DRAFT SYLLABUS FOR B.A./B. Sc. (MATHEMATICS), June, 2019

Course Structure: Semester-wise distribution.

First Semester (Total marks: General –100)
GHS 11 : Algebra-I & Calculus – I (100 marks, 80 lectures)

Second Semester (Total marks: General – 100)
GHS 21 : Geometry & Vector Calculus (100 marks, 80 lectures)

Third Semester (Total marks: General – 100)
GHS 31: Statics & Calculus – II (100 marks, 80 lectures)

Fourth Semester (Total marks: General – 100)
GHS 41: Algebra II & Dynamics (100 marks, 80 lectures)

Fifth Semester (Total marks: Honours - 200)
H 51 : Elementary Number Theory (40 marks, 32 lectures)
H 52 : Advanced Calculus I (60 marks, 48 lectures)
H 53 : Differential Equations (40 marks, 32 lectures)
H 54 : Advanced Dynamics . (60 marks, 48 lectures)

Sixth Semester (Total marks: Honours - 200)
H 61 : Advanced Calculus II (40 marks, 32 lectures)
H 62 : Advanced Algebra (60 marks, 48 lectures)
HOP X: Optional paper (100 marks, 80 lectures)

Optional Papers : Any one of the following (100 marks, 80 lectures)
HOP 1 : Computer programming in C & Computer Oriented Numerical Analysis
HOP 2 : Operations Research
HOP 3 : Fluid Mechanics
HOP 4 : Complex Function Theory
HOP 5 : Discrete Mathematics
HOP 6 : Probability Theory
HOP 7 : Elementary Differential Geometry

(Abbreviation: GHS = General and Honours, H = Honours,
HOP X = Honours Optional Paper No. X)

Notes:
1. The distribution for marks for each paper shall be 25% for Internal assessment and 75% for External assessment.
2. Each question paper should contain the paper name and the corresponding paper number as mentioned in the syllabus.

GHS 11
ALGEBRA-I & CALCULUS – I

(Number of Teaching hours: 80; Time:3 hrs; Marks: 100)
(To answer five questions, choosing one out of two questions from each unit)

SECTION – A (Algebra –I, 40 marks)

UNIT I : Brief review of sets, subsets and equality of two sets; relation on a set: reflexive, symmetric, anti-symmetric, transitive; examples from geometry and number systems; equivalence relation and equivalence classes; partitions.
Brief review of functions/mappings, inclusion maps, restriction of a map, composition of maps, associativity, onto, one-one, bijective maps; inverse images of sets, inverse of a bijective map; finite and infinite sets; proof of "If A is a finite set f:A–> A is one one if and only if f is onto"; examples where this assertion does not hold. Graph of a function: real valued functions such as polynomials, rational functions, logarithmic functions, exponential functions and hyperbolic functions. Limits, ε-δ definition, standard theorems on limits, standard limits; continuity: Intuitive idea, ε-δ definition, theorems on sums, differences, product, quotient and composites of continuous functions; continuity of functions.

UNIT II : A brief review of m × n matrix over R/C as a rectangular array of numbers (motivation through systems of linear equations); transpose, conjugate transpose; definition of inverse of a matrix; special type of matrices: diagonal , scalar, upper/lower triangular, nilpotent, idempotent, symmetric, skew symmetric, Hermitian, skew Hermitian matrices; trace of a square matrix; row vectors and column vectors of a matrix; row rank/column rank of an m × n matrix (in terms of linear independence of row/column vectors of the matrix); adjoint of a matrix; inverse in terms of adjoints; determinantal rank of matrix; equality of rank and determinantal rank; Elementary operations; elementary matrices; row/column reduced echelon form of a matrix; determination of the inverse of a matrix by elementary operations; theorem on the equality of row-rank and column-rank; rank of a matrix; determination of the rank by elementary operations; systems of linear equations: homogeneous and non-homogeneous.

SECTION – B (Calculus – I, 60 marks)

UNIT III : Properties of continuous functions defined on closed and bounded intervals, (statements with illustrations only for the following) boundedness, intermediate value theorem, uniform continuity; derivatives of real valued functions on intervals : definition; derivative as a rate measurer, derivative as the gradient of tangent (geometrical interpretation only); theorems on sum, difference, product, quotient and composite of differentiable functions; review of methods of differentiation; successive differentiation; Leibniz's theorem; l'Hôpital's rule (statements only with applications).

