

**TRUNCATED UG SYLLABUS IN**  
**MATHEMATICS HONOURS**  
**PROGRAMME - ODD**  
**SEMESTERS 2020-2021**

**Credit Distribution**

Course Type	Total Papers	Credits	Marks
1. Hard Core Courses (HCC)	14	$13 \times 5 + 13 \times 1 = 78$ , $1 \times 4 + 1 \times 2 = 6$ for HCC-XII	$75 (60+10+5)$ , 40+20+10+5 (for HCC-XII)
2. D.S. Elective (DSE)	4	$4 \times 5 + (4 \times 1) = 24$	75 (60+10+5)
3. General Elective (GE)	4	$4 \times 5 + (4 \times 1) = 24$	75 (60+10+5)
4. Skill Enhance (SE)	2	$2 \times 2 = 4$	75 (60+10+5)
5. Ability Enhance (AE)	2	$2 \times 2 = 4$	80+15+5=100 (AE-I), 35+10+5=50 (AE-II)
	26	140	1950

**SEMESTER-1**

Subject Course No.	Syllabus Code	Course	Credit
MATH 15 AE-I	AE-I	Eng com./Env.Sc.	2
MATH 11 HCC-I	HCC-I	Cal, Geo & D.E.	5 + 1
MATH 11 HCC-II	HCC-II	Algebra	5 + 1
MATH 13 GE-I	GE-I	Other Department	5 + 1

**SEMESTER-2**

Subject Course No.	Syllabus Code	Course	Credit
MATH 25 AE-II	AE-II	Eng Com/EVS	2
MATH 21 HCC-III	HCC-III	Real Analysis	5 + 1
MATH 21 HCC-IV	HCC-IV	D.E & Vector Calculus	5 + 1
MATH 23 GE-II	GE-II	Other Department	5 + 1

**SEMESTER-3**

Subject Course No.	Syllabus Code	Course	Credit
MATH 31 HCC-V	HCC-V	Theory Of Real Functions & Introduction of the metric space	5 + 1
MATH 31 HCC-VI	HCC-VI	Group Theory-I	5 + 1
MATH 31 HCC-VII	HCC-VII	Riemann Integration & Series of functions	5 + 1
MATH 33 GE-III	GE-III	Other Department	5 + 1
MATH 34 SE-I	SE-I	Logic & Sets/C++	2

**SEMESTER-4**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MATH 41 HCC-VIII	HCC-VIII	Multivariate Calculus	5 + 1
MATH 41 HCC-IX	HCC-IX	Ring Theory & Linear Algebra I	5 + 1
MATH 41 HCC-X	HCC-X	Metric Space & Complex Theory	5 + 1
MATH 43 GE-IV	GE-IV	Other Department	5 + 1
MATH 44 SE-II	SE-II	Graph Theory/Operating System: Linux	2

**SEMESTER-5**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MATH 51 HCC-XI	HCC-XI	Group TheoryII	5 + 1
MATH 51 HCC-XII	HCC-XII	Numerical Methods+Lab	4 + 2
MATH 52 DSE-I	DSE-I	Probability & Statistics/Linear Programming	5 + 1
MATH 52 DSE-II	DSE-II	Number Theory/Mechanics	5 + 1

**SEMESTER-6**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MATH 61 HCC-XIII	HCC-XIII	Ring Theory & Linear Algebra-II	5 + 1
MATH 61 HCC-XIV	HCC-XIV	Partial Differential Equations & Applications	5 + 1
MATH 62 DSE-III	DSE-III	Point Set Topology/Boolean Algebra & Automata Theory	5 + 1
MATH 62 DSE-IV	DSE-IV	Differential Geometry/Theory Of Equation	5 + 1

## DETAILED SYLLABUS

### SEMESTER-1

Subject Course No.	Syllabus Code	Course	Credit
MATH 15 AE-I	AE-I	Eng com./Env.Sc.	2
MATH 11 HCC-I	HCC-I	Cal, Geo & D.E.	5 + 1
MATH 11 HCC-II	HCC-II	Algebra	5 + 1
MATH 13 GE-I	GE-I	Other Department	5 + 1

### **MATH11 HCC-I: Calculus, Geometry and Differential Equation**

6 Credits

#### **Unit 1**

Hyperbolic functions, higher order derivatives, concavity and inflection points, envelopes, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves.

