MATHEMATICS SYLLABUS 2015 (PATNA UNIVERSITY)

B.A./B.Sc. PART I   MATHEMATICS   (HONOURS COURSE)

*Stress should be given on **development of ideas and theories** rather than on solving difficult problems. Problems should be short and illustrative to theories.*

Honours course for Part I will consist of two papers.

Paper I Time : 3 Hours Full Marks : 100

1.1 Set Theory	- 4 Questions (Group A)
1.2 Algebra 1	- 4 Questions (Group B)
1.3 Algebra 2	- 4 Questions (Group C)

There will be __twelve questions__ in the paper in three groups i.e A, B and C. The examinees will be required to answer __six questions__, selecting __at least one__ from each group.

1.1 Set Theory:- General form of **De-Morgan's laws**, **Fundamental Theorem on equivalence** relation, **Partial and Total order relation**, Maximal and Minimal element in a partially ordered set, Composition and factorization of mappings, set mapping, Countable and uncountable set, Countability of rational, real and algebraic number systems. Countability of union and Cartesian product of sets. Domination and cardinality, **Cantor's theorem**, Schroeder – Bernsteirn theorem Sum and product of cardinal numbers, Cardinality of power set of a set.   **(3 Questions)**

Concept of a Fuzzy set, Fuzzy power set, Relation between Fuzzy sets, Operations on Fuzzy sets. Height, core and support of a Fuzzy set.**(1 Question)**

1.2 Algebra 1:- Division algorithm, Euclidean algorithm. Euclid's lemma, Notion of groups with examples, Residue classes, **Formulation of groups**, Elementary properties of groups, cancellation laws, Solvability of equations, **Subgroups,** cyclic group, order of an element. Cosets and Lagrange's theorem, Homomorphism and Isomorphism of groups, Normal Subgroup ,Quotient subgroup ,Fundamental theorm of homomorphism of groups, Cayley's Theorem. **(3 Questions).**

Theory of Equations:-Relation between roots and coefficients of a polynomial equation, Evaluation of symmetric functions of roots, Solution of cubic equation, (*Cordon's method*) and bi-quadratic equation (*Euler's method*)   **(1 Question).**

1.3 Algebra 2:- **Notion of Rings**, Integral domain, field and their general properties and illustrations, Subrings and subfields Homomorphism and Isomorphism of rings. Kernels and Ideals. Quotient ring and Fundamental theorem of homomorphism of rings. **(3 Questions**)

*Trigonometry***:- De-Moivre's theorem** and its applications, Hyperbolic functions, **Gregory's Series,** Summation of Trigonometric series **(1 Question).**

Paper II   Time : **3 Hours**   Full Marks : **100**

2.1 Calculus   -   8 Questions (Group A)

2.2 Geometry -   4 Questions Group B)

There shall be **twelve questions** in the paper consisting of two groups A and B. The examinees will be required to answer **six questions**, selecting **at least two from Group A and one from Group B .**

2.1 CALCULUS

Differential Calculus:- Successive differentiation and **Leibnitz's theorem**, Tangent and Normal, Partial differentiation, **Euler's theorem**, exact differential, Indeterminate forms and **L'Hospital rule**, Curvature, Convexity of functions, **Asymptotes**. (**3 Questions)**

Integral Calculus:- Evaluation of definite integrals, Reduction formulae, Curve tracing, rectification and **Quadrature**, volumes and surface areas of solids of revolution, Multiple integrals and change of order of integration, Improper integrals, M.I.,C.G **Beta & Gamma functions**

(3 Questions)

*Vector Calculus***:-** Product of Three & Four vectors, Differentiation of vector point functions, differentiation of product of vectors, Gradient of a scalar and Divergence & Curl of a vector in Cartesian coordinates. **(2 Questions)**

2.2 Geometry:

Analytical Geometry of two dimensions: Transformation of rectangular axes, General equation of second degree and its reduction to normal form. Systems of Conics, Polar equation of a conic, tangents and normals. **(2 Questions)**

*Analytical Geometry of Three dimensions***:** Sphere, Cone, Cylinder, standard equations of conicoids, Normal and conjugate diameters of an ellipsoid.   **(2 Questions)**

B.A. /B.Sc. PART II *MATHEMATICS* (HONOURS COURSE)

Honours Course of Part II will consist of two papers.

Paper III   Time : 3 Hours   Full Marks : 100

3.1 Linear Algebra   -   4 Questions (Group A)

3.2 Real Analysis   -   4 Questions (Group B)

3.3 Sequence and series   -   4 Questions (Group C)

3.1 **Linear Algebra**:- Orthogonal matrix and their properties, Elementary transformation and elementary matrices, Rank of matrix, solution of linear equations. (**1 Question**)

Definition, examples and simple properties of **vector space**, vector subspaces and linear combination, sum and direct sum, linear independence, Basis and dimension of finitely generated vector space, linear transformations, their nullity and rank, quotient space .