UNIT IV : Anti-derivative : review of the standard methods; integration by parts and by partial fractions; integral of a continuous function as the limit of Riemann sum (including sums arising out of unequal distribution of interval); examples of evaluation of integrals from the definition. Definite integrals, fundamental theorem of integral calculus and differentiability of integrals of continuous functions(statements with illustrations only) properties of definite integral, evaluation of integrals using these properties; reduction formulas for $\int sin^n x dx$, $\int cos^n x dx$, $\int tan^n x dx$, $\int e^{ax} sin(nx) dx$, $\int e^{ax} x^n dx$, $\int e^{ax} (logx)^n dx$, $\int sin^n x cos^m x dx$ and their combinations; improper integrals, convergence and evaluation from definition.

UNIT V : Brief review of first order first degree equations; Bernoulli's equation; exact equations; reduction to exact form by integrating factors; differential equations of first order but higher degrees;

Clairut's equation and singular solution; geometrical interpretation applications of first order differential equations to geometric and physical problems (simple cases only) including orthogonal trajectories, introduction of second order homogeneous differential equations with constant coefficients

Text Books:

1. Bhattacharya, P. B., Jain, S. K., and Nagpaul, S. R. : *Basic Abstract Algebra*, Cambridge University Press, 2003.
2. Maity, K. C. and Ghosh, R. K. : *An introduction to Analysis: Differential Calculus: Part I*, New Cental Book Agency Pvt Ltd., 2011.
3. Maity, K. C. and Ghosh, R. K. : *An Introduction to Analysis: Integral Calculus*, New Central Book Agency Pvt Ltd., 2013.

Reference Books

1. Fraleigh, J. B., *A First Course in Abstract Algebra*, Pearson Education India, 2013.
2. Gopala Krishnan, N.S., *University Algebra*, New Age International Pvt. Ltd. Publishers, 2007.
3. Stewart, J., *Essential Calculus: Early Transcendentals*, Cengage India Pvt Ltd, 2017.
4. Saikia, P. K.: *Linear Algebra, Pearson*, Delhi, 2014.
5. Das, B C. and Mukherjee, B.N., *Differential Calculus* , UN Dhar and Sons Pvt Ltd, 52nd edition, 2012.
6. Das, B.C. and Mukherjee, B.N., *Integral Calculus* , UN Dhar and Sons Pvt Ltd, 52nd edition, 2012.
7. Thomas, G. B., and Finney, R. L.: *Calculus and Analytic Geometry* (9th Edition), Pearson Education India, 2010.

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GHS 31
Statics and Calculus-II
(Number of Teaching hours:80; Time: 3hrs; Marks:100)
(To answer five questions, choosing one out of two questions from each unit)

SECTION-A (Statics, 40 marks)

UNIT I : Composition and resolution of forces; parallelogram of forces, Components and resolved parts, Coplanar forces: Equilibrium of concurrent forces, Triangle of forces, Lami's Theorem and its converse; Parallel forces; Moment of a force; Definition, geometrical representation of Moments, Varignon's Theorem. Couples; definition, equilibrium of Couples, Equivalence of two Couples, Resultant of Couples, Resultant of a couple and a force.

UNIT II : Reduction of coplanar forces, equilibrium of coplanar forces. Friction: laws of statical friction, laws of limiting friction, solution of problems on equilibrium of heavy bodies (such as uniform rods) resting on plane surfaces.
Centre of gravity: centre of gravity of thin uniform rod, uniform lamina, triangular lamina and lamina in the form of a parallelogram and trapezium.

SECTION-B (Calculus-II, 60 marks)

UNIT III : Sequences of real numbers : definitions of bounded sequence, convergent sequence, limit of a sequence, monotonic sequence; examples; proof of the fact that monotonic and bounded sequences are convergent (using completeness of R as an axiom); Cauchy sequence; Cauchy's general principle of convergence;
Infinite series of real numbers: partial sums, convergent series, comparison test, ratio test, Raabe's test, root test; absolute convergence; Leibnitz's theorem for alternating series; power series; radius of convergenoe (without the notion of limit superior), standard examples of power series.

UNIT IV : Application of differential calculus: Sign of the derivatives of a real valued function of a real variable, vanishing of $f(x)$; Rolle's theorem; geometric interpretation, mean value theorems; applications of the mean value theorems: (i) increasing and decreasing functions, (ii) concavity

upwards and downwards, (iii) points of inflections, multiple roots. Use of differentials in approximation and error estimates; maxima and minima; asymptotes; curvature of plane curves (Cartesian and parametric equations only);
Real-valued functions of two or three variables: limits; continuity; partial derivatives of first and second orders; Schwarz's theorem (statement only); differentials; chain rules; Euler's theorem on homogeneous functions, proof upto three variable case.

