Module for B.Sc. Mathematics Honours

Academic Year 2016 – 2017

1. Module for Part – I:

Name of the Teacher	Duration	Course
Sri Anjan Choudhury	August – October, 2016	**<u>Paper - I</u>** *Classical Algebra*: Inequalities: Arithmetic mean, geometric mean and harmonic mean; Schwarz inequality and Weierstrass's inequality. Simple continued fraction and its convergence, representation of real numbers. Complex numbers: De Moivre's theorem, roots of unity, exponential function, Logarithmic function, Trigonometric function, hyperbolic function and inverse circular function. Summation of Series. [12L]
	November – December, 2016	Polynomial: polynomial equation, Fundamental theorem of algebra (statement only), multiple roots, statement of Rolle's theorem only and its application, equation with real coefficients, complex roots, Descarte's rule of sign. [8L]
	January – March, 2017	Relation between roots and coefficients, transformation of equation, Reciprocal equations, special roots of unity, solution of cubic equations-Cardan's method, solution of biquadratic equation – Ferrari's method. [10L]
Sri Buddhadeb Ghosh	August – October, 2016	*Abstract Algebra:* Prerequisite: [Surjective, injective and bijective mapping, composition of two mappings, inverse mapping, extension and restriction of mappings, equivalence relation]. Partition of a set, countable and uncountable sets, countability of rational numbers and uncountability of real numbers. Group: Definition, examples, subgroups, necessary and sufficient condition for a nonempty set to be a subgroup, generator of a group and a subgroup, order of a group and order of an element, Abelian group. [12L]
	November – December, 2016	Permutation group, cycles, length of a cycle, transposition, even and odd permutation, alternating group, important examples such as S3 and K4 (Klein 4-group). [8L]
	January – March, 2017	Cyclic subgroups of a group, cyclic groups and their properties, groups of prime order, coset, Lagrange's theorem. Ring, subring, integral domain, elementary properties, field, subfields, characteristic of a field or integral domain, finite integral domain, elementary properties. [10L]
Sri Tufan Mehata	August – October, 2016	*Geometry of two dimensions*: Prerequisite: [Historical aspects of Geometry. Fundamental concepts of Geometry: Euclid's postulates. Cartesian Frame of reference]. Transformation of rectangular coordinate axes using matrix treatment: Translation, Rotation and both. Theory of invariants using matrix method. General second degree equation. Reduction to its normal form. Classification of conics. [6L]

	November – December, 2016	Pair of tangents. Chord of contacts. Pole and polar, Conjugate points and conjugate lines. Diameter and conjugate diameter. [4L]
	January – March, 2017	Pair of straight lines. Homogeneous second degree equation. Angle between them. Bisectors of angles of pair of lines. Condition that a second degree equation represents a pair of lines. Point of intersection. Pair of lines through the origin and the points of intersection of a line with a conic. Polar equation of a conic, tangent, normals, chord of contact. [5L]
Sri Subhasis Khan	August – October, 2016	*Geometry of three dimensions*: Prerequisite: [Fundamental concepts. Orthogonal Cartesian Frame of reference. Coordinate system. Orthogonal projection. Direction cosines and ratios]. Transformations of rectangular coordinate axes using matrix treatment: Translation, Rotation and rigid motion. Theory of invariants using matrix method. General second degree equation involving three variables. Reduction to its normal form. Classification of surfaces. Plane. Various form of equations of planes. Pair of planes. Angle between them. Bisectors of angles of pair of lines. Condition that a second degree equation represents a pair of planes. Point of intersection. Condition of perpendicularity and parallelism of pair of planes. [10L]
	November – December, 2016	Straight line. Symmetric and non-symmetric form of straight line and conversion of one into another form. Angle between two straight lines. Distance of a point from a line. Angle between a line and a plane. Coplanarity of two lines. Shortest distance between two lines and its equation. Position of a line relative to a plane. Lines intersecting a number of lines. Tetrahedron. [6L]
	January – March, 2017	Sphere, Cone, Cylinder. Condition that a general second degree equation represents these surfaces. Section of these surfaces by a plane. Circle. Generators. Sphere through a circle. Radical plane. Tangent plane. Tangent line. Normal. Enveloping cone and cylinder. Reciprocal cone. Surfaces of revolution. Ellipsoid. Hyperboloid of one and two sheets. Elliptic Paraboloid. Hyperbolic paraboloid. Normal forms. Tangent Plane. Normal line. Generating lines and their several properties. [9L]
Dr. Swapan Mukherjee	August – October, 2016	**Paper – II** *Analysis-I (30 marks):* A brief discussion on the real number system: Field structure of R, order relation, order completeness properties of R. Arithmetic continuum, geometric continuum, Archimedean properties, interior points, open sets, limit points, closed sets, closure. Sequence, limit of a sequence, convergence, divergence (only definitions and simple examples). Bounded functions, monotone functions. Limit of a function at a point. Continuity of a function at a point and on an interval. Properties of continuous functions over a closed and bounded interval. Uniform continuity. [12L]
	November – December, 2016	Derivative of a function. Successive differentiation, Leibnitz's theorem, Rolle's theorem, mean value theorems. Intermediate value property, Darboux theorem. Taylor's theorem, and Maclaurin's theorem with Lagrange's and Cauchy's forms of remainders. Taylor's series. Expansion

