University of Kalyani

CBCS CURRICULUM FOR SEMESTERIZED UNDER-GRADUATE COURSE
IN
Mathematics (GENERAL)

WITH EFFECT FROM THE ACADEMIC SESSION
2021-22

FOREWORD

The draft syllabus for B.A./ B.Sc. (General) in Mathematics was prepared by the Undergraduate Board of Studies (UGBOS) in Mathematics, University of Kalyani by maintaining the guidelines of Choice Based Credit System (CBCS) course curriculum prescribed by University of Kalyani.

The Chairman of the UGBOS placed before the members a draft syllabus in its 5th meeting of in Mathematics held on 29th July, 2021.

After threadbare discussion, this Board unanimously resolved to recommend the Course curriculum for B.A./ B.Sc. (Hons.) program in Mathematics under Choice Based Credit System. The Board, after a thorough perusal of all details within prescribed units of each course, recommended the same and authorized the Chairman to forward the proposal in its totality to the appropriate section of the university administration so that it could be finalized and introduced from the new academic session of 2021-2022.

Existing Members of UGBOS in Mathematics, KU

1. **Dr. Animesh Biswas**, HOD, Mathematics, KU – ***Chairman***
2. **Dr. Sahidul Islam**, Department of Mathematics, KU – ***Member***
3. **Dr. Debi Prasad Acharyya**, Nabadwip Vidyasagar College, Nadia – ***Member***
4. **Dr. Manob Kumar Ghosh**, Kalyani Mahavidyalaya, Nadia – ***Member***
5. **Dr. Joydeb Bhattacharya**, Karimpur Pannadevi College, Nadia – ***Member***
6. **Mr. Dipankar Pal**, Prof. Syed Nurul Hassan College, Murshidabad – ***Member***
7. **Mr. Sudhansu Kumar Biswas**, Sripat Singh College, Murshidabad – ***Member***

Kalyani
29th July, 2021

--Chairman, UGBOS in Mathematics, KU

CBCS CURRICULUM FOR SEMESTERIZED UNDER-GRADUATE COURSE IN Mathematics (PROGRAMME/GENERAL)

INTRODUCTION:

The University Grants Commission (UGC) has taken various measures by means of formulating regulations and guidelines and updating them, in order to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions in India. The various steps that the UGC has initiated are all targeted towards bringing equity, efficiency and excellence in the Higher Education System of country. These steps include introduction of innovation and improvements in curriculum structure and content, the teaching-learning process, the examination and evaluation systems, along with governance and other matters. The introduction of Choice Based Credit System is one such attempt towards improvement and bringing in uniformity of system with diversity of courses across all higher education institutes in the country. The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising of core, elective, skill enhancement or ability enhancement courses. The courses shall be evaluated following the grading system, is considered to be better than conventional marks system. This will make it possible for the students to move across institutions within India to begin with and across countries for studying courses of their choice. The uniform grading system shall also prove to be helpful in assessment of the performance of the candidates in the context of employment.

Outline of the Choice Based Credit System being introduced:

1. **Core Course (CC):** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the student's proficiency/skill is termed as an Elective Course.
   - 2.1 **Discipline Specific Elective Course (DSEC):** Elective courses that are offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
   - 2.2 **Generic Elective Course (GEC):** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
3. **Ability Enhancement Courses/ Skill Enhancement Courses:**
   - 3.1 **Ability Enhancement Compulsory Course (AECC):** Ability enhancement courses are the courses based upon the content that leads to Knowledge enhancement. They (i) Environmental Science, (ii) English Communication) are mandatory for all disciplines.
   - 3.2 **Skill Enhancement Course (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

CBCS CURRICULUM FOR SEMESTERIZED UNDER-GRADUATE COURSE IN Mathematics (GENERAL)

A. TOTAL Number of courses in UG-CBCS (B.A./B.Sc. GENERAL):

Types of course	Core Course (CC)	Elective course		Ability Enhancement Course		TOTAL
		Discipline Specific Elective course (DSE)	Generic Elective course (GE)	Ability Enhancement Compulsory Course (AECC)	Skill Enhancement Course (SEC)	
No. of course	12	6 (BSc)/ 4 (BA/B. Com)	2 ((BA/B. Com)	2	2	24
Credit/course	6	6	6	2	2	120