UNIT V : Location of roots of f(x), proof of the fundamental theorem of integral calculus; Taylor's and Maclaurin's theorem with Cauchy's form of remainders; Taylor's and Maclaurin's series; expansion of standard functions such as ex, $sin\ x$, $cos\ x$, $log\ (1+x)$, $(1+x)n$. Applications of integral calculus : determination of (i) areas under simple plane curves, (ii) lengths of simple plane curves, (iii) volume and surface areas of solids of revolution in standard cases. Evaluation of line integrals (in a plane); double integrals; change of order of integration; application in determination of area, volume (simple cases only).

Text books:

1. Das, B. C. and Mukherjee, B. N.: *Statics*, U. N. Dhar & Sons Publications, Kolkata, 2002.
2. Maity, K. C. and Ghosh, R. K.: *Differential Calculus*, New Cental Book Agency Pvt Ltd., 2002.
3. Maity, K. C. and Ghosh, R. K.: *Integral Calculus*, New Cental Book Agency Pvt. Ltd., 2002.

Reference Books:

1. Loney, S. L.: *An elementary treatise on the Dynamics of a particle and of rigid bodies*, New Age International Pvt. Ltd, 2016.
2. Stewart, J.: *Essential Calculus Early Transcendentals*, Cengage India Pvt Ltd, 2017.
3. Bernside, W. S., and Panton, A. W.: *Theory of Equations, Vol. I*, S. Chand & Co., New Delhi,2000.
4. Thomas, G. B., and Finney, R. L. : *Calculus and Analytic Geometry* (9th Edition), Pearson Education India, 2010.
5. Narayan S.: *A course of Mathematical Analysis*, S.Chand and Co., 2005.
6. Das, B.C. and Mukherjee B.N., *Differential Calculus* , UN Dhar and Sons Publisher, 52nd edition, 2012.

H 51

Elementary Number Theory

(Number of Teaching hours:32; Time: 2 hours; Marks:40)

(To answer two questions, choosing one out of two questions from each unit)

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UNIT I : Divisibility in the set of integers; basic properties; the division algorithm; gcd; elementary properties; the Euclidean algorithm; lcm; primes (in the set of natural numbers); fundamental theorem of arithmetic; Euclid's proof of the infinitude of primes; arbitrary gaps in the distribution of primes; congruences in the set of integers modulo a positive integer; basic properties; complete residue system; reduced residue system; Euler's ϕ-function; Fermat's theorem: Euler's generalization of Fermat's theorem; applications, Wilson's theorem.

Unit II : Solution of congruences; linear congruences; Chinese remainder theorem; consequences of higher degree modulo a prime. Some functions of number theory – greatest integer function; elementary properties; Arithmetic functions, multiplicative functions; functions such as $\phi(n)$, $\mu(n)$, $o(n)$, $\sigma_k(n)$.

Text Books
1. Niven, I., Zuckerman, H.S., and Montogomery, H.L. : *An Introduction to the Theory of Numbers*, Wiley Eastern Ltd., 2000.

Reference Books
1. Telang, S.G. : *Number Theory*, Tata McGraw-Hill, New Delhi, 1996.
2. Burton, David M.: *Elementary Number Theory*, Universal Book Stall, 2001.

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H 52
Advanced Calculus I
(Number of Teaching hours:48; Time: 3hrs; Marks:60)
(To answer three questions, choosing one out of two questions from each unit)

UNIT I : Riemann integral of functions of one variable; Darboux's theorem (statement and application);conditions for integrability; classes of bounded and integrable functions; properties of integrable functions; inequalities for integrals; functions defined by integrals; their continuity and differentiability; Mean value theorems for integrals. Improper integrals; test for convergence when the integrand is non-negative; absolute convergence; tests for absolute and conditional convergence, beta and gamma functions; Abel's theorem, Dirichlet's theorem; Frullani's integral.

UNIT II : Integrals as functions of parameters; continuity, differentiability and integrability of such a function; applications to evaluation of integrals; Improper integrals as functions of a parameter; uniform convergence and tests for uniform convergence; continuity, differentiability and integrability of uniformly convergent improper integrals of continuous functions involving parameters; evaluation of integrals.

UNIT III : Line integral in R^2; Riemann integral of real valued functions of two variables; evaluation of double integrals – change of order of integration; change of variable and simple problems; Green's theorem in R^2, Surface Integral and Stokes Theorem, Volume integral and Gauss's divergence theorem (statements and applications only).