		of elementary functions such as e^x, $\cos x$, $\sin x$, $(1+x)^n$, $\log_e(1+x)$ etc. [8L]
	January – March, 2017	Envelope, asymptote, curvature. Curve tracing: Astroid, cycloid, cardioids, folium of Descartes. Maxima, minima, concavity, convexity, singularity. Indeterminate forms. L'Hospital's theorem. Functions of several variables (two and three variables). Continuity and differentiability. Partial derivatives. Commutativity of the orders of partial derivatives. Schwarz's theorem, Young's theorem, Euler's theorem. [10L]
Sri Uttam Mahanty	August – October, 2016	*Integral Calculus (20 Marks)* Definite Integral – Definition of Definite Integral as the Limit of a Sum; Fundamental Theorem of Integral Calculus (statement only). General Properties of Definite Integral; Integration of Indefinite and Definite Integral by Successive Reduction. [8L]
	November – December, 2016	Multiple Integral – Definition of Double Integral and Triple Integral as the Limit of a Sum; Evaluation of Double Integral and Triple Integral; Fubini's Theorem (statement and applications). [5L]
	January – March, 2017	Applications of Integral Calculus – Quadrature and Rectification; Intrinsic Equations of Plane Curves; Evaluation of Lengths of Space Curves, Areas of Surfaces and Volumes of Solids of Revolution. Evaluation of Centre of Gravity of some Standard Symmetric Uniform Bodies: Rod; Rectangular Area, Rectangular Parallelepiped, Circular Arc, Circular Ring and Disc, Solid and Hollow Spheres, Right Circular Cylinder and Right Circular Cone. [7L]
Dr. Samiran Karmakar	August – October, 2016	*Ordinary Differential Equations:* Picard's existence theorem (statement only) for $\frac{dy}{dx} = f(x, y)$ with $y = y_0$ at $x = x_0$. Exact differential equations, condition of integrability. Equation of first order and first degree-exact equations and those reducible to exact forms. Equations of first order higher degree-equations solvable for p = $\frac{dy}{dx}$, equations solvable for y, equation solvable for x, singular solutions, Clairaut's form. Singular solution as envelope to family of general solution to the equation. [20L]
	November – December, 2016	Linear differential equations of second and higher order. Two linearly independent solutions of second order linear differential equation and Wronskian, general solution of second order linear differential equation, solution of linear differential equation of second order with constant coefficients. Particular integral for second order linear differential equation with constant coefficients for polynomial, sine, cosine, exponential function and for function as combination of them or involving them. Method of variation of parameters for P.I. of linear differential equation of second order. Homogeneous linear equation of n-th order with constant coefficients. Reduction of order of linear differential equation of second order when one solution is known. [12L]

	January – March, 2017	Simultaneous linear ordinary differential equation in two dependent variables. Solution of simultaneous equations of the form $\frac{dx}{P}=\frac{dy}{Q}=\frac{dz}{R}$. Equation of the form (Paffian form) $Pdx + Qdy + Rdz = 0$. Necessary and sufficient condition for existence of integrals of the above. [8L] *Partial Differential Equations:* Formulation of partial differential equation, Lagrange's Linear equation. General integral and complete integral. Integral surface passing through a given curve. [10L]

