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## CORE COURSES

B.Sc. (Honours)-Mathematics

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### Semester-I

**MATH.( Hons ) -CC-1: Calculus-I**  
(Total Marks: 100)

**Part-I (Marks: 75) Time – 3 hrs.**  
(Theory:Sem-60 Marks+Mid-Sem-15 Marks, Credit – 6 [4(Th.) + 2 (Pr.)])

#### **Unit-I**

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of the type  $e^{ax+b}\sin x$ ,  $e^{ax+b}\cos x$ ,  $(ax+b)^n\sin x$ ,  $(ax+b)^n\cos x$ , concavity and inflection points, asymptotes.

#### **Unit-II**

Curve tracing in Cartesian coordinates, tracing in polar coordinate of standard curves, L'Hospital's rule, applications in business, economics and life sciences, Reduction formulae, Derivations and illustrations of reduction formulae of the type  $\int \sin^n x dx$ ,  $\int \cos^n x dx$ ,  $\int \tan^n x dx$ ,  $\int \sec^n x dx$ ,  $\int (\log x)^n dx$ ,  $\int \sin^n x \cos^n x dx$

#### **Unit-III**

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

#### **Unit-IV**

Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics. Sphere, Cone, Cylinder, Central Conicoids.

#### **Unit-V**

Triple product, introduction to vector functions, operations with vector-valued functions, limits and Continuity of vector functions, differentiation and integration of vector functions, tangent and normal Components of acceleration.

### **Math. Part-II C – I (Practical, Marks:25)**

#### **List of Practicals (Using any software)**

#### **Practical/ Lab work to be performed on a Computer.**

1. Plotting the graph of the function  $se^{ax+b}$ ,  $\log(ax+b)$ ,  $1/\sqrt{ax+b}$ ,  $\sin(ax+b)$ ,  $\cos(ax+b)$ ,  $|ax+b|$  and to illustrate the effect of  $a$  and  $b$  on the graph.
2. Plotting the graphs of the polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
4. Tracing of conics in cartesian coordinates/ polar coordinates.

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5. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic paraboloid, hyperbolic paraboloid using Cartesian coordinates.
  6. Matrix operation (addition, multiplication, inverse, transpose).

**Books Recommended:**

1. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007. Chapters: 4 (4.3, 4.4, 4.5 & 4.7), 9(9.4), 10(10.1-10.4).
2. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002. Chapters: 6, (6.2-6.5), 7(7.8), 8(8.2-8.3, Pages: 532-538), 11(11.1), 13(13.5)
3. Analytical Geometry of Quadratic Surfaces, B. P. Acharya and D. C. Sahu, Kalyani Publishers, New Delhi, Ludhiana.
4. Elements of vector calculus by Sarana & Prasad +878

**Books for Reference:**

1. G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
3. Text Book of Calculus, Part-II- Shantin Narayan, S. Chand & Co.,
4. Text Book of Calculus, Part-III- Shantin Narayan, S. Chand & Co.,
5. Shanti Narayan and P. K. Mittal- Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.

**CORE COURSES**

**MATHEMATICS- SEMESTER- 1**

**Math ( Hons ) C-II : Algebra-I                      Time – 3 hrs.**

**Total Marks: 100**

**Theory: Sem.-80 Marks + Mid- Sem: 20 Marks                      Credit - 6**

**5 Lectures, 1 Tutorial (per week per student)**

**Unit-I**

Polar representation of complex numbers,  $n$ -th roots of unity, De Moivre's theorem and its applications.

**Unit-II**

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm.

**Unit-III**

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation  $Ax=b$ , solution sets of linear systems, applications of linear systems, linear independence.

**Unit-IV**

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Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices

Sub spaces of  $\mathbb{R}^n$ , dimension of sub spaces of  $\mathbb{R}^n$

#### **Unit-IV**

Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental theorem of Arithmetic Rank of a matrix, Eigenvalues, Eigen Vectors and Characteristic Equation of a matrix.