TABLE-1: DETAILS OF COURSES OF B.A./ B.SC. (GENERAL) UNDER CBCS

S. No.	Particulars of Course	Credit Point	
1.	**Core Course: 14 Papers**	**Theory + Practical**	**Theory + Tutorial**
1.A.	Core Course: Theory (12 papers)	12x4 = 48	12x5 = 60
1.B.	Core Course (Practical/Tutorial) *(12 papers)	12x2 = 24	12x1 = 12
2.	**Elective Courses: (6 papers)**		
A.	DSE (6 papers for B.Sc./ 4 papers for B.A. & B.Com.)	6x4 = 24	4x5 = 20
B.	DSE (Pract. / Tutor.) * (6 papers for B.Sc./4 for B.A. & B.Com)	6x2 = 12	4x1 = 4
C.	GE (Interdisciplinary) (2 papers for B.A. & B.Com.)	--	2x5 = 10
D.	GE (Pract. /Tutor.) * (4 papers) (2 papers for B.A. & B.Com.)	--	2x1 = 2
#Optional Dissertation/ Project Work in place of* one *DSE paper (6 credits) in 6th semester			
3. Ability Enhancement Courses			
A.	AECC (2 papers of 2 credits each) ENVS, English Communication / MIL	2x2 = 4	2x2 = 4
B.	Skill Enhancement Course (SEC) (4 papers of 2 credits each)	4x2 = 8	4x2 = 8
Total Credit:		**120**	**120**
## ***Wherever there is a practical, there will be no tutorial and vice- versa.***			

TABLE-2: SEMESTER WISE DISTRIBUTION OF COURSES & CREDITS IN B.A./B.SC. (GENERAL)

Courses/ (Credits)	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-Vi	Total No. of Courses	Total credit
CC-1,2,3 (6)	3 (1A,2A,3A)	3 (1B,2B,3B)	3 (1C,2C, 3C)	3 (1D,2D, 3D)			12	72
DSE - 1,2,3 (6)	-	-	-	-	3 (1A,2A,3A)	3 (1B,2B,3B)	6	36
GE (6)	--	--	--	--	--	--	--	--
AECC (2)	1	1					2	04
SEC (2)			1	1	1	1	4	08
Total No. of Course/ Sem	4	4	4	4	4	4	24	--
Total Credit /Semester	**20**	**20**	**20**	**20**	**20**	**20**	**--**	**120**

TABLE-3: SEMESTER & COURSEWISE CREDIT DISTRIBUTION IN B.A./ B.SC.(GENERAL)

(6 Credit: 75 Marks)

SEMESTER-I			
Course Code	**Course Title**	**Course wise Class (L+T+P)**	**Credit**
MATH-G-CC-T-01	Algebra & Analytical Geometry	5:1:0	6
Other Discipline		Core	6
Other Discipline		Core	6
AECC-T-01	Environmental Studies	2:0:0	2
Total	**4 courses**	**Total**	**20**
SEMESTER-II			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-G-CC-T-02	Calculus & Differential Equations	5:1:0	6
Other Discipline		Core	6
Other Discipline		Core	6
AECC-T-02	English/Modern Indian Language	2:0:0	2
Total	**4 courses**	**Total**	**20**
SEMESTER-III			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-G-CC-T-03	Real Analysis	5:1:0	6
Other Discipline		Core	6
Other Discipline		Core	6
MATH-G-SEC-T-01	A. Logic and Sets B. Vector Calculus (Choose any one)	2:0:0	2
Total	**5 courses**	**Total**	**20**
SEMESTER-IV			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-G-CC-T-04	Linear Programming Problems & Game Theory	5:1:0	6
Other Discipline		Core	6
Other Discipline		Core	6
MATH-G-SEC-T-02	A. Graph Theory B. Operating System (Linux) (Choose any one)	2:0:0	2
Total	**5 courses**	**Total**	**20**
SEMESTER-V			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-G-DSE-T-01	A. Group Theory & Linear Algebra B. Complex Analysis (Choose any one)	5:1:0	6
Other Discipline		DSE	6
Other Discipline		DSE	6
MATH-G-SEC-T-03	A. Theory of Probability B. Boolean Algebra (Choose any one)	2:0:0	2
Total	**4 courses**	**Total**	**20**
SEMESTER-VI			
Course Code	**Course Title**	**Course Nature**	**Credit**
MATH-G-DSE-T-02	A. Dynamics of a Particle B. Numerical Methods (Theory) (Choose any one)	5:1:0	6
Other Discipline		DSE	6
Other Discipline		DSE	6
MATH-G-SEC-T-04	A. Programming in 'C' B. Programming in Python (Choose any one)	2:0:0	2
Total	**4 courses**	**Total**	**20**
Total (All semesters)	***26 courses***	***Total***	***120***

