# TRUNCATED UG SYLLABUS IN MATHEMATICS HONOURS PROGRAMME COURSE UNDER CBCS SYSTEM FOR EVEN (2ND, 4TH, AND 6TH) SEMESTERS 2020-2021

## Credit Distribution

| Sl. No. | Course Type | Total Papers | Credits | Marks |
|---|---|---|---|---|
| 1 | Hard Core Courses (HCC) | 14 | $(13 \times 5) + (13 \times 1) = 78$ | 75 (60+10+5) |
| | | | $(1 \times 4) + (1 \times 2) = 6$ **for HCC-XII** | 75 (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 | $2 \times 2 = 4$ | 100 (80+15+5) **(AE-I)** |
| | | | | 50 (35+10+5) **(AE-II)** |
| | | 26 | 140 | 1950 |

## SEMESTER-1

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 15 AE-I | AE-I | | Eng. com./Env. Sc. | 2 |
| MATH 11 HCC-I | HCC-I | MATHCC1 | Cal, Geo & D.E. | 5 + 1 |
| MATH 11 HCC-II | HCC-II | MATHCC2 | Algebra | 5 + 1 |
| MATH 13 GE-I | GE-I | MATHGE1 | Other Department | 5 + 1 |

## SEMESTER-2

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 25 AE-II | AE-II | | Eng. Com/EVS | 2 |
| MATH 21 HCC-III | HCC-III | MATHCC3 | Real Analysis | 5 + 1 |
| MATH 21 HCC-IV | HCC-IV | MATHCC4 | D.E & Vector Calculus | 5 + 1 |
| MATH 23 GE-II | GE-II | MATHGE2 | Other Department | 5 + 1 |

## SEMESTER-3

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 31 HCC-V | HCC-V | MATHCC5 | Theory of Real Functions & Introduction of the metric space | 5 + 1 |
| MATH 31 HCC-VI | HCC-VI | MATHCC6 | Group Theory-I | 5 + 1 |
| MATH 31 HCC-VII | HCC-VII | MATHCC7 | Riemann Integration & Series of functions | 5 + 1 |
| MATH 33 GE-III | GE-III | MATHGE3 | Other Department | 5 + 1 |
| MATH 34 SE-I | SE-I | MATHSE1 | Logic & Sets/ C++ | 2 |

## SEMESTER-4

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 41 HCC-VIII | HCC-VIII | MATHCC8 | Multivariate Calculus | 5 + 1 |
| MATH 41 HCC-IX | HCC-IX | MATHCC9 | Ring Theory & Linear Algebra I | 5 + 1 |
| MATH 41 HCC-X | HCC-X | MATHCC10 | Metric Space & Complex Theory | 5 + 1 |
| MATH 43 GE-IV | GE-IV | MATHGE4 | Other Department | 5 + 1 |
| MATH 44 SE-II | SE-II | MATHSE2 | Graph Theory/<br>Operating System: Linux | 2 |

## SEMESTER-5

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 51 HCC-XI | HCC-XI | MATHCC11 | Group Theory II | 5 + 1 |
| MATH 51 HCC-XII | HCC-XII | MATHCC12 | Numerical Methods + Lab | 4 + 2 |
| MATH 52 DSE-I | DSE-I | MATHDSE1 | Probability & Statistics/<br>Linear Programming | 5 + 1 |
| MATH 52 DSE-II | DSE-II | MATHDSE2 | Number Theory/<br>Mechanics | 5 + 1 |

## SEMESTER-6

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 61 HCC-XIII | HCC-XIII | MATHCC13 | Ring Theory & Linear Algebra-II | 5 + 1 |
| MATH 61 HCC-XIV | HCC-XIV | MATHCC14 | Partial Differential Equations & Applications | 5 + 1 |
| MATH 62 DSE-III | DSE-III | MATHDSE3 | Point Set Topology/<br>Boolean Algebra & Automata Theory | 5 + 1 |
| MATH 62 DSE-IV | DSE-IV | MATHDSE4 | Differential Geometry/<br>Theory of Equation | 5 + 1 |