2. Module for Part – II:

Name of the Teacher	Duration	Course
Sri Buddhadeb Ghosh	August – October, 2016	**<u>Paper - III</u>** *Abstract Algebra - II*: Normal subgroups, properties of normal subgroups, homomorphism between the two groups, isomorphism, kernel of a homomorphism, first isomorphism theorem, isomorphism of cyclic groups. [8L]
	November – December, 2016	Ideal of a Ring (definition, examples and simple properties). Partial order relation, Poset, maximal and minimal elements, infimum and supremum of subsets. [5L]
	January – March, 2017	Lattices, definition of lattice in terms of meet and join, equivalence of two definitions. Boolean algebra, Huntington postulates, examples, principle of duality, atom, Boolean function, conjunctive normal form, disjunctive normal form, switching circuits. [7L]
Sri Uttam Mahanti	August – October, 2016	*Linear Algebra:* Matrices of real and complex numbers: Prerequisite [Algebra of matrices. Symmetric and skew-symmetric matrices]. Hermitian and skew-Hermitian matrices. Orthogonal matrices. Determinants: Prerequisite [Definition, Basic properties of determinants, Minors and cofactors]. Laplaces method. Vandermonde's determinant. Symmetric and skew symmetric determinants. (No proof of theorems). [4L]
	November – December, 2016	Adjoint of a square matrix. Invertible matrix, Non-singular matrix. Inverse of an orthogonal Matrix. [3L]
	January – March, 2017	Elementary operations on matrices. Echelon matrix. Rank of a matrix. Determination of rank of a matrix (relevant results are to be state only). Normal forms. Elementary matrices. Statements and application of results on elementary matrices. Congruence of matrices (relevant results are to be state only), normal form under congruence, signature and index of a real symmetric matrix. [5L]

Sri Subhasis Khan	August – October, 2016	*Linear Algebra:* Vector space: Definitions and examples, Subspace, Union and intersection of subspaces. Linear sum of two subspaces. Linear combination, independence and dependence. Linear span. Generators of vector space. Dimension of a vector space. Finite dimensional vector space. Examples of infinite dimensional vector spaces. Replacement Theorem, Extension theorem. Extraction of basis. Complement of a subspace. Row space and column space of a matrix. Row rank and column rank of a matrix. Equality of row rank, column rank and rank of a matrix. Linear homogeneous system of equations: Solution space. Necessary and sufficient condition for consistency of a linear non-homogeneous system of equations. Solution of system of equations (Matrix method). [12L]
	November – December, 2016	Linear Transformation on Vector Spaces: Definition of Linear Transformation, Null space, range space of a Linear Transformation, Rank and Nullity, Rank-Nullity Theorem and related problems. Diagonalization: Eigen values and eigenvectors, Statement of Cayley–Hamilton theorem and its application, Diagonalization of matrices of order 2 and 3 with application to Geometry. [6L]
	January – March, 2017	*Number Theory*: Well ordering principle for N, Division algorithm, Principle of mathematical induction and its applications. Primes and composite numbers, Fundamental theorem of arithmetic, greatest common divisor, relatively prime numbers, Euclid's algorithm, least common multiple. Congruences : properties and algebra of congruences, power of congruence, Fermat's congruence, Fermat's theorem, Wilson's theorem, Euler's theorem (generalization of Fermat's theorem) [10L]
Dr. Swapan Mukherjee	August – October, 2016	*Analysis-II (30 marks)* Definition of Riemann integration. Uniqueness. Darboux theory of Riemann integration. Equivalence of the two definitions. Darboux theorem (proof not required). Properties of Riemann integral. Riemann integrability of continuous function, monotone function and function having countable number of discontinuities, functions defined by the integral, their continuity and differentiability. [18L]
	November – December, 2016	Fundamental theorem of integral calculus. Equivalence of Riemann integral and the anti derivative (i.e., integration as inverse process of differentiation) for continuous functions. First and second mean value theorems of integral calculus integration by parts for Riemann integrals. [5L]
	January – March, 2017	Improper integral and their convergence (for unbounded functions and for unbounded range of integration) Abel's and Dirichlet's test. Beta and Gamma functions. Evaluation of improper integrals: $\int_0^{\frac{\pi}{2}} \log \sin x \, dx$; $\int_0^{\infty} \frac{\sin x}{x} dx$; $\int_0^{\infty} e^{-\alpha x} \frac{\sin \beta x}{x} dx, \alpha > 0$; and integrals dependent on them. [7L]