#### **Unit 2**

Reduction formulae, derivations and illustrations of reduction formulae of the type  $\int \sin nx \, dx$ ,  $\int \cos nx \, dx$ ,  $\int \tan nx \, dx$ ,  $\int \sec nx \, dx$ ,  $\int (\log x)^n \, dx$ ,  $\int \sin^n x \cos^m x \, dx$ , parametric equations, parameterizing a curve arc length of a curve, arc length of parametric curves, area under a curve, area and volume of revolution.

#### **Unit 3**

Reflection properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics. Spheres.

#### **Unit 4**

Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

### Reference Books

- G. B. Thomas and R. L. Finney, Calculus, 9<sup>th</sup> Ed., Pearson education, Delhi, 2005.
- M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3<sup>rd</sup> Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- H. Anton, I. Bivens and S. Davis, Calculus, 7<sup>th</sup> Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
- S. L. Ross, Differential Equations, 3<sup>rd</sup> Ed., John Wiley and Sons, India, 2004.
- Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
- G. F. Simmons, Differential Equations, Tata Mcgraw Hill.
- T. Apostol, Calculus, Volumes I and II.
- S. Goldberg, Calculus and mathematical analysis.

## **MATH11 HCC- II- ALGEBRA**

6 Credits

### **Unit 1**

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Theory of equations : relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation. Graphical representation of a polynomial and maximum, minimum of polynomial.

Inequality: The inequality involving  $AM \geq GM \geq HM$ , Cauchy-Schwartz inequality.

### **Unit 2**

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. Congruence relation between integers. Principles of mathematical induction, statement of Fundamental Theorem of Arithmetic.

### **Unit 3**

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.

**Reference Books**

- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006
- 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.
- David C. Lay, Linear Algebra and its Applications, 3<sup>rd</sup> Ed., Pearson Education Asia, Indian Reprint, 2007.
- K. B. Dutta, Matrix and linear algebra.
- K. Hoffman, R. Kunze, Linear algebra.
- W. S. Burnstine and A. W. Panton, Theory of equations.

**SEMESTER-3**

Subject Course No.	Syllabus Code	Course	Credit
MATH 31 HCC-V	HCC-V	Theory Of Real Functions & Introduction of the metric space	5 + 1
MATH 31 HCC-VI	HCC-VI	Group Theory-I	5 + 1
MATH 31 HCC-VII	HCC-VII	Riemann Integration & Series of functions	5 + 1
MATH 33 GE-III	GE-III	Other Department	5 + 1
MATH 34 SE-I	SE-I	Logic & Sets/C++	2

**MATH31 HCC-V: THEORY OF REAL FUNCTIONS AND  
INTRODUCTION TO METRIC SPACE**

6 Credits

**Unit 1**

Limits of functions ( $\epsilon$ - $\delta$  approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

**Unit 2**

Differentiability of a function at a point and in an interval, algebra of differentiable functions . Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Cauchy's Mean Value Theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

**Unit 3**

Metric spaces: Definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, subspaces. Sequences in metric spaces.

**Reference Books**

- R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
- K. A. Ross, Elementary Analysis : The Theory of Calculus, Springer, 2004.
- A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
- S. R. Ghorpade and B. V. Limaye, a Course in Calculus and Real Analysis, Springer, 2006.
- T. Apostol, Mathematical Analysis, Narosa Publishing House.
- Courant and John, Introduction to Calculus and Analysis, Voll II, Springer.
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
- Terence Tao, Analysis II, Hindustan Book Agency, 2006
- SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
- S. Kumareasan, Topology of Metric Spaces, 2<sup>nd</sup> Ed., Narosa Publishing House, 2011.
- G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.