Text Books:
1. Narayan, S.: *A Course of Mathematical Analysis*, S. Chand. Delhi, 2005.
2. Apostol, T.M. : *Mathematical Analysis*, Narosa Book Distributors, 2002.

Reference Books
1. Stewart, J.: *Essential Calculus Early Transcendentals*, Cengage India Pvt Ltd, 2017.

2. Bartle, R. G., and Sherbert, D. R. : *Introduction to Real Analysis* (Wiley India Edition), Wiley & Sons, Inc, 2000.
3. Rudin, W. : *Principles of Mathematical Analysis* (3rd Edition), McGraw Hill Education, 2013.
4. Malik, S. C. and Arora, S. : *Mathematical Analysis*, New Age International Pvt Ltd., 2017.
5. Ghosh, R.K. and Maity, K.C.: *Introduction to Analysis*, New Central Book Agency (P) Ltd, 2002.
6. Raisinghania M.D.: *Elements of Real Analysis*, S. Chand and Co, 2003.

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H 53
Differential Equations

(Number of Teaching hours:32; Time: 2 hours; Marks:40)
(To answer two questions, choosing one out of two questions from each unit)

UNIT I : Linear equations of second and third order with constant coefficients, – complementary functions and particular integrals for $x^n e^{ax}, e^{ax}\sin(mx), e^{ax}\cos(mx), x^n \sin(mx), x^n \cos(mx)$; equations of type $a_1 x^2 y'' + a_2 x y^1 + a_3 y = f(x)$; Linear differential equations of second order with variable coefficients; homogeneous equations; exact equations; transformation of the equation by changing the dependent variable/the independent variable, Normal form. Method of variation of parameters; simultaneous equations; total differential equation $Pdx + Qdy + Rdz = 0$

UNIT II: Partial differential equation. Formation of equation, solutions of linear equations of first order, Lagrange's methods, Non linear partial differential equations of first order- Standard forms I, II, III & IV; Integral surfaces passing through a given curve, orthogonal surfaces, non linear equations of first order, Charpit's method.

Text Books:

1. Raisinghania , M.D. : *Ordinary and Partial Differential Equations* , S. Chand and Co, 2013.
2. Sneddon, I. N.: *Elements of Partial Differential Equation*, Dover, 2006.

Reference Book:

1. Coddington, Earl A.: *An Introduction to Ordinary Differential Equations*, PHI Learning Pvt. Ltd., New Delhi, 1998.
2. Piaggio, I.: *An Elementary Treatise on Differential Equations and Applications*, G. Bell & Sons, 2000.

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H 54
Advanced Dynamics

(Number of Teaching hours:48; Time: 3 hours; Marks:60)
(To answer three questions, choosing one out of two questions from each unit)

UNIT I : Central forces; central orbits; centre of force, motion of a particle under the action of central forces, motion on a rough cycloid, description of a central conic under a central force; use of reciprocal polar co-ordinate; stability of a nearly circular orbit; use of pedal co-ordinates and pedal equations; apse; apsidal distance; apsidal angle; perihelion and aphelion; Kepler's laws of planetary motion and its deductions.

UNIT II : Moments and products of inertia; moments of inertia of a uniform rod, a rectangular lamina, a parallopiped, a circular ring, a circular disc; theorems of parallel and perpendicular axes about a fixed axis; principal axes (definition only); momental ellipsoid equimomental systems. D'Alembert's Principle, the general equations of motion, motion of the centre of inertia, motion relative to the centre of inertia.

UNIT III : Motion about a fixed axis: moment of the effective forces about the axis of rotation, equation of motion of a rigid body about a fixed axis, expression for kinetic energy of the body and moment of momentum of the rigid body moving about a fixed axis. The compound pendulum: interchangeability of the centre of suspension and centre of oscillation, minimum time of oscillation; motion in two dimensions (only finite forces), friction, kinetic energy of a body moving in two dimensions, moments of momentum about the origin of a body moving in two dimension and problems illustrating the above cases. (varying mass is not included).

Text Book:

1. Loney, S. L.: *An elementary treatise on the Dynamics of a particle and of rigid bodies*, New Age International Pvt Ltd, 2016.

Reference Books:

1. Vasistha, A.R., Agarwal, D.C.: *Dynamics of a particle*, Krishna Prakashan Mandir Publication, 2015.
2. Rohman, M.M : *Rigid Dynamics*, New Central Book Agency, 2011.

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