Characteristic equation of a matrix, **Eigen values** and Eigen vectors, Cayley-Hamilton theorem, solution of system of linear, homogeneous and non-homogeneous equations. Dimensions of the space of solution of AX=B. **(3 Questions)**

3.2 **Real Analysis**: **Dedekind theory** of real numbers, Algebraic and order properties of real numbers, Theorems on l.u.b and g.l.b, Dedekind's theorem, **Fundamental theorem of classical analysis** , Archimedean property of real numbers, properties of open sets and neighbourhoods in R, Accumulation point of a set, Bolzano- Weierstrass theorem compact sets in R, Heine Borel Theorem. Properties of continuous and discontinuous real functions of two variables, Boundedness of continuous functions, Intermediate value theorem , **Mean value theorem**, Taylor's theorem with the remainder of Lagrange's and Cauchy's forms, **Taylor and Maclaurin's series**.

(**4 Questions**)

3.3 **Sequence and Series**:   **Sequence and its convergence**, Cauchy's sequence, Cauchy's general principle of convergence, Monotonic sequence, Limit superior and limit inferior.

Infinite series and their convergence comparison test, **Cauchy's root test**, Ratio test, **Gauss's ratio test**, Kummer's test, De-Morgan and Bertrand test, **Logarithmic ratio test**, Cauchy's condensation test, **Leibnitz test**, Absolute convergence and conditionally convergent series, Dirichlet's theorem, Multiplication of series, Cauchy, Abel and Dirichlet tests. **(4 Questions)**

Paper IV   Time : 3 Hours   Full Marks : 100

4.1 Differential Equations   -   4 Questions (Group A)

4.2 Vectors & Statics   4 Questions (Group B)

4.3 Dynamics   4 Questions (Group C)

There will be **twelve questions** consisting of three groups A, B and C , Examinees will have to answer **six Questions** selecting **at least one** from each group.

4.1 **Differential equations**:- Exact differential equations, Equations of first order but not of the first degree, **Clairaut's form**, orthogonal trajectory, singular solutions , Linear differential equations of the second order with constant coefficients and variable coefficients, **Method of variation of parameter.(4 Questions**)

4.2 **Vectors and Statics**:-

Vectors :- Integrals of vector functions, line, surface and volume integrals, Gauss, Green and Stokes theorems.   (**1 Question**)

Statics:- Reduction of a system of coplanar forces, equation of the line of   action of the resultant, **Virtual work**, Principle of virtual work for a system of   particles, Stable and unstable equilibrium, Energy test of stability (Problems   involving one variable only), Common catenary. (**3 Questions**)

4.3 **Dynamics**: Rectilinear motion in a non-resisting and a resisting medium, Harmonic oscillator, damped and free vibrations, elastic strings and springs, vertical and horizontal motion of a particle attached to an elastic string.

4.4 **Statics:-** Motion in a plane, velocities and accelerations in Cartesian, polar and intrinsic

Co-ordinates, motion of a projectile in non-resisting and resisting medium,

constrained motion in a smooth horizontal and vertical circle, simple pendulum . Motion of a particle under a central force , differential equation of a central orbit in rectilinear, polar and pedal coordinates, Central orbits, Kepler's laws of motion deduced from Newton's law of Gravitaion and vice-versa. (**4 Questions**)

BA/B.Sc. Part III : **MATHEMATICS** *(Honours)*

Paper V   Time : 3 Hours   Full Marks : 100

5.1 Theory of Metric spaces   - 5 Question (Group A)

5.2 Riemann Integration   - 2 Questions (Group B)

5.3 Infinite Series   - 3 Questions (Group C)

5.4 Fourier Series and Function of   - 2 Questions (Group D)

  Bounded variation

    There will be twelve questions divided in four groups A, B, C and D. Examinees will be required to answer six questions selecting atleast one from each group.