Detail Course & Contents of Mathematics (General) syllabus

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-I
Course: MATH-G-CC-T-01
Course title: Algebra & Analytical Geometry
General Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[40L]**

- Complex Numbers: De Moivre's theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of a^z. Inverse circular and hyperbolic functions.
- Polynomials: Fundamental theorem of algebra (Statement only). Polynomials with real coefficients, nature of roots of an equation (surd or complex roots occur in pairs). Statement of Descartes rule of signs and its applications. Relation between roots and coefficients, transformations of equations. Cardan's method of solution of a cubic equation.
- Rank of a matrix: Determination of rank either by considering minors or by sweep-out process. Consistency and solution of a system of linear equations with not more than 3 variables by matrix method.
- Equivalence relations and partitions. Functions, composition of functions, invertible functions, one to one correspondence and cardinality of a set.
- Definition and elementary properties of groups. Concepts of permutation Group, alternating group, finite groups: S_3, V_4. The group Z_n of integers under addition modulo n.
- Order of an element, order of a group, subgroups and examples of subgroups.

Unit 2. **[35L]**

- Transformations of rectangular axes: Translation, rotation and their combinations. Invariants.
- General equation of second degree in x and y: Reduction to canonical forms. Classification of conics.
- Pair of straight lines: Condition that the general equation of 2nd degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic.
- Polar equation of straight lines and circles, polar equation of a conic refers to a focus as a pole, polar equation of chord joining two points, polar equations of tangents and normals.

SUGGESTED READINGS/REFERENCES:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser.
2. W. S. Burnstine and A.W. Panton, Theory of Equations, Nabu Press.
3. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India.
4. K. B. Dutta, Matrix and Linear Algebra, Prentice-Hall of India Pvt. Ltd.
5. David C. Lay, Linear Algebra and its Applications, Pearson Education Asia, Indian Reprint.
6. P. K. Saikai, Linear Algebra, Pearson.
7. K. Hoffman, R. Kunze, Linear Algebra, Pearson.

8. John B. Fraleigh, A First Course in Abstract Algebra, Pearson.
9. P. R. Vittal, Analytical Geometry 2D and 3D, Pearson.
10. S. L. Loney, Co-ordinate Geometry, Arihant Publications.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-II
Course: MATH-G-CC-T-02
Course title: Calculus & Differential Equations
General Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[35L]**

- Real-valued functions defined on an interval, limit and Continuity of a function (using $\varepsilon - \delta$). Algebra of limits. Differentiability of a function.
- Successive derivative: Leibnitz's theorem and its application to problems of type $e^{ax+b}sinx, e^{ax+b}cosx, (ax+b)^n sinx, (ax+b)^n cosx$.
- Partial derivatives. Euler's theorem on homogeneous function of two and three variables.
- Indeterminate Forms: L'Hospital's Rule (Statement and Problems only).
- Statement of Rolle's Theorem and its geometrical interpretation. Mean value theorems of Lagrange and Cauchy. Statements of Taylor's and Maclaurin's theorems with Lagrange's and Cauchy's forms of remainders. Taylor's and Maclaurin's infinite series of functions like $e^x, sinx, cosx, (1+x)^n, log(1+x)$ with restrictions wherever necessary.
- Application of the principle of maxima and minima for a function of a single variable.

Unit 2. **[15L]**

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

Unit 3. **[25L]**

- First order equations: (i) Exact equations and those reducible to such equations. (ii) Euler's and Bernoulli's equations (Linear). (iii) Clairaut's Equations: General and Singular solutions.
- Second order differential equation: (i) Method of variation of parameters, (ii) Method of undetermined coefficients.