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# DETAILED SYLLABUS

**SEMESTER-2**

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 25 AE-II | AE-II | | Eng. Com/EVS | 2 |
| MATH 21 HCC-III | HCC-III | MATHCC3 | Real Analysis | 5 + 1 |
| MATH 21 HCC-IV | HCC-IV | MATHCC4 | D.E & Vector Calculus | 5 + 1 |
| MATH 23 GE-II | GE-II | MATHGE2 | Other Department | 5 + 1 |

## MATH 21 HCC–III (MATHCC3): REAL ANALYSIS

6 Credits

**Unit 1**

Review of Algebraic and order properties of **R**, ε-neighbourhood of a point in **R**, Idea of countable sets, uncountable sets and uncountability of **R**, Bounded above sets, bounded below sets, bounded sets, unbounded sets, Suprema and infima, Completeness property of **R** and its equivalent properties, The Archimedean property, density of rational (and irrational) numbers in **R**, intervals, Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in **R**, Heine-Boreal Theorem.

**Unit 2**

Sequences, bounded sequence, convergent sequence, limit of a sequence, lim inf, lim sup, 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 3**

Infinite series, convergence and divergence of infinite series.

**Reference Books**


- R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
- Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, An Introduction to Analysis, 2nd 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.

# MATH 21 HCC–IV (MATHCC4): DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

6 Credits

**Unit 1**

Lipschitz condition and Picard's Theorem (Statement only), General solution of homogeneous equation of second order, Wronskian, 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, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

**Unit 3**

Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

**Reference Books**


- Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd 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, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd 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. Speigel, Schaum's outline of Vector Analysis.

**SEMESTER-4**

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 41 HCC-VIII | HCC-VIII | MATHCC8 | Multivariate Calculus | 5 + 1 |
| MATH 41 HCC-IX | HCC-IX | MATHCC9 | Ring Theory & Linear Algebra-I | 5 + 1 |
| MATH 41 HCC-X | HCC-X | MATHCC10 | Metric Space & Complex Theory | 5 + 1 |
| MATH 43 GE-IV | GE-IV | MATHGE4 | To be decided by concerned departments | 5 + 1 |
| MATH 44 SE-II | SE-II | MATHSE2 | Graph Theory/ Operating System: Linux | 2 |

# MATH 41 HCC-VIII (MATHCC8): MULTIVARIATE CALCULUS

6 Credits

**Unit 1**

Functions of several variables, limit and continuity of functions of two or more variables, Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability, Chain rule for one and two independent parameters, directional derivatives.

**Unit 2**

Double integration over rectangular region, double integration over non-rectangular region, double integrals in polar co-ordinates, Change of variables in double integrals.

**Unit 3**

Definition of vector field, divergence and curl, Line integrals, applications of line integrals: mass and work, Fundamental theorem for line integrals, conservative vector fields, independence of path.

**Unit 4**

Green's theorem, Stoke's theorem, Divergence theorem.

**Reference Books**


- G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
- E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Caculus, Springer(SIE), Indian reprint, 2005.
- James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks/ Cole, Thomson Learning, USA, 2001.
- T. Apostol, Mathematical Analysis, Narosa Publishing House.
- Courant and John, Introduction to Calculus and Analysis, Vol II, Springer.
- W. Rudin, Principles of Mathematical Analysis, 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.
- Terence Tao, Analysis II, Hindustan Book Agency, 2006.
- M. R. Speigel, Schaum's outline of Vector Analysis.

## MATH 41 HCC-IX (MATHCC9): RING THEORY AND LINEAR ALGEBRA-I

6 Credits

**Unit 1**

Definition and example of rings, Properties of rings, Subrings, Integral domains, Fields, Characteristics of a ring, Ideal, Ideal generated by a subset of a ring, Operations on ideals, Factor rings.

**Unit 2**

Ring homomorphisms, Properties of ring homomorphisms, Isomorphism theorems I, II and III, (Statement only) and its applications.

**Unit 3**

Vector spaces, Subspaces, Algebra of subspaces, Linear dependence and independence, Basis, Dimension of vector spaces, Linear transformations, Null space, Range, Rank, Nullity and Inverse of a linear transformation, Algebra of linear transformations, Linear space, Matrix representation of a linear transformation.

**Reference Books**


- John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
- M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
- Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
- S. Lang, Introduction to Linear Algebra, 2nd 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, 2nd 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.