**MATH31 HCC VI :  
GROUP THEORY 1**

6 Credits

**Unit 1**

Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

**Unit 2**

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

**Unit 3**

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, properties of cosets, Lagrange's theorem.

**Reference Books**

- John B. Fraleigh, A First Course in Abstract Algebra, 7<sup>th</sup> Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2<sup>nd</sup> Ed., Pearson, 2011.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4<sup>th</sup> Ed., Narosa Publishing House, New Delhi, 1999.
- Joseph J. Rotman, An Introduction to the Theory of Groups, 4<sup>th</sup> Ed., Springer Verlag, 1995.
- I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
- D. S. Malik, John M. Mordeson and M. K. Sen, Fundamentals of abstract algebra.

6 Credits

**MATH 31 HCC- VII: RIEMANN INTEGRATION AND SERIES OF FUNCTIONS****Unit 1**

Riemann integration: inequalities of upper and lower sums, Riemann conditions of integrability.



## Unit 2

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions.

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence.

## Unit3

Power series, radius of convergence, Cauchy Hadamard theorem. Differentiation and integration of power series ; Abel's theorem ; Weierstrass approximation theorem.

### Reference Books

- K. A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- R. G. Bartle D. R. Sherbert, Introduction to Real Analysis, 3<sup>rd</sup> Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.
- S. Goldberg, Calculus and mathematical analysis.
- Santi Narayan, Integral calculus.
- T. Apostol, Calculus I, II.

## MATH34 SE-I: LOGIC AND SETS

2 Credits

### Unit 1

Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, equivalence relations.

**Reference Books**

- R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
- P.R. Halmos, Naive Set Theory, Springer, 1974.
- E. Kamke, Theory of Sets, Dover Publishers, 1950.

**OR**

**MATH34 SE-I:**

**C++**

2 Credits

**Unit 1**

Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer.

**Unit 2**

Objects, classes, constructor and destructors, friend function, inline function, encapsulation, data abstraction, inheritance, polymorphism, dynamic binding, operator overloading, method overloading, overloading arithmetic operator and comparison operators.

**Reference Books**

- R. Venugopal, Rajkumar, and T. Ravishanker, Mastering C++, TMH, 1997.
- S. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
- Bruce Eckel, Thinking in C++, 2nd Ed., President, Mindview Inc., Prentice Hall.
- D. Parsons, Object Oriented Programming with C++, BPB Publication.
- Bjarne Stroustrup, The C++ Programming Language, 3rd Ed., Addison Wesley.
- E. Balaguruswami, Object Oriented Programming In C++, Tata McGrawHill
- Herbert Schildt, C++, The Complete Reference, Tata McGrawHill.

**SEMESTER-5**

Subject Course No.	Syllabus Code	Course	Credit
MATH 51 HCC-XI	HCC-XI	Group TheoryII	5 + 1
MATH 51 HCC-XII	HCC-XII	Numerical Methods+Lab	4 + 2
MATH 52 DSE-I	DSE-I	Probability & Statistics/Linear Programming	5 + 1
MATH 52 DSE-II	DSE-II	Number Theory/Mechanics	5 + 1

**MATH51 HCC-XI:  
GROUP THEORY II**

6 Credits

**Unit 1**

Automorphism, inner automorphism, automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.

**Unit 2**

Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions. Generalized Cayley's theorem. Index theorem. Groups acting on themselves by conjugation, class equation and consequences.

**Reference Books**

- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
- David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
- J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.
- D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.
- D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of abstract algebra.
- I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

**MATH51 HCC-XII -  
NUMERICAL  
METHODS**

4 Credits

**Unit 1**

Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.

**Unit 2**

Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

**Unit 3**

System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition.

**Reference Books**

- Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
- M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
- Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
- John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
- Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
- Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
- Yashavant Kanetkar, Let Us C , BPB Publications.

**NUMERICAL METHODS LAB (INTERNAL)**

2 Credits

List of practical (using any software)

1. Calculate the sum  $1/1 + 1/2 + 1/3 + 1/4 + \dots + 1/N$ .
2. Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by
  - i. Bisection method
  - ii. Newton Raphson method.
  - iii. Secant method.
  - iv. Regula Falsi method.