		Number Theory: Linear congruence, system of linear congruence theorem. Chinese remainder theorem. Number of divisors of a number and their sum, least number with given number of divisors. Eulers φ function, properties of φ function, arithmetic function, Mobius μ - function, relation between φ function and μ function. Diophantine equations of the form $ax + by = c$, a, b, c integers. [10L]
Sri Anjan Choudhury	August – October, 2016	**<u>Paper – IV</u>** *Vector Analysis (30 marks)*: Prerequisites: [Vector Algebra: Addition of vectors, scalar and vector products of two vectors, representation of a vector in E3, components and resolved parts of vectors. Point of division of a line segment, signed distance of a point from a plane, vector equation of a straight line and a plane, shortest distance between two skew lines]. Product of vectors: Scalar and vector triple products, product of four vectors. Applications of vector algebra - (i) in geometrical and trigonometrical problems (ii) to find work done by a force, moment of a force about a point and about a line (iii) to calculate volume of a tetrahedron. [12L]
	November – December, 2016	Continuity and differentiability of vector-valued function of one variable. Velocity and acceleration. Space curve, arc length, tangent, normal. Integration of vector-valued function of one variable. Serret-Frenet Formula [8L]
	January – March, 2017	Vector-valued functions of two and three variables, gradient of scalar function, gradient vector as normal to a surface. Divergence and curl, their properties. Evaluation of line integral of the type: $\int_C \varphi(x,y,z)\,d\vec{\gamma}, \int_C \vec{F}.d\vec{\gamma}, \int_C \vec{F}\times d\vec{\gamma}$ Green's theorem in the plane. Gauss and Stokes theorems (Proof not required), Green's first and second identities. Evaluation of surface integrals of the type $\iint_S \varphi\, d\vec{S}, \iint_S \vec{F}\,\vec{dS}, \iint_S \vec{n}\times\vec{F}\vec{dS}$. [10L]
Dr. Samiran Karmakar	August – October, 2016	*Dynamics of a Particle (Marks: 50)* Prerequisite: [Basic concepts of Dynamics: Motion in a straight line with uniform acceleration, Vertical motion under gravity, Momentum of a body, Newton's laws of motion, Reaction on the lift when a body is carried on a lift moving with an acceleration]. Motion of two bodies connected by a string, Composition and resolution of velocities, Relative velocity and relative acceleration.

		Work, Power and Energy: Work, Power, Energy, Principle of energy, Conservative and non-conservative forces, Kinetic and potential energy, Principle of conservation of energy, Verification of principle of conservation of energy for a particle (i) moving along a straight line under a constant force, (ii) falling from rest under gravity, (iii) moving down a smooth inclined plane under gravity alone, (iv) projected in vacuum from the horizon with a constant velocity. Impulse and Impulsive forces: Impulse, Impulsive forces, Change of momentum under impulsive forces, Principle of conservation of linear momentum, Motion of a shot and gun, Impulsive tension in a string, Principle of angular momentum. Collision of elastic bodies: Direct and oblique impacts, Newton's experimental law of impact, Direct and oblique impacts of a smooth sphere on a fixed horizontal plane, Direct and oblique impacts of two smooth spheres, Loss of kinetic energy due to impact, Projection of a ball from a horizontal plane. [22L]
	November – December, 2016	Rectilinear motion: Motion under repulsive force (i) proportional to distance (ii) inversely proportional to square of the distance, Motion under attractive force inversely proportional to square of the distance, Motion under gravitational acceleration. Simple Harmonic Motion: Simple harmonic motion, Compounding of two simple harmonic motions of the same period, Elastic string and spiral string, Hook's law, Particle attached to a horizontal elastic string, Particle attached to a vertical elastic string, Forced vibrations, Damped harmonic oscillations, Damped forced oscillations. [12L]
	January – March, 2017	Two dimensional motion: Angular velocity and angular acceleration, Relation between angular and linear velocity, Radial and transverse components of velocity and acceleration, Velocity and acceleration components referred to rotating axes, Tangential and normal components of velocity and acceleration, Motion of a projectile under gravity (supposed constant). Central orbits: Motion in a plane under central forces, Central orbit in polar and pedal forms, Rate of description of sectorial area, Different forms of velocity at a point in a central orbit, Apse, apse line, apsidal distance, apsidal angle, Law of force when the centre of force and the central orbit are known, Differential equation and classifications of paths under central accelerations, Stability of circular orbits, Conditions for stability of circular orbits under central force (general case). Planetary motion: Newton's law of gravitation, Kepler's laws of planetary motion, Modification of Kepler's third law, Escape velocity, Time to describe a given arc of an orbit. Motion in a resisting medium & Constrained motion: Motion of a heavy particle on a smooth curve in a vertical plane, Motion under gravity with resistance proportional to some integral power of velocity, Motion of a projectile in a resisting mediumTerminal velocity, Motion of a particle in a plane under different laws of resistance, Motion on a smooth cycloid in a vertical plane, Motion of a particle along a rough curve (circle, cycloid). [16L]
Sri Tufan Meheta	August – October, 2016	*Tensor Calculus (20 Marks)* Historical study of tensor. Concept of E^n. Tensor as a generalization of vector in E^2, E^3 and E^n. Einstein's Summation convention. Kronecker delta. Algebra of tensor: Invariant. Contravariant and covariant vectors.