5.1 Theory of Metric spaces:-Definition and examples of metric spaces. Notion of open sphere and open sets. Neighbourhood in a metric space and their properties. Derived set, Closed set and closure in a metric space and their properties. Convergence of sequence in a metric space, continous mapping in a metric space, their characterization by open sets and closed sets. Characterization of continuity in terms of convergent sequence ,properties of completeness including Cantor's intersection theorem and Baire's category theorem Banach fixed point theorem**. (5 Questions)**

5.2 Riemann Integration: Definition and existence of Riemann Integral of bounded functions. Darbourx's theorem Necessary and Sufficient condition for R-Integrability, Riemanm integrability of continous functions, Monotonic function and function having finite number of discontinuites. Riemann integral as the limit of a sum, fundamental theorem of integral calculus, Mean value theorem**.(2 Questions)**

5.3 Infinite Series: Integral test for series of arbitrary terms, Euler's constant, Riemann's theorem and Pringsheim theorem on rearrangement of terms of conditionally convergent series. Dirichelet's and Abel's tests for series of arbitrary terms, Infinite product and its convergence. Double series, sum by rows, sum by columns and sum by rectangles**.(3 Questions**)

5.4 Fourier series and Functions of bounded variation:-Fourier series for odd and even functions, Half range series, other forms of Fourier series, Functions of bounded variation. **(2 Questions)**

Paper VI
Time : **3 Hours**   Full Marks : **100**

6.1 Algebra III – 5 Questions (Group A)

6.2 Number theory- 3 Questions (Group B)

6.3 Complex Analysis- 4 Questions (Group C)

There will be **twelve questions** divided into three groups A,B and C. Examinees will be required to answer six questions, selecting **at least one** from each group.

6.1 Algebra III

Coset of a Group, automorphism of a group, inner automorphism, Relation of Conjugacy on a group, Normalizer of a subgroup, centralizer of an element in a group.

Class equation of a group, Quotient field of an integral domain, Inbedding of an integral domain in a field, characteristic of a ring and an integral domain, polynomial rings, division algorithm, Sylow's theorem**.(5 Questions**)

6.2 Number theory:-Division algorithm, Euclidean algorithm and Greatest Common Divisior (GCD or HCF), Diophantine equations, Prime and composite numbers, unique factorization theorem (Fundamental theorem of arithmetic), Co-primes, Divisors of a composite number, Definition of congruence modulo m and its properties, solution of linear congruence, complete Residue system modulo m, Reduced Residue system. Chinese Remainder theorem, Euler's theorem, Fermat's (little) theorem, Wilson's theorem**.(3 Questions)**

6.3 Complex Analysis:-Continuity and differentiability of function of a complex variable. Analytic function, Cauchy-Riemann differential equation, Integration of a complex function, Cauchy's integral theorem, Morera's theorem, Liouville theorem, Cauchy integral formula, Higher order derivatives, Singularities of an analytic function, Taylor's and Laurent's expansion, Fundamental theorem of algebra, Poles and residues**.(4 Questions)**

Paper VII

Time : 3 Hours   Full Marks : 100

7.1 Linear Programming: 3 Questions (Group A)

7.2 Differential Equations II : 4 Questions (Group B)

7.3 Attraction and Potential – 2 Questions (Group C)

7.4 Hydrostatics - 3 Questions(Group D)

There will be twelve questions divided into four groups A, B, C and D. Examinees will be required to answer six questions, selecting at least one from each group.

7.1 Linear Programming:-Convex sets and their properties, Linear programming and their graphical solution. Theory of simplex method and their applications. Transporation and Assignment problems.**(3Questions**)

7.2 Differential Equations II:- Total differential equations in three independent variables, simultaneous differential equations. **Lagrange's linear** partial differential equation, standard forms, **Charpit's method**, partial differential equation of higher order with constant coefficients. **Monge's method**, solution in serie. **(4 Questions)**

7.3 Attraction and Potential:-Attraction and Potential of rods, rectangles and circular discs, spherical shell, sphere, Laplace's and Poisson's equations, theorems on equipotential surfaces. **(2 Questions)**

7.4 Hydrostatics :-Fluid pressure, thrust on plane surfaces, centre of pressure, Equilibrium of fluids in a given field of forces, Equilibrium of floating bodies, Resultant thrust on curved surface, Gases. **(3 Questions)**

Paper VIII (Optional Paper)   Time: 3 Hours   Full Marks: 100

In this paper the students will study **any one** of the following.

1. **Numerical analysis**
2. Spherical Astronomy.
3. Probability theory.
4. Computational methods.
5. Biomathematics.
6. Linear Programming and its application in theoretical Economics.
7. Partial differential Equations of Mathematical Physics.

8.1 Numerical Analysis :- **Finite Central** and divided differences, Interpolation, Inverse Interpolation, Numerical differentiation, Numerical Integration. **Trapezoidal rule**, Simpson's one third and three-eight rules, **Weddel's rule**, Gauss quadrature formula of Integration, Gregory's formula and **Euler-Maclauin's formula**

Solution of difference equation of the first order, General solution, Linear difference equation with constant co-efficient, Solution of ordinary differential equations one step method :Euler's modified, Picard's, **Runge-kutta** methods, Methods of starting the solution and continuing the solution, Adams Bashforth, Milne's method.