## MATH 41 HCC-X (MATHCC10): METRIC SPACES AND COMPLEX ANALYSIS

6 Credits

**Unit 1**

Continuous mapping, sequential criterion and other characterizations of continuity, Uniform continuity, Connectedness, connected subsets of $\mathbb{R}$, Compactness: Sequential compactness, Heine-Borel property, Totally bounded spaces, Finite intersection property and continuous functions on compact sets.

**Unit 2**

Derivatives, differentiation formulas, Cauchy-Riemann equations, Sufficient conditions for differentiability.

**Unit 3**

Analytic functions, examples of analytic functions, exponential function, logarithmic function, trigonometric function, derivatives of functions, Contours, Contour integrals, Cauchy-Goursat theorem, Cauchy integral formula.

**Unit 4**

Liouville's theorem and the fundamental theorem of algebra, Taylor series and its examples, Laurent series and its examples.

**Reference Books**


- SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
- S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
- G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
- James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
- Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.
- S. Ponnusamy, Foundations of Complex analysis.
- E. M. Stein and R. Shakrachi, Complex Analysis, Princeton University Press.


# MATH 44 SE-II (MATHSE2): GRAPH THEORY

2 Credits

**Unit 1**

Definition, Example and Basic properties of graphs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths, Shortest paths, Cycles, Trees, Forests.

**Unit 2**

Eulerian circuits, Eulerian graphs, Hamiltonian cycles, Representation of a graph by matrix, Adjacency matrix, Incidence matrix, Weighted graph.

**Unit 3**

Travelling salesman's problem, Spanning trees, Warshall algorithm, Connectivity.

**Reference Books**


- B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 2ndEdition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
- Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India Ptv. Ltd., New Delhi.
- Reinhard Diestel, Graph Theory, Springer-Verlag, 2000.

# OR

## MATH 44 SE-II (MATHSE2): OPERATING SYSTEM-LINUX

2 Credits

**Unit 1**

Linux – The operating system: Linux history, Linux features, overview of Linux architecture, installation, startup scripts, system processes (an overview).

**Unit 2**

Essential Linux commands - cd, ls, cp, md, rm, mkdir, rmdir, pwd,file, more, less, creating and viewing files using cat, file comparisons–cmp & amp; comm, View files, disk related commands, checking disk free spaces, file permissions, types of users, the powers of roots, managing users (adding and deleting): using the command line and GUI tools, batch processing (Preliminary level).

**Unit 3**

File and directory management, Creating and editing files with vi & vim editor.

**Reference Books**


- Arnold Robbins, Linux Programming by Examples the Fundamentals, 2nd Ed., Pearson Education, 2008.
- Cox K, Red Hat Linux Administrator's Guide, PHI, 2009.
- R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
- Sumitabha Das, UNIX Concepts and Applications, 4th Ed., TMH, 2009.
- Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6th Ed.,O'Reilly Media, 2009.
- Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed., 2004.

**SEMESTER-6**

| Subject Course No. | Syllabus Code | Alpha Numeric Code | Course | Credit |
|---|---|---|---|---|
| MATH 61 HCC-XIII | HCC-XIII | MATHCC13 | Ring Theory & Linear Algebra-II | 5 + 1 |
| MATH 61 HCC-XIV | HCC-XIV | MATHCC14 | Partial Differential Equations & Applications | 5 + 1 |
| MATH 62 DSE-III | DSE-III | MATHDSE3 | Point Set Topology/ Boolean Algebra & Automata Theory | 5 + 1 |
| MATH 62 DSE-IV | DSE-IV | MATHDSE4 | Differential Geometry/ Theory of Equation | 5 + 1 |

# MATH 61 HCC-XIII (MATHCC13): RING THOERY & LINEAR ALGEBRA-II

6 Credits

**Unit 1**

Prime ideals, Maximal ideals, Prime and irreducible elements, Divisibility in integral domains, Principal ideal domains, Unique factorization domains, Euclidean domains.

**Unit 2**

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, Cayley-Hamilton theorem, the minimal polynomial for a linear operator,

**Unit 3**

Inner product spaces, norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, minimal solutions to systems of linear equations, Normal and self-adjoint operators.

**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.
- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
- S. Lang, Introduction to Linear Algebra, 2nd 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 Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
- S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., 2004.