		Contravariant, covariant and mixed tensors. Symmetric and skew-symmetric tensors. Addition, subtraction and scalar multiplication of tensors. Outer product, inner product and contraction. Quotient law. [8L]
	November – December, 2016	Calculus of tensor: Riemannian space. Line element. Metric tensor. Reciprocal metric tensor. Raising and lowering of indices. Associated tensor. Magnitude of vector. Angle between two vectors. [5L]
	January – March, 2017	Christoffel symbols of different kinds and laws of transformations. Covariant differentiation. Gradient, divergence, curl and Laplacian. Ricci's theorem. Riemann-Christoffel curvature tensor. Ricci tensor. Scalar curvature. Einstein's space (Definition only). [7L]

3. Module for Part – III:

Name of the Teacher	Duration	Course
Dr. Swapan Mukherjee	August – October, 2016	**<u>Paper – V (Old Syllabus)</u>** *Metric Space*: Metric, examples of standard metric spaces including Eucleadean and Discrete metrics; open ball, closed ball, open sets; metric topology; closed sets, limit points. and their fundamental properties; interior, closure and boundary of subsets and their interrelation; denseness; separable and second countable metric spaces and their relationship. Continuity: Definition of continuous functions, algebra of real/complex valued continuous functions, distance between a point and a subset, distance between two subsets. Connectedness: Connected subsets of the real line R, open connected subsets in R^2, components; components of open sets in R and R^2; Structure of open set in R, continuity and connectedness; intermediate value theorem. Sequence and completeness: Sequence, subsequence and their convergence; Cauchy sequence and completeness, completeness of R^n; Cantor's theorem concerning completeness. Definition of completion of a metric space, construction of the reals as the completion of the incomplete metric space of the rationals with usual distance (proof not required). Continuity preserves convergence. Compactness: Definitions (by means of open covering), Compact metric spaces and finite intersection property (FIP) of closed sets; Compact subsets, continuity and compactness; sequential compactness, Equivalence between compactness and sequential compactness, relation between compactness, completeness and total boundedness. Heine-Borel theorem concerning characterization of compact subsets of R^n. Uniform continuity and continuity on compact sets; distance between two non empty disjoint closed set one of which is compact is a positive real. [50L]
	November – December, 2016	Complex Analysis: Introduction of complex number as ordered pair of reals, geometric interpretation, metric structure of the complex plane **C**, regions in **C.** Stereographic projection and extended complex plane $\mathbf{C}_{\infty}$ and circles in $\mathbf{C}_{\infty}$