Simultaneous linear equations,: Gauss elimination method, Jordan method ,Gauss -Seidel an Relaxation methods(Simple problems).

Finding roots of Transcendental and Polynomial equation. **Regula Falsi** , Bisection, **Newton-Raphson** method ,Ierative method and its generalization. Chebyshev's ,Birge-vieta, Lin-Bairstow's , Graeffe's root squaring method and their convergence .

Note: If a student opts for other optional, syllabus will be provided by the department.

B.A./B.Sc. Part I – MATHEMATICS (SUBSIDIARY)

Stress should be given on development of ideas and theories, rather than on solving problems. Problems should be short and intelligent.

Paper I   Time : 3 Hours   Full Marks : 100

1.1 Set Theory and Matrices   -   3 Questions (Group A)

1.2 Calculus 1   -   3 Questions   (Group B)

1.3 Algebra   -   3 Questions (Group C)

1.4 Real Analysis and Geometry   -   3 Questions (Group D)

The question paper will be divided into Four Groups A,B, C and D respectively. The examinees will be required to answer **six question** selecting **at least one** from each group.

1.1 **Set Theory and Matrices**: General form of De Morgan's laws, Equivalence relation, Fundamental theorem on equivalence relation, composition and Factorization of mapping, Set mapping, Countability of rational, real and algebraic number systems.**(2 Questions**)

Kinds of matrices, transpose, adjoint and inverse of a matix. Solution of consistent system of linear equations in two and three variables.(**1 Question**).

1.2 *Calculus 1*: Successive differentiation, Leibnitz theorem, Taylor's and Maclaurin's series, Partial derivatives, Euler's theorem, indeterminate forms, Tangents and Normals Asymptotes, radius of curvature in different coordinate system.   (**2 Questions).**

Vector: Triple product of vectors, differentiation of vector point functions , Differentiation of product of vectors, Gradient of a scalar, Divergence and curl of vectors in cartesian coordinates. (**1 Question**)

1.3 *Algebra:* Definition of a group with examples, Abelian and non-abelian, groups, cancellation laws, definition of subgroup and cyclic group with examples. Definition of ring, integral domain and field with examples. (**2 Questions**)

Trigonometry:- **De-Moivre's theorem** and its application, Expansions of sinx, cosx and tanx, complex argument, trigonometric function **of complex angles, Hyperbolic functions, Gregory's series, summation of series.(1** Question).

1.4 *Real Analysis and Geometry*

Real Analysis:- Sequence of real numbers and their limits, bounded sequence, monotonic sequence, Cauchy's general principle of convergence, convergent and divergent series, convergence of series of positive terms, comparison test, Cauchy's root test, D'Alembert's ratio test and Raabe's test, Alternating series and Leibnitz test, Absolute convergence of series differentiability of real function of one variable.   **(3 Questions)**

Analytical Geometry of Two dimensions:- General equation of second degree & its reduction to standard forms, Tangents and normal.   **(1 Question)**

B.A./B.Sc. Part II – MATHEMATICS   (Subsidiary)

Paper II   Time : 3 Hours   Full Marks : 100

2.1 Calculus II   -   4 Questions (Group A)

2.3 Differential Equations

  & Linear Programming -   4 Questions (Group B)

2.3 Mechanics & Geometry -   4 Questions (Group C)

The question paper will be divided into three groups A, B and C. The examinees will be required to answer **six questions**, selecting *at least one from each group.*

2.1 Calculus II: Reduction formulae, Rectification and Quadrature, volume and surface area of solids of revolution, moment of inertia and centre of gravity, simple use of double and triple integration, **Beta and Gamma function. (4 Questions)**

2.2 Differential Equations: Exact differential equation, Differential equations of first order but not of first degree, Clairaut's form, orthogonal trajectories linear, differential equations of higher order with constant coefficents. (**2 Questions**)

Linear Programming: Convex set, Convex Combination, Properties of convex sets Linear Programming problem(LPP)- its formulation, and solution by graphical method & simplex method. (**2 Questions**)

2.3 Mechanics: Reduction of a system of coplanar forces, equation of line of action of resultant, Principle of virtual work. (**1 Question**)

Rectilinear motion in non-resisting and resisting medium, elastic string and spring Horizontal and vertical motion of a particle attached to an elastic string.   (**1 Question**)

Motion in a plane, components of velocity and acceleration in Cartesian, polar and intrinsic coordinates. .(**1 Question**)

Analytical Geometry of three dimensions: Standard equation of sphere, cone and cylinder, equation of their tangent planes. (**1 Question**)