SUGGESTED READINGS/REFERENCES:

1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
2. T. Apostol, Mathematical Analysis, Narosa Publishing House.
3. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
4. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc.
5. G. B. Thomas and R.L. Finney, Calculus, Pearson Education.
6. Santi Narayan, Integral Calculus, S. Chand.

7. S. L. Ross, Differential Equations, John Wiley and Sons, India.
8. E. L. Ince, Ordinary Differential Equations, Dover Publications.
9. E. Rukmangadachari, Differential Equations, Pearson.
10. D. Murray, Introductory Course in Differential Equations, Longmans Green and Co.
11. G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw Hill.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-III
Course: MATH-G-CC-T-03
Course title: Real Analysis
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[25L]**

- Review of algebraic and order properties of $\mathbb{R}$.
- Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Countability of $\mathbb{Q}$.
- 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.
- Intervals, ε-neighborhood of a point in $\mathbb{R}$, Interior points, Limit points of a set, isolated points, open set, closed set, union and intersection of open and closed sets. derived set, Closure of a set, Interior of a set.
- Bolzano-Weierstrass theorem for sets (statement only).

Unit 2. **[20L]**

- Sequences, bounded sequence, convergent sequence, Sandwich theorem.
- Cauchy's convergence criterion for sequences. Cauchy's theorem on limits
- Monotone sequences, monotone convergence theorem (without proof).

Unit 3. **[30L]**

- Infinite series, Convergence and divergence of infinite series, Cauchy's criterion.
- Series of positive terms, Geometric Series, p-Series.
- Tests for convergence: comparison test, limit comparison test, ratio test: D'Alembert's ratio test, Raabe's test, Cauchy's root test.
- Alternating series, Leibnitz test (without proof), definition and examples of Absolute and conditional convergence.
- Power series and radius of convergence (problems only).

SUGGESTED READINGS/REFERENCES:

1. T. M. Apostol, Calculus (Vol. I), John Wiley and Sons (Asia) P. Ltd.
2. R. G. Bartle and D. R Sherbert, Introduction to Real Analysis, John Wiley and Sons (Asia) P.Ltd.
3. E. Fischer, Intermediate Real Analysis, Springer Verlag.
4. S. K. Berberian, a First Course in Real Analysis, Springer Verlag, New York.

5. K. A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer.
6. V. Karunakaran, Real Analysis, Pearson.
7. Terence, Tao, Analysis I, Hindustan Book Agency.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-III
Course: MATH-G-SEC-T-1A
Course title: Logic & Sets
Skill Enhancement Course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1. **[10L]**

- Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contrapositive and inverse proportions and precedence of logical operators.
- Propositional equivalence: Logical equivalences.
- Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.

Unit 2. **[7L]**

- 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.

Unit 3. **[8L]**

- Difference and Symmetric difference of two sets. Set identities, generalized union and intersections.
- Relation: Product set. Composition of relations, types of relations, partitions, equivalence Relations with example of congruence modulo relation. Partial ordering relations, n-ary relations.

SUGGESTED READINGS/REFERENCES:

1. R. P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education.
2. P. R. Halmos, Naive Set Theory, Springer.
3. E. Kamke, Theory of Sets, Dover Publishers.
4. R. R. Stoll, Set Theory and Logic, Dover Publications.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-III
Course: MATH-G-SEC-T-1B
Course title: Vector Calculus
Skill Enhancement Course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1: **[10L]**

- Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors.
- Gradient, divergence and curl with applications.

Unit 2: **[15L]**

- Vector integration: Line, surface and volume integrals.
- Green's theorem (statement only), surface integrals, integrals over parametrically defined surfaces. Stoke's theorem (statement only), divergence theorem (statement only). Applications of Green's, Stoke's and divergence theorems.