#### **Books Recommended:**

1. L.V.Ahlfors, Complex Analysis, McGraw-Hill (International Student Edn.)
2. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006. Chapter: 2
3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3<sup>rd</sup> Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005. Chapters: 2 (2.4), 3, 4 (4.1-4.1.6, 4.2-4.2.11, 4.4(4.1-4.4.8), 4.3-4.3.9, 5(5.1-5.1.4).
4. David C. Lay, Linear Algebra and its Applications, 3<sup>rd</sup> Ed., Pearson Education Asia, Indian Reprint
5. V. Krishanmurthy, V. P. Mainra & J. B. Arara – An Introduction of Linear Algebra Chapters: 1(1.1-1.9), 2(2.1-2.3, 2.8, 2.9), 5(5.1, 5.2)

### **Semester-II**

#### **CORE COURSES**

**Math ( Hons) CC-III : Real Analysis ( Analysis-I)**

**Time – 3 hrs.**

**Total Marks: 100**

**Theory: Sem.-80 Marks + Mid-Sem: 20 Marks**

**Credit - 6**

**5 Lectures, 1 Tutorial (per week per student)**

#### **Unit-I**

Review of Algebraic and Order Properties of  $\mathbb{R}$ , Neighborhood of a point in  $\mathbb{R}$ , Idea of countable sets, uncountable sets and uncountability of  $\mathbb{R}$ . Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

#### **Unit-II**

The Completeness Property of  $\mathbb{R}$ , The Archimedean Property, Density of Rational (and Irrational) numbers in  $\mathbb{R}$ , Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano – Weierstrass theorem for sets.

#### **Unit-III**

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Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only) ,Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.

#### **Unit-IV**

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's  $n$ -th root test, Integral test.

#### **Unit-V**

,Alternating series,Leibniz test, Absolute and Conditional convergence.

#### **Books Recommended:**

1.G.DasandS.Pattanayak,Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters: 2(2.1 to 2.4, 2.5 to 2.7), 3(3.1-3.5), 4(4.1 to 4.7, 4.10, 4.11, 4.12, 4.13).

#### **Books for References:**

1.R.G.Bartle and D.R.Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.

2.Gerald G.Bilodeau, Paul R.Thie, G.E.Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.

3.Brian S.Thomson, Andrew M.Bruckner and Judith B.Bruckner, Elementary Real Analysis, Prentice Hall, 2001.

4.S.K.Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.

5.S.C.Mallik and S.Arora- Mathematical Analysis, New Age International Publications.

6.D.Smasundaram and B.Choudhury- A First Course in Mathematical Analysis, Narosa Publishing House.

7.S.L.Gupta and Nisha Rani- Real Analysis, Vikas Publishing House Pvt.Ltd., New Delhi.

8. R.B. Dash & D.D. Dalai – A Course on Mathematical analysis, Kalyani Publisher

### **CORE COURSES**

#### **Semester-II**

**Math ( Hons ) – CC -IV : Differential Equations**

**Time – 3 hrs. Full Marks: 100 [60 (Sem.) + 15 (In.) + 25 (Pr.)]**

**Credit – 6 [4(Th.) + 2 (Pr.)]**

## **Part-I (Marks:75)**

**Theory: 60 Marks + Mid-Sem:15 Marks**

**04 Lectures (per week per student)**

### **Unit-I**

Differential equations and mathematical models. First order and first degree ODE (variables separable, homogeneous, exact, and linear). Equations of first order but of higher degree. Applications of first order differential equations (Growth, Decay and Chemical Reactions, Heatflow, Oxygen debt, Economics).

### **Unit-II**

Second order linear equations (homogeneous and non-homogeneous) with constant coefficients, second order equations with variable coefficients, variation of parameters, method of undetermined coefficients

### **Unit-III**

Euler's equations reducible to linear equations with constant coefficients, Euler's equation. Applications of second order differential equations.

### **Unit-IV**

Power series solutions of second order differential equations.

### **Unit-V**

Laplace transforms and its applications to solutions of differential equations.

## **Part-II C – IV (Practical: Marks:25)**

### **List of Practicals (Using any Software)**

#### **Practical /Lab work to be performed on a Computer.**

1. Plotting of second order solution of family of differential equations.
2. Growth model (exponential case only).
3. Decay model (exponential case only).
4. Oxygen debt model.
5. Economic model.

#### **Book Recommended:**

1. J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi. Chapters: 1, 2 (2.1 to 2.7), 3, 4 (4.1 to 4.7), 5, 7 (7.1-7.4), 9 (9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

#### **Books for References:**

1. Martin Braun, Differential Equations and their Applications, Springer International.

2.M.D.Raisinghania-AdvancedDifferentialEquations,S.Chand &CompanyLtd.,NewDelhi.