#### 4. Solution of system of linear equations

- i. LU decomposition method
- ii. Gaussian elimination method
- iii. Gauss-Jacobi method
- iv. Gauss-Seidel method

### **MATH52 DSE-I: PROBABILITY & STATISTICS**

6 Credits

#### **Unit 1**

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.

### Reference Books

- Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
- Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7<sup>th</sup> Ed., Pearson Education, Asia, 2006.
- Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
- Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.
- A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers.

OR

### **MATH52 DSE-I: LINEAR PROGRAMMING**

6 Credits

#### **Unit 1**

Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison.

#### **Unit 2**

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

### Reference Books

- Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
- F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
- Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
- G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

## **MATH52 DSE-II: NUMBER THEORY**

6 Credits

### **Unit 1**

Diophantine equation, Gaussian integers, Euclidean Algorithm for gcd, linear representation of gcd, primes and factorizations, consequences of unique prime factorization, linear Diophantine equation.

### **Unit 2**

Congruence arithmetic, inverse mod  $p$ , Fermat's little Theorem, congruence theorem of Wilson and Lagrange, linear congruence, Chinese remainder theorem.

### **Reference Books**

- Elements of Number Theory, John Stillwell, Springer, 2003.
- An introduction to theory of numbers, Niven and Zuckerman, Wiley 1991.
- David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
- Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

OR

## **MATH52 DSE-II: MECHANICS**

6 Credits

### **Unit 1**

Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

### **Unit 2**

Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law. Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone and on any surface of revolution.

### **Reference Books**

1. I. H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4<sup>th</sup> Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
3. Chorlton, F., Textbook of Dynamics.
4. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press.
5. Loney, S. L., Elements of Statics and Dynamics I and II.

6. Ghosh, M. C, Analytical Statics.
7. Verma, R. S., A Textbook on Statics, Pothishala, 1962.
8. Matiur Rahman, Md., Statics.
9. Ramsey, A. S., Dynamics (Part I).

**Prof. S De Sarkar**  
**Chairman**  
**UG Board of Studies in Mathematics**  
**University of North Bengal**



## ANEXURE

**For Generic Elective (GE) Course taken by students of Honours other than Mathematics Honours, any two of the following five (05) courses with credit (5+1) be chosen**

### **MATPGE1: Calculus, Geometry and DE**

6 Credits

#### **Unit 1**

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to the 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, envelopes, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule.

#### **Unit 2**

Reduction formulae, derivations and illustrations of reduction formulae of the type  $\int \sin nx \, dx$ ,  $\int \cos nx \, dx$ ,  $\int \tan nx \, dx$ ,  $\int \sec nx \, dx$ ,  $\int (\log x)^n \, dx$ ,  $\int \sin^n x \cos^m x \, dx$ , parametric equations, parameterizing a curve arc length of a curve, arc length of parametric curves, area under a curve, area and volume of revolution.

### Reference Books

- G. B. Thomas and R. L. Finney, Calculus, 9<sup>th</sup> Ed., Pearson education, Delhi, 2005.
- M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3<sup>rd</sup> Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- H. Anton, I. Bivens and S. Davis, Calculus, 7<sup>th</sup> Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
- S. L. Ross, Differential Equations, 3<sup>rd</sup> Ed., John Wiley and Sons, India, 2004.
- Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
- G. F. Simmons, Differential Equations, Tata Mcgraw Hill.
- T. Apostol, Calculus, Volumes I and II.
- S. Goldberg, Calculus and mathematical analysis.

### **MATPGE2:**

#### Algebra

6 Credits

#### **Unit 1**

Theory of equations : relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation. Graphical representation of a polynomial and maximum, minimum of polynomial.