SUGGESTED READINGS/REFERENCES:

1. G. B. Thomas and R. L. Finney, Calculus, Pearson Education, Delhi.
2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons.
3. P. C. Matthew's, Vector Calculus, Springer Verlag London Limited.
4. J. E. Marsden, A. Tromba, Vector Calculus, McGraw Hill.
5. M. R. Spiegel, Schaum's outline of Vector Analysis.
6. P. K. Nayak, Vector Algebra and Analysis with Application, University Press.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-IV
Course: MATH-G-CC-T-04
Course title: Linear Programming Problems & Game Theory
Core Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[10L]**

- Introduction to linear programming problems, Graphical solution of LPP.
- Convex sets. Basic solutions and non-basic solutions. Reduction of B.F.S from B.S.

Unit 2 **[20L]**

- Simplex method, two-phase method, Big-M method and their comparison.
- Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

Unit 3. **[25L]**

- Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel's approximation method for determination of initial basic solution. Algorithms for solving transportation problems.

- Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit 4. **[20L]**

- Game theory: formulation of two-person zero sum games.
- Solving two-person zero sum games. Games with mixed strategies. Graphical solution procedure.
- Solving game Using Simplex Algorithm.

SUGGESTED READINGS/REFERENCES:

1. Hamdy A. Taha, Operations Research, An Introduction, Prentice-Hall India.
2. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi.
3. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, John Wiley and Sons, India.
4. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, Tata McGraw Hill, Singapore.
5. S.I. Gass, Linear Programming: Methods and Applications, Dover Publications.
6. T. Veerarajan, Operation Research, University Press.
7. K. Swarup, P.K. Gupta and Man Mohan, Operations Research, Sultanchand.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-IV
Course: MATH-G-SEC-T-2A
Course title: Graph Theory
Skill Enhancement Course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1. **[8L]**

- Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs isomorphism of graphs.

Unit 2 **[10L]**

- Eulerian circuits, Eulerian graphs, semi-Eulerian graphs, Hamiltonian cycles.
- Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph.

Unit 3. **[7L]**

- Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

SUGGESTED READINGS/REFERENCES:

1. B. A. Davey, H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge.
2. R. J. Wilson, Introduction to Graph Theory, Pearson.
3. Rudolf Lidl, Gunter Pilz, Applied Abstract Algebra, Undergraduate Texts in Mathematics, Springer.
4. Edgar G. Goodaire, Michael M. Parmenter, Discrete Mathematics with Graph Theory, Pearson Education.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-IV
Course: MATH-G-SEC-T-2B
Course title: Operating System (Linux)
Skill Enhancement Course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1. **[8L]**

- Linux – The operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, overview of Linux architecture, installation, startup scripts, system processes (an overview), Linux security.

Unit 2. **[10L]**

- The Ext2 and Ext3 file systems: General characteristics of the Ext3 file system, file permissions. User management: types of users, the powers of root, managing users (adding and deleting): using the command line and GUI tools.

Unit 3. **[7L]**

- Resource management in Linux: file and directory management, system calls for files process Management, signals, IPC: Pipes, FIFOs, System V IPC, message queues, system calls for processes, memory management, library and system calls for memory.

SUGGESTED READINGS/REFERENCES:

1. Arnold Robbins, Linux Programming by Examples, The Fundamentals, Pearson Education.
2. Cox K, Red Hat Linux Administrator's Guide, PHI.
3. R. Stevens, UNIX Network Programming, PHI.
4. Sumitabha Das, UNIX Concepts and Applications, TMH.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, O'Reilly Media.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-V
Course: MATH-G-DSE-T-1A
Course title: Group Theory & Linear Algebra
Discipline Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[30L]**

- Definition and examples of groups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of a group, examples of subgroups including the center of a group.
- Cosets, Index of subgroups, Lagrange's theorem, order of an element.
- Normal subgroups, their definition, examples, and characterizations, Quotient groups.

Unit 2: **[45L]**

- Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

- Characteristic Polynomial, Eigenvalues and Eigenvectors.
- Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.
- Dual Space, Dual Basis, Change of basis.
- Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3.

SUGGESTED READINGS/REFERENCES:

1. John B. Fraleigh, A First Course in Abstract Algebra, Pearson.
2. M. Artin, Abstract Algebra, Pearson.
3. M.K. Sen, S. Ghosh, P. Mukhopadhyay, Abstract Algebra, University Press.
4. Joseph A Gallian, Contemporary Abstract Algebra, Narosa.
5. George E Andrews, Number Theory, Hindustan Publishing Corporation.
6. S. H. Friedberg, A