# Mathematics III (PDE, Probability & Statistics)

## BSC202 Mathematics III (PDE, Probability & Statistics)

## 4 credits

### Module 1:
Definition of Partial Differential Equations, First order partial differential equations, solutions of first order linear PDEs; Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method. Second-order linear equations and their classification, Initial and boundary conditions, D'Alembert's solution of the wave equation; Duhamel's principle for one dimensional wave equation. Heat diffusion and vibration problems, Separation of variables method to simple problems in Cartesian coordinates. The Laplacian in plane, cylindrical and spherical polar coordinates, solutions with Bessel functions and Legendre functions. One dimensional diffusion equation and its solution by separation of variables.

### Module 2:
Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality. Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities. Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

### Module 3:
Basic Statistics, Measures of Central tendency: Moments, skewness

and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi- square test for goodness of fit and independence of attributes.

**Textbooks/References:**
1. Erwin Kreyszig, Advanced Engineering Mathematics, 9 thEdition, John Wiley & Sons, 2006.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications.
3. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall.
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India,2002.

# Biology

## BSC203 Biology

## 3 credits

## Module 1: Introduction
**Purpose**: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

## Module 2:
**Purpose:** To convey that classification per seis not what biology is all about. The underlying criterion,
such as morphological, biochemical or ecological be highlighted.

Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilisation - Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata-acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E. coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

## Module 3: Genetics
**Purpose:** To convey that "Genetics is to biology what Newton's laws are to Physical Sciences"

Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

## Module 4: Biomolecules
**Purpose:** To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine

Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

## Module 5: Enzymes
**Purpose:** To convey that without catalysis life would not have existed on earth.

Enzymology: How to monitor enzyme catalysed reactions. How does an enzyme catalyze reactions? Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

## Module 6: Information Transfer
**Purpose:** The molecular basis of coding and decoding genetic information is universal

Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

## Module 7: Macromolecular analysis
**Purpose:** How to analyse biological processes at the reductionist level

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements.

## Module 8: Metabolism
**Purpose:** The fundamental principles of energy transactions are the same in physical and biological world.

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keqand its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to $CO_2 + H_2O$ (Glycolysis and Krebs cycle) and synthesis of glucose from $CO_2$and $H_2O$ (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge

## Module 9: Microbiology
Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.

## References:
1. Biology: A global approach: Campbell, N. A. ; Reece, J. B.; Urr y, Lisa; Cain, M, L.; Wasser man, S. A. ; Minorsk y, P. V.; Jackson, R. B. Pearson Education Ltd
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H. John Wiley and Sons
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company

4. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R. W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher

5. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

# Basic Electronic Engineering

## ESC 201 Basic Electronic Engineering

## 4 credits

### Module 1:
**Semiconductor Devices and Applications:** Introduction to P-N Junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

### Module 2:
**Operational amplifier and its applications:** Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

### Module 3:
**Timing Circuits and Oscillators:** RC-timing circuits, IC 555 and its applications as table and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

### Module 4:
**Digital Electronics Fundamentals:** Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using Kmap, Logic ICs, half and full adder/subtractor, multiplexers, de-multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

### Module 5:

**Electronic Communication Systems:** The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

**Text /Reference Books:**
1. Floyd ," Electronic Devices" Pearson Education 9th edition, 2012.
2. R.P. Jain , "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.
3. Frenzel, "Communication Electronics: Principles and Applications", Tata Mc Graw Hill, 3rd Edition, 2001

# Engineering Mechanics

### ESC 202 Engineering Mechanics

### 4 credits

### Module 1:
Statics: Force System, Moment of a force about a point and an axis; Equivalent force and moment

### Module 2:
Equilibrium: Free body diagram; equations of equilibrium; problems in two and three dimension; plane frames and trusses.

### Module 3:
Friction: Laws of Coulomb friction, impending motion problems involving large and small contact surfaces; square threaded screw; principle of virtual work and stability.

### Module 4:
Dynamics: Kinematics and kinetics of particles dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables.

### Module 5:
Properties of areas: Center of mass; Moments of inertia; kinematics of rigid bodies;Chasle's Theorem, concept of fixed vector, velocity and acceleration of particles in different frames of references. General plane motion.

### Module 6:

Work & Energy and impulse and Momentum methods for particles and rigid bodies: Conservation of momentum, coefficient of restitution, moment of momentum equation.

**Text /Reference Books:**
1. Engineering Mechanics by Shames, Pearson's Education.
2. Mechanics for Engineers. Beer, F.P. and Johnston. Tata McGraw Hill. New Delhi
3. Engineering mechanics. Meriam Wiley pub.
4. Engineering Mechanics. Timoshenko. McGraw Hill lnc.

# Thermodynamics

## PCC-ME 201 Thermodynamics

## 4 credits

## Module 1:
Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.

## Module 2:
Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.

## Module 3:
Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.

## Module 4:
First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes;

examples of steady and unsteady I law applications for system and control volume.

## Module 5:
Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external reversibility; Carnot cycle; Absolute temperature scale.

## Module 6:
Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of Entropy for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of entropy from steam tables-Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles-Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.

## Module 7:
Properties of dry and wet air, use of psychometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.

## Text Books:
1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

4. Yunus A. Cengel; Michael A. Boles, Thermodynamics: An Engineering Approach, McGraw- Hill.

5. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.