#### **Unit 2**

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

### Reference Books

- Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006
- 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.
- David C. Lay, Linear Algebra and its Applications, 3<sup>rd</sup> Ed., Pearson Education Asia, Indian Reprint, 2007.
- K. B. Dutta, Matrix and linear algebra.
- K. Hoffman, R. Kunze, Linear algebra.
- W. S. Burnstine and A. W. Panton, Theory of equations.

### **MATPGE3: DE and Vector Calculus**

6 Credits

#### **Unit 1**

Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian : its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

#### **Unit 2**

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients,

Basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

### Reference Books

- Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2<sup>nd</sup> Ed., Taylor and Francis group, London and New York, 2009.
- C. H. Edwards and D. E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
- S. L. Ross, Differential Equations, 3<sup>rd</sup> Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3<sup>rd</sup> Ed., Elsevier Academic Press, 2004.

- Murray, D., Introductory Course in Differential Equations, Longmans Green and Co.
- Boyce and Diprima, Elementary Differential equations and boundary Value problems, Wiley.
- G. F. Simmons, Differential Equations, Tata McGraw Hill.
- Marsden, J., and Tromba, Vector Calculus, McGraw Hill.
- Maity, K. C. and Ghosh, R. K. Vector Analysis, New Central Book Agency (P) Ltd. Kolkata (India).
- M. R. Spiegel, Schaum's outline of Vector Analysis.

### **MATPGE4: GROUP THEORY**

6 Credits

#### **Unit 1**

Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

#### **Unit 2**

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

#### **Reference Books**

- John B. Fraleigh, A First Course in Abstract Algebra, 7<sup>th</sup> Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2<sup>nd</sup> Ed., Pearson, 2011.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4<sup>th</sup> Ed., Narosa Publishing House, New Delhi, 1999.
- Joseph J. Rotman, An Introduction to the Theory of Groups, 4<sup>th</sup> Ed., Springer Verlag, 1995.
- I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.
- D. S. Malik, John M. Mordeson and M. K. Sen, Fundamentals of abstract algebra.

### **MATPGE5: Numerical Methods**

**Unit 1**

Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.

**Unit 2**

Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

**Unit 3**

System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

**Reference Books**

- Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
- M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
- C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
- Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

- John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
- Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
- Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
- Yashavant Kanetkar, Let Us C , BPB Publications.

**Prof. S De Sarkar**

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**TRUNCATED UG SYLLABUS IN**  
**MATHEMATICS PROGRAMME-**  
**ODD**  
**SEMESTER 2020-2021**

**Credit Distribution**

<b>Course Type</b>	<b>Total Papers</b>	<b>Credits</b>	<b>Marks</b>
1. Discipline Specific Core (DSC)	12	$12 \times 5 + 12 \times 1 = 72$	75 (60+10+5),
2. Discipline Specific Elective (DSE)	6	$6 \times 5 + (6 \times 1) = 36$	75 (60+10+5)
3. Skill Enhancement (SEC)	4	$4 \times 2 = 8$	75 (60+10+5)
4. Ability Enhancement Compulsory Course (AECC)	2	$2 \times 2 = 4$	80+15+5=100 (AE-I), 35+10+5=50 (AE-II)
	24	120	1800

**SEMESTER-1**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MAT P14 AE-I	AE-I	Env.Sc.	2
MATP 11 DSC	DSC Paper 1	Calculus and Geometry	5 + 1
	DSC	Other Department	5+1
	DSC	Other Department	5+1

**SEMESTER-2**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MAT P24 AE-I	AE-I	Env.Sc.	2
MATP 21 DSC	DSC Paper 2	Algebra	5 + 1
	DSC	Other Department	5+1
	DSC	Other Department	5+1

**SEMESTER-3**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MATP 31 DSC	DSC Paper 3	Real Analysis	5 + 1
	DSC	Other Department	5+1
	DSC	Other Department	5+1

MATP33 SEC	SEC SEM 3 Paper 1	Logic & Sets/C++	2
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**SEMESTER-4**

Subject Course No.	Syllabus Code	Course	Credit
MATP 41 DSC	DSC Paper 4	D.E & Vector Calculus	5 + 1
	DSC	Other Department	5+1
	DSC	Other Department	5+1
MATP43SEC	SEC SEM 4 Paper 2	Theory of Equations/Number Theory	2