## MATH 61 HCC-XIV (MATHCC14): PARTIAL DIFFERENTIAL EQUATIONS & APPLICATIONS

6 Credits

**Unit 1**

Partial differential equations – Basic concepts and definitions, Mathematical problems, First-order equations: classification, construction and geometrical interpretation, Method of characteristics for obtaining general solution of quasi linear equations, Canonical forms of first-order linear equations, Method of separation of variables for solving first order partial differential equations.

**Unit 2**

Derivation of heat equation, wave equation and Laplace equation, Classification of second order linear equations as hyperbolic, parabolic or elliptic, Reduction of second order linear equations to canonical forms.

**Unit 3**

The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string, Initial boundary value problems, Semi-infinite string with a fixed end, semi-infinite string with a free end.

**Reference Books**


- Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
- S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
- Sneddon, I. N., Elements of Partial Differential Equations, McGraw Hill.
- Miller, F. H., Partial Differential Equations, John Wiley and Sons.
- Loney, S. L., An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, Loney Press.


## MATH 62 DSE-III (MATHDSE3): POINT SET TOPOLOGY

6 Credits

**Unit 1**

Countable and Uncountable Sets, Schroeder-Bernstein Theorem, Cantor's Theorem, Cardinal numbers and cardinal arithmetic, Continuum Hypothesis, Zorns Lemma, Axiom of Choice, Well-ordered sets, Hausdorff's maximal principle, Ordinal numbers.

**Unit 2**

Topological spaces, basis and Sub basis for a topology, subspace topology, interior points, limit points, derived set, boundary of a set, closed sets, closure and interior of a set, Continuous functions, open maps, closed maps and homeomorphisms, Product topology, quotient topology, metric topology, Baire category theorem.

**Unit 3**

Connectedness, Intermediate value theorem, Compact spaces, Compact subspaces of the real line.

**Reference Books**


- Munkres, J.R., Topology, A First Course, Prentice Hall of India Pvt.Ltd.,New Delhi, 2000.
- Dugundji, J., Topology, Allyn and Bacon, 1966.
- Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
- Kelley, J.L., General Topology, Van Nostrand Reinhold Co., New York,1995.
- Hocking, J., Young, G., Topology, Addison-Wesley Reading, 1961.
- Steen, L., Seebach, J., Counter Examples in Topology, Holt, Reinhart andWinston, New York, 1970.
- Abhijit Dasgupta, Set Theory, Birkhäuser.I. H. Shames and G. Krishna Mohan Rao.
- Adams and Franzosa, Introduction to topology, Pearson2008.


# OR

## MATH 62 DSE-III (MATHDSE3): BOOLEAN ALGEBRA & AUTOMATA THEORY

6 Credits

**Unit 1**

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, Definition, examples and properties of modular and distributive lattices.

**Unit 2**

Boolean algebra, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Karnaugh diagrams, Logic gates, switching circuits and applications of switching circuits.

**Unit 3**

Introduction: Alphabets, strings and languages, Finite automata and regular languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata.

**Unit 4**

Context free grammars and pushdown automata: context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA. Turing Machines: Turing machine as a model of computation.

**References Books**


- B. A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge 1990.
- Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
- Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Edition, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
- J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages and Computation, 2nd Ed., Addison-Wesley, 2001.
- H. R. Lewis, C. H. Papadimitriou, C. Papadimitriou, Elements of the Theory of Computation, 2nd Ed., Prentice-Hall, NJ, 1997.
- J. A. Anderson, Automata Theory with Modern Applications, Cambridge University Press, 2006.


# MATH 62 DSE-IV (MATHDSE4): DIFFERENTIAL GEOMETRY

6 Credits

**Unit 1**

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

**Unit 2**

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

**Unit 3**

Developable: Developable associated with space curves and curves on surfaces, Minimal surfaces, Geodesics: Canonical geodesic equations, Nature of geodesics on a surface of revolution.

**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 Press2003.
- 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

# OR

## MATH 62 DSE-IV (MATHDSE4): THEORY OF EQUATIONS

6 Credits

**Unit 1**

Polynomials, Divisional algorithm (statement only), Synthetic division, Statement of Fundamental Theorem of Algebra, Nature of roots of an equation, Rolle's Theorem (statement only), Descartes' rule of signs, Separation of the roots of equations, Symmetric functions, Relation between the roots and the coefficients of equations and its application in symmetric function of the roots.