		Continuity and differentiability of a complex function. Analytic functions and Cauchy Riemann equation, harmonic functions. Power series, radius of convergence, sum function and its analytic behaviour within the circle of convergence, Cauchy-Hadamard Theorem. Introduction of exp(z), sin z, cos z, tan z and the branches of log z and their analytic behaviour. Transformation (mapping), Concept of Conformal mapping, Bilinear (Mobius) transformation and its geometrical meaning, fixed points and circle preserving character of Mobius transformation. [20L]
	January – March, 2017	Real Analysis: Definition of Riemann integration, Uniqueness, Cauchy's criterion, Linear property, Darboux theory of Riemann integration, equivalence, Darboux theorem (proof not required), Riemann integral as the limit of a sum, equivalence. Fundamental theorem of integral calculus, Properties of the Riemann integral; Riemann integrability of continuous and monotone functions, discontinuous function. First and second Mean value theorems of Integral Calculus. Functions defined by integrals, their continuity and differentiability. Convergence of sequence and series of functions, uniform convergence, Cauchy's Criterion of uniform convergence, continuity of sum function of a uniformly convergent series of continuous functions, term by term differentiation and integration for proper integrals. Functions of several variables, theory of extrema, maxima, minima, Lagranges' method of miltipliers, Jacobian, Implicit function theorem (proof not required). Integral as a function of parameter. Differentiation and integration under the sign of integration, change of order of integration for repeated integrals. Inproper integrals, their convergance (for unbounded functions and unbounded range of integration) Abel's and Dirchlets' test, Beta and Gamma function, Evaluation of improper integrals: $\int_0^{\frac{\pi}{2}} \log \sin x \, dx\,;\int_0^{\infty} \frac{\sin x}{x} dx\,;\int_0^{\infty} e^{-\alpha x} \frac{\sin \beta x}{x} dx, \alpha > 0\,;$ and integrals dependent on them. Fourier series associated with a function, Series of odd and even functions, Main theorem concerning Fourier series expansion of piece wise monotone functions (proof not required). [50L]
Sri Buddhadeb Ghosh	August – October, 2016	**<u>Paper – VI</u>** ***Physical Foundations of Classical Dynamics : (Marks - 10)*** Inertial frames, Newton's laws of motion, Galilean transformation. Form-invariance of Newton's laws of motion under Galilean transformation. Fundamental forces in classical physics (gravitation). Electric and Magnetic forces, action-at-a-distance. Body forces; contact forces: Friction, Viscosity. [10L] ***II. Dynamics of a system of particles and of a rigid body (Vector treatment): (Marks - 40)*** ***System of particles :*** Fundamental concepts, centre of mass, momentum, angular momentum, kinetic energy, work done by a field of force, conservative

		system of forces – potential and potential energy, internal potential energy, total energy. Following important results to be deduced : (i) Centre of mass moves as if the total external force were acting on the entire mass of the system concentrated at the centre of mass (examples of exploding shell, jet and rocket propulsion). (ii) The total angular momentum of the system about a point is the angular momentum of the system concentrated at the centre of mass, plus the angular momentum for motion about the center. (iii) Similar theorem as in (ii) for kinetic energy. Conservation laws: conservation of linear momentum, angular momentum and total energy for conservative system of forces. An idea of constraints that may limit the motion of the system, definition of rigid bodies. D'Alembert's principle, principle of virtual work for equilibrium of a connected system. [30L]
	November – December, 2016	***Dynamics of Rigid Body :*** Moments and products of inertia (in three-dimensional rectangular co-ordinates). Inertia matrix. Principal values and principal axes of inertia matrix. Principal moments and principal axes of inertia for (i) a rod, (ii) a rectangular plate, (iii) a circular plate, (iv) an elliptic plate, (v) a sphere, (vi) a right circular cone, (vii) a rectangular parallelepiped and (viii) a circular cylinder. [12L]
	January – March, 2017	Two-dimensional motion of a rigid body. Following examples of the two-dimensional motion of a rigid body to be studied : (i) Motion of a uniform heavy sphere (solid and hollow) along a perfectly rough inclined plane; (ii) Motion of a uniform heavy circular cylinder (solid and hollow) along a perfectly rough inclined plane: (iii) Motion of a rod when released from a vertical position with one end resting upon a perfectly rough table or smooth table. (iv) Motion of a uniform heavy solid sphere along an imperfectly rough inclined plane ; (v) Motion of a uniform circular disc, projected with its plane vertical along an imperfectly rough horizontal plane with a velocity of translation and angular velocity about the centre. [13L]
Sri Tufan Mehata	August – October, 2016	***III) Analytical Statics:*** Forces, concurrent forces, Parallel forces. Moment of a force, Couple. Resultant of a force and a couple (Fundamental concept only). Reduction of forces in three-dimensions, Pointsot's central axis, conditions of equilibrium. Virtual work, Principle of Virtual work. Simple examples of finding tension or thrust in a two-dimensional structure in equilibrium by the principle of virtual work. Stable and unstable equilibrium- Energy test of stability, stability of a heavy body resting on a fixed body with smooth surfaces- simple examples. General equations of equilibrium of a uniform heavy inextensible string under the action of given coplanar forces, common catenary, catenary of uniform strength. [20L]