3.G.DennisZill-AFirstCourseinDifferentialEquationswithModellingApplications,Cengage Learning India Pvt.Ltd.

4.S.L.Ross,DifferentialEquations,JohnWiley&Sons,India,2004

### **MATHMATICS- SEMESTER - 1 / III (Interdisciplinary):**

#### **GE-I: Calculus and Ordinary Differential Equations**

**Time – 3 hrs. F.M.–100 [80(End Sem) + 20(Mid Sem)] Credit - 6**

#### **Unit-I**

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, Volume and Surface area of solids of revolution.

#### **Unit-II**

Sphere, Cones and Cylinders, Conicoid.

#### **Unit-III**

Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers. Multiple integrals.

#### **Unit-IV**

Ordinary Differential Equations of 1<sup>st</sup> order and 1<sup>st</sup> degree (Variables separable, homogenous, exact and linear). Equations of 1<sup>st</sup> order but higher degree.

#### **Unit-V**

Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters. Laplace transforms and its applications to solutions of differential equations.

#### **Books Recommended:**

1. Advanced Higher Calculus (Vidyapuri Dr. Ghanasyam Sen & Others)  
Ch- 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
2. B. P. Acharya and D. C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana. Ch. (2,3,4)
3. J. SinharoyandS.Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.Chapters:2(2.1to2.7),3,4(4.1to4.7),5,9(9.1,9.2,9.3,9.4,9.5,9.10,9.11,9.13).

#### **BooksforReferences:**

1. Shanti Narayan and P.K.Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd.,

NewDelhi.

2. David V. Weider-Advanced Calculus, Dover Publications.

3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.

4. M. D. Raisinghania- Advanced Differential Equations, S. Chand & Company Ltd., New Delhi

5. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.

## **MATH.-DSC-I, SEM-I IS SAME AS MATH.-CC-I, SEM-I**

### **MATHEMATICS- SEMESTER – II / IV (Interdisciplinary):**

#### **GE-II: : Linear Algebra and Advanced Algebra**

Time – 3 hrs. F.M. – 100 [80 (Th.) + 20 (Pr.)] Credit - 6

#### **Unit-I**

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

#### **Unit-II**

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigenvalues, Eigenvectors, Quadratic forms.

#### **Unit-III**

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

#### **Unit-IV**

Ring Theory: Definition and examples, Some special classes of Rings, Ideals, Quotient rings, Ring homomorphism. Isomorphism theorems.

#### **Unit-V**

Zero divisors, Integral domain, Finite fields, Finite field  $\mathbb{Z}/p\mathbb{Z}$ , Field of quotients of an Integral domain, Polynomial ring, Division algorithm, Remainder theorem, Factorization of polynomials, irreducible and reducible polynomials, Primitive polynomials, Irreducibility tests, Eisenstein Criterion.

#### **Books Recommended:**

1.V.Krishnamurty,V.P.Mainra,J.L.Arora-AnintroductiontoLinearAlgebra,AffiliatedEast-WestPressPvt.Ltd.,NewDelhi,Chapters:3,4(4.1to4.7),5(except5.3),6(6.1,6.2,6.5,6.6,6.8),7(7.4only).

2. I.N Iterstein, Topics in Algebra

Ch-1(1.3 only), 2 (2.1 to 2.6;2.7 excluding application, 2.10), 3 (3.1 to 3.6, 3.9, 3.10)

**BooksforReferences:**

1. I.H.Seth-Abstract Algebra, Prentice Hall of India Pvt.Ltd.,NewDelhi.Chapters:13,14,15,16,17,18,19,20.

2.RaoandBhimasankaran-LinearAlgebra,HindustanPublishingHouse.

3.S.Singh-LinearAlgebra,VikasPublishingHousePvt.Ltd.,NewDelhi.

4.GilbertStrang-LinearAlgebra&itsApplications,CengageLearningIndiaPvt.Ltd.

5.Gallian-ContemporaryAbstractAlgebra,NarosapublishingHouse.

6.Artin-Algebra,PrenticeHallofIndia.

8.V.K.KhannaandS.K.Bhambri-A Course in Abstract Algebra, Vikas Publishing House Pvt.Ltd.,NewDelhi.

**MATH.-DSC-II, SEM-II IS SAME AS MATH.-CC-IV, SEM-II**