Pollution, Global Warming and Climate Change: Air pollution (local, regional and global); Water pollution problems; Land pollution and food chain contaminations; Carbon cycle, greenhouse gases and global warming; Climate change – causes and consequences; Carbon footprint; Management of greenhouse gases at the source and at the sinks

Energy Technologies and Environment: Electrical energy and steam energy; Fossil fuels, hydropower and nuclear energy; Solar energy, wind energy and biofuels; Wave, ocean thermal, tidal energy and ocean currents; Geothermal energy; Future energy sources; Hydrogen fuels; Sustainable energy

Group Assignments: Assignments related to Sanitary landfill systems; e-waste management; Municipal solid waste management; Biodiversity and biopiracy; Air pollution control systems; Water treatment systems; Wastewater treatment plants; Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels; Environmental status assessments; Energy status assessments, etc.

Course Learning Outcomes (CLO):

After the completion of this course, the student will be able to:

1. outline the scenario of natural resources and their status
2. calculate the flow of energy and mass balance in ecosystems
3. analyze environmental status of human settlements
4. monitor the energy performance of systems

Text Books:

1. *Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).*
2. *Chapman, J.L. and Reiss, M.J., Ecology- Principles and Application, Cambridge University Press (LPE) (1999).*
3. *Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).*

4. *Eastop, T.P. and Croft, D.R. Energy Efficiency for Engineers and Technologists,Longman and Harow (2006).*

Reference Books:

1. *Miller, G.T., Environmental Science- Working with Earth, Thomson (2006).*
2. *Wright, R.T., Environmental Science-Towards a sustainable Future, Prentice Hall (2008).*
3. *O'Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).*

Evaluation Scheme:

Sr. No.	Evaluation Elements	Weightage (%)
1.	MST	30
2.	EST	50
3.	Sessionals (Quizzes/assignments/group presentations)	20

UBM002 COMPUTER PROGRAMMING FOR BIOMEDICAL ENGINEERS

	L	T	P	Cr
	2	0	4	4.0

Course Objectives: The students will understand the basic principles of programming and of implementing mathematical concepts in MATLAB. Specifically, they will be able to write numerical algorithms and evaluate the computational results using graphical representations

Detail contents

SOLIDWORKS

Basics and User interface: File Handling, User Interface, Pull down Menus, Command Manager, Mouse Buttons, and Keyboard Shortcuts

Sketching: 2D Sketching, Sketching Planes, Entities, Relations, Dimensioning

Part Modeling: Extrusion Boss, Cut, Revolve, Hole, Fillet, Round, Chamfers, Sweep, Loft, Patterns- Linear & Circular, Shelling and Ribs, Draft Standard views, Base Feature, Editing Tools.

Bottom Up Assembly Modeling: Adding & Manipulating Components, Assembly constraints, Sub-assemblies, Mass Properties, Interference Check, Exploded Assemblies, Bill of Materials, Adding Balloons,

Creating Drawings: Drawing views, Driving and Driven Dimensions, Associativity, Creating section views, Annotations.

MATLAB Fundamentals: Variables, The workspace, Arrays: Vectors and matrices, Vertical motion under gravity, Operators, expressions, and statements, Output, Repeating with for Decisions, Complex numbers

Program Design and Algorithm Development: The program design process, Programming MATLAB functions

MATLAB Functions and Data Import-Export Utilities: Common functions, Importing and exporting data

Logical Vectors: Logical operators, Subscripting with logical vectors, Logical functions, Logical vectors instead of elseif ladders

Matrices and Arrays: Matrices, Matrix operations, Other matrix functions, Population growth: Leslie matrices, Markov processes, Linear equations, sparse matrices

Function M-files: Newton's method again, Basic rules, Function handles, Command/function duality, Function name resolution, Debugging M-files, Recursion

MATLAB Graphics: Basic 2-D graphs, 3-D plots, Handle graphics, Editing plots, Animation, Color etc., Lighting and camera, Saving, printing and exporting graphs

Vectors as Arrays and Other Data Structures: Update processes, Frequencies, bar charts and histograms, Sorting, Structures, Cell arrays, Classes and objects

Errors and Pitfalls: Syntax errors, Logic errors, rounding error

Course Learning Outcomes (CLO):

Students will be able to

1. Creatively comprehend geometrical details of common engineering objects and assemblies
2. Use parametric 3D CAD software tools for creating their geometric part models, assemblies and automated drawings.
3. Translate mathematical methods to MATLAB code
4. Break a complex task up into smaller, simpler tasks
5. Represent mathematical objects as data structures
6. Tabulate results and represent data visually

Text Books:
1. Tickoo Sham, SOLIDWORKS 2018 for Designers, 16th Edition, CADCIM Technologies (2018)
2. Ronald E. Barr, Davor Juricic, Thomas J. Krueger, Engineering & Computer Graphics Workbook Using SOLIDWORKS 2019, SDC Publications, ISBN: 978-1-63057-219-8
3. MATLAB: An Introduction with Applications, by Amos Gilat, 2nd edition, Wiley, 2004, ISBN-13 978-0471694205.
4. Essential MATLAB for Engineers and Scientists, 5th Edition by B. Hahn and D. Valentine, Academic Press, (2013).

Evaluation Scheme:

Sr.No.	Evaluation Elements	Weight age (%)
1.	MST	25
2.	EST	35
3.	Sessional (May include Quizzes/Assignments/Lab Evaluation)	40