	November – December, 2016	***Elements of Continuum Mechanics with Hydrostatics (Marks - 30)*** ***1. Elements of Continuum Mechanics:*** Deformable body. Idea of a continuum (continuous medium). Surface forces or contact forces. Stress at point in a continuous medium, stress vector, components of stress (normal stress and shear stress) in rectangular Cartesian co-ordinate system; stress matrix. Definition of ideal fluid and viscous fluid. [10L]
	January – March, 2017	II. ***Hydrostatics :*** Pressure (pressure at a point in a fluid in equilibrium is same in every direction). Incompressible and compressible fluid, Homogeneous and non-homogeneous fluids. Equilibrium of fluids in a given field of force; pressure gradient. Equipressure surfaces, equilibrium of a mass of liquid rotating uniformly like a rigid body about an axis. Simple applications. Pressure in a heavy homogeneous liquid. Trust on plane surfaces: center of pressure, effect of increasing the depth without rotation. Centre of pressure of a triangular & rectangular area and of a circular area immersed in any manner in a heavy homogeneous liquid. Simple problems. Thrust on curved surfaces: Archemedes' principle. Equilibrium of freely floating bodies under constraints. (Consideration of stability not required). Equation of state of a 'perfect gas', Isothermal and adiabatic processes in an isothermal atmosphere. Pressure and temperature in atmosphere in convective equilibrium. [20L]
Sri Anjan Choudhury	August – October, 2016	**Paper – VII** ***Mathematical Probability:*** Concept of mathematical probability, classical statistical and axiomatic definition of probability, addition and multiplication rule of probability. Conditional probability, Baye's theorem. Independent events. Bernoulli's trial, Binomial and Multinomial Law. Random Variables. Distribution function. Discrete and continuous distributions. Binomial, Poisson, Uniform, Normal, Cauchy, Gamma, distribution and Beta distribution of the first and second kind. Transformation of random variables. [15L]
	November – December, 2016	Discrete and continuous distributions in two dimensions. Mathematical expectation. Theorems on the expectation of sum and product of random variables. [10L]
	January – March, 2017	Two dimensional expectation, covariance, Correlation co-efficient. Moment generating function. Characteristic function, conditional expectations, Regression curve, χ^2 and t distributions and their interrelations, convergence in probability Chebyshev's inequality. Bernoulli's limit theorem, Convergence in probability. Concept of asymptotically normal distribution, central limit theorem in case of equal components. [15L]
Dr. Samiran Karmakar	August – October, 2016	***Elements of Operations Research (Marks - 40)*** General introduction to optimization problem, Definition of L.P.P., Mathematical formulation of the problem, Canonical & Standard form of L.P.P., Basic solutions, feasible, basic feasible & optimal solutions, Reduction of a feasible solution to basic feasible solution.