**SEMESTER-5**

Subject Course No.	Syllabus Code	Course	Credit
MATP 52 DSE	DSE Paper 1	Mechanics/Group Theory and Linear Algebra	5 + 1
	DSE	Other Department	5+1
	DSE	Other Department	5+1
MATP 53 SEC	SEC SEM 5 Paper 1	Probability and Statistics / Differential Geometry	2

**SEMESTER-6**

Subject Course No.	Syllabus Code	Course	Credit
MATP 62 DSE	DSE Paper 2	Metric Spaces and Complex Analysis/ Linear Programming	5 + 1
	DSE	Other Department	5+1
	DSE	Other Department	5+1
MATP 63 SEC	SEC SEM 6 Paper 2	Graph Theory / Boolean Algebra and Automata Theory	2

## DETAILED SYLLABUS

### SEMESTER-1

Subject Course No.	Syllabus Code	Course	Credit
MAT P14 AE-I	AE-I	Env.Sc.	2
MATP 11 DSC	DSC Paper 1	Calculus and Geometry	5 + 1
	DSC	Other Department	5+1
	DSC	Other Department	5+1

### **MATP11DSC, Paper-1: CALCULUS AND GEOMETRY**

6 Credits

### **Unit 1**

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to the 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, envelopes, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule.

### **Unit 2**

Reduction formulae, derivations and illustrations of reduction formulae of the type  $\int \sin nx \, dx$ ,  $\int \cos nx \, dx$ ,  $\int \tan nx \, dx$ ,  $\int \sec nx \, dx$ ,  $\int (\log x)^n \, dx$ ,  $\int \sin^n x \cos^m x \, dx$ , area under a curve.

### **Unit 3**

Properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

Spheres. Cylindrical surfaces.

**Reference Books**

- G. B. Thomas and R. L. Finney, Calculus, 9<sup>th</sup> Ed., Pearson education, Delhi, 2005.
- M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, 3<sup>rd</sup> Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
- H. Anton, I. Bivens and S. Davis, Calculus, 7<sup>th</sup> Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer- Verlag, New York, Inc., 1989.
- T. Apostol, Calculus, Volumes I and II.
- S. Goldberg, Calculus and mathematical analysis.

**SEMESTER-3**

<b>Subject Course No.</b>	<b>Syllabus Code</b>	<b>Course</b>	<b>Credit</b>
MATP 31 DSC	DSC Paper 3	Real Analysis	5 + 1
	DSC	Other Department	5+1
	DSC	Other Department	5+1
MATP33 SEC	SEC SEM 3 Paper 1	Logic & Sets/C++	2

**MATP31 DSC,**  
**Paper-3: REAL**  
**ANALYSIS**

6 Credits

**Unit 1**

Review of Algebraic and order properties of  $\mathbb{R}$ ,  $\varepsilon$ -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. Completeness property of  $\mathbb{R}$  and its equivalent properties. The Archimedean property, density of rational (and irrational) numbers in  $\mathbb{R}$ , intervals. Limit points of a set, isolated points, open set, closed set, derived set.

**Unit 2**

Sequences, bounded sequence, convergent sequence, limit of a sequence,  $\liminf$ ,  $\limsup$ . Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only).

**Reference Books**

- R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3<sup>rd</sup> Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, An Introduction to Analysis, 2<sup>nd</sup> ed., Jones & Bartlett, 2010.
- Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
- S. K. Berberian, a First Course in Real Analysis, Springer Verlag, New York, 1994.
- T. Apostol, Mathematical Analysis, Narosa Publishing House.
- Courant and John, Introduction to Calculus and Analysis, Vol I, Springer.
- W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill.
- Terence Tao, Analysis I, Hindustan Book Agency, 2006
- S. Goldberg, Calculus and mathematical analysis.

**MATP33 SEC SEM-3**  
**Paper-1: LOGIC AND**  
**SETS**

2 Credits

**Unit 1**

Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, equivalence relations.