**Unit 2**

Transformation of equations, Solutions of reciprocal and binomial equations, Algebraic solutions of the cubic and biquadratic equations.

**Unit 3**

Newton's theorem on the sums of powers of roots, homogeneous products, Strums theorem, Finding the number of real roots of a polynomial in a given interval using Strum's algorithm.

**Reference Books**


- W. S. Burnside and A. W. Panton, The Theory of Equations, Dublin University Press, 1954.
- C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc., 1954.



**Dr. Paltu Sarkar**
Chairman
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# 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

## (MATHGE1/MATHGE2/MATHGE3/MATHGE4)

## GE1: 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, L'Hospital's rule.

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int sin^m x\ cos^n x\ \mathrm{dx}$, $\int x^m (logx)^n \mathrm{dx}$, $\int sin^n x\ sin^m x\ \mathrm{dx}$, parameterizing a curve, arc length of a curve, area under a curve, area and volume of revolution with respect to coordinate axes only.

**Unit 2**

Properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant (without reduction process), polar equations of conics, Spheres, Cylindrical surfaces, classification of quadrics.

**Unit 3**

Differential equations and mathematical models. General, particular 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.

**Reference Books**


- G. B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson education, Delhi, 2005.
- R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
- S. L. Ross, Differential Equations, 3rd 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.

# GE2: ALGEBRA

6 Credits

**Unit 1**

Polar form of complex numbers, $n^{th}$ roots of unity, De Moivre's theorem (statement only) and its applications.

Theory of equations: Relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation.

Inequality: The inequality involving AM≥ GM≥ HM, Cauchy-Schwartz inequality (statement) and its application.

**Unit 2**

Equivalence relations, Functions, Composition of functions, Invertible functions, Congruence relation between integers. Principles of mathematical induction, Statement of Fundamental Theorem of Arithmetic.

**Unit 3**

Row reduction and echelon forms, Rank of matrix, Eigen values, Eigen vectors, Cayley-Hamilton theorem and its use in finding the inverse of a matrix. Solution of system of linear equations $Ax = b$ by using row reduced echelon form.

**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, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
- David C. Lay, Linear Algebra and its Applications, 3rd 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.


# GE3: DE AND VECTOR CALCULUS

6 Credits

**Unit 1**

Lipschitz condition and Picard's Theorem (Statement only), General solution of homogeneous equation of second order, Wronskian: its properties, 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, Homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

**Unit 3**

Introduction to vector functions, Operations with vector-valued functions, Limits and continuity of vector functions, Differentiation and integration of vector functions.

**Reference Books**


- Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd 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, 3rd Ed., John Wiley and Sons, India, 2004.
- Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd 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.
- M. R. Speigel, Schaum's outline of Vector Analysis.


## GE4: GROUP THEORY

6 Credits

**Unit 1**

Definition and example of groups including $V_4$, $\mathbb{Z}_n$, $GL(n,\mathbb{R})$, $M_n(\mathbb{R})$, symmetric group $S_n$, alternating group $A_n$, dihedral group $D_n$ etc., Properties of groups.

**Unit 2**

Subgroups, Necessary and sufficient conditions, union; intersection; product of subgroups.

**Unit 3**

Cyclic groups, Cosets, Lagrange's theorem, Normal subgroups, Factor groups. Group homomorphisms and isomorphisms, basic properties, First, Second and Third isomorphism theorems (Statement only) and its application.

**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, New Delhi, 1999.
- Joseph J. Rotman, An Itroduction to the Theory of Groups, 4th 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.

# GE5: NUMERICAL METHODS

6 Credits

**Unit 1**

Errors: relative, absolute. Percentage, Round off. Truncation errors and relevant problems. Transcendental and polynomial equations: Bisection method, secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

**Unit 2**

System of linear algebraic equations: Gaussian elimination, Gauss-Jacobi method, Gauss-Seidel method and their convergence analysis. Interpolation: Finite difference operators. Newton's forward and backward interpolation formula. Lagrange interpolation formula.

**Unit 3**

Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule. Ordinary differential equations: Picard's method of successive approximations, Euler's method, the modified Euler method, R-K methods of orders two.

**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.
- Atkinson, K. E., An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
- Yashavant Kanetkar, Let Us C, BPB Publications.



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