		Hyperplanes and Hyperspheres, Convex sets and their properties, Convex functions, Extreme points, Convex feasible region, Convex polyhedron, Polytope. Graphical solution. of L. P.P. Fundamental theorems of L.P.P., Replacement of a basis vector, Improved basic feasible solutions, Unbounded solution, Condition of optimality, Simplex method, Simplex algorithm, Artificial variable technique (Big M method, Two phase method), Inversion of a matrix by Simplex method. Duality in L.P.P.: Concept of duality, Fundamental properties of duality, Fundamental theorem of duality, Duality & Simplex method, Dual simplex method and algorithm. [25L]
	November – December, 2016	Transportation Problem (T.P.) : Matrix form of T.P., the transportation table, Initial basic feasible solutions (different methods like North West corner, Row minima, Column minima, Matrix minima & Vogel's Approximation method), Loops in T.P. table and their properties, Optimal solutions, Degeneracy in T.P., Unbalanced T.P. Theory of Games : Introduction, Two person zero-sum games, Minimax and Maximin priciples, Minimax and Saddle point theorems, Mixed Strategies games without saddle points, Minimax (Maximin) criterion, The rules of Dominance. Solution methods of games without Saddle point: Algebraic method, Matrix method, Graphical method and Linear Programming method. [15L]
	January – March, 2017	***Statistics (Marks - 20)*** Description of statistical data, simple measures of central tendency-mean, mode, median, measures of dispersion – standard deviation, quartile deviation. Moments and measures of Skewness and Kurtosis. Bivariate frequency distribution. Scatter diagram, Correlation co-efficients, regression lines and their properties. Concept of statistical population and random sample. Sampling distribution of sample mean and related χ^2, t and F distribution. Estimation – Unbiasedness and minimum variance, consistency and efficiency, method of maximum likelihood, interval estimation for mean or variance of normal populations. [20L]
Sri Subhasis Khan	August – October, 2016	***Numerical Analysis (Marks - 35)*** Approximation of numbers, decimal places, significant figures. Round off. errors in numerical calculations. Addition, subtraction, multiplication and division. Loss of significant figures, Inherent errors in numerical methods. Ordinary and divided differences, Proagation of error in difference table. Problems of interpolation, remainder in interpolation. Newton's forward and backward interpolation formulae. Newton's divided difference formula. Central interpolation formulae: Gauss, Stirling and Bessel's formulae (Deduction not necessary). Lagranges interpolation formula. Inverse interpolation formula. Numerical integration: Newton-Cotes' formula (error term may be stated). Trapezoidal rule, Simpson's one-third rule, Inherent errors, degree of precision. [25L]
	November – December, 2016	Numerical methods for finding the real roots of algebraic and transcendental equations: Location of roots by Tabulation and Graphical method. Finding the roots by the method of (i) Regula-Falsi (ii) Fixed

		point iteration and (iii) Newton Raphson & their convergences. Solution of a system of linear equation: Gauss' elimination method and Gauss-Seidel method; statement of convergence criteria. Solution of first order ordinary differential equations: Picard's method, Euler's method (modified), Taylor's method and Runge-Kutta's method of second and fourth order (derivation of 2^{nd} order formula only). [15L]
	January – March, 2017	***Computer Programming (Marks – 15)*** Anatomy of a computer: Basic structure, Input unit, Output unit, Memory unit, Control unit, Arithmetic logical unit. Computer generation and classification; Machine language, Assembly language, computer-high level languages. Compiler, Interpreter, Operating system.. Source programs and objects programs. Binary number system, Conversions and arithmetic operation. Representation for Integers and Real numbers, Fixed and floating point. Programming in FORTRAN-77 Language: Fortran Characters. Basic data types; Numeric Constant & Variables; Arithmetic Expressions, Assignment statements, I/O –statements(Format-free) ; STOP & END statement; Control statement: Unconditional GOTO, Computed GOTO, Assigned GOTO, Logical IF and Arithmetic IF. Repetitive operations: DO statement; CONTINUE statement, Arithmetic statement functions; Library functions in FORTRAN. [20L]

Module for ***Computer Aided Numerical Methods –Practical:***

Students are divided into three groups and three teachers are allotted for these groups:

I) Group A: Dr. Samiran Karmakar
II) Group B: Sri Subhasis Khan
III) Group C: Sri Anjan Choudhury

November – December, 2016	Prerequisites : PC – operating system and DOS commands, Concepts of Algorithms, Flowchart and Subscripted variables 1. Finding a real Root of an equation by (a) Fixed point iteration and (b) Newton-Rapson's method. [20L]
January – March, 2017	2. Finding the solution of linear equations by Gauss-Seidel method **3.** Interpolation (Taking at least six points) by Lagrange's formula 4. Integration by (i) Trapezoidal rule (ii) Simpson's $1/3^{rd}$ rule (taking at least 10 sub-intervals) 5. Solution of a 1^{st} order ordinary differential equation by fourth-order R. K. Method, taking at least four steps. [30L]