### Reference Books

- R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
- P.R. Halmos, Naive Set Theory, Springer, 1974.
- E. Kamke, Theory of Sets, Dover Publishers, 1950.

**OR**

### MATP33 SEC SEM- 3 PAPER- 1: C++

2 Credits

#### Unit 1

Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer.

#### Unit 2

Objects, classes, constructor and destructors, friend function, inline function, encapsulation, data abstraction, inheritance, polymorphism, dynamic binding.

### Reference Books

- R. Venugopal, Rajkumar, and T. Ravishanker, Mastering C++, TMH, 1997.
- S. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley, 2000.
- Bruce Eckel, Thinking in C++, 2nd Ed., President, Mindview Inc., Prentice Hall.
- D. Parasons, Object Oriented Programming with C++, BPB Publication.
- BjarneStroustrup, The C++ Programming Language, 3rd Ed., Addison Welsley.
- E. Balaguruswami, Object Oriented Programming In C++, Tata McGrawHill
- Herbert Schildt, C++, The Complete Reference, Tata McGrawHill.

### SEMESTER-5

Subject Course No.	Syllabus Code	Course	Credit
MATP 52 DSE	DSE Paper 1	Mechanics/Group Theory and Linear Algebra	5 + 1
	DSE	Other Department	5+1
	DSE	Other Department	5+1
MATP 53 SEC	SEC SEM 5 Paper 1	Probability and Statistics / Differential Geometry	2

**MATP52DSE****Paper 1:  
Mechanics**

6 Credits

**Unit 1**

Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

**Unit 2**

Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law. Slightly disturbed orbits. Motion of artificial satellites..

**Reference Books**

1. I. H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4<sup>th</sup> Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
3. Chorlton, F., Textbook of Dynamics.
4. Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press.
5. Loney, S. L., Elements of Statics and Dynamics I and II.
6. Ghosh, M. C, Analytical Statics.
7. Verma, R. S., A Textbook on Statics, Pothishala, 1962.
8. Matiur Rahman, Md., Statics.
9. Ramsey, A. S., Dynamics (Part I).

**OR****MATP52DSE Paper 1: Group Theory and Linear Algebra**



**Unit 1**

Definition and examples of groups including permutation groups, elementary properties of groups.

**Unit 2**

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

**Unit 3**

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, null space, range, rank and nullity of a linear transformation.

**Reference Books**

- John B. Fraleigh, A First Course in Abstract Algebra, 7<sup>th</sup> Ed., Pearson, 2002.
- I. Herstein, Abstract Algebra.
- M. Artin, Abstract Algebra, 2<sup>nd</sup> Ed., Pearson, 2011.
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4<sup>th</sup> Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4<sup>th</sup> Ed., Narosa Publishing House, New Delhi, 1999.
- S. Lang, Introduction to Linear Algebra, 2<sup>nd</sup> Ed., Springer, 2005.
- Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
- S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
- Kenneth Hoffman, Ray Aiden Kunze, Linear Algebra, 2<sup>nd</sup> Ed., Prentice – Hall of India Pvt. Ltd., 1971.
- D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.
- D. S. Malik, John M. Mordeson and M. K. Sen, Fundamentals of Abstract Algebra.

**MATP53SEC SEM 5 Paper 1:**  
**Probability and Statistics**

2 Credits

**Unit 1**

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.

**Reference Books**

- Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
- Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7<sup>th</sup> Ed., Pearson Education, Asia, 2006.
- Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
- Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.
- A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers.

**OR**

**MATP53SEC SEM 5**  
**Paper 1: Differential**  
**Geometry**

2 Credits

**Unit 1**

Theory of space curves: Space curves. Planer curves, curvature, torsion and Serret-Frenet formula. Osculating circles, osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

Theory of surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures.

#### **Reference Books**

- T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
- B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
- C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.
- D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.
- S. Lang, Fundamentals of Differential Geometry, Springer, 1999.
- B. Spain, Tensor Calculus: A Concise Course, Dover Publications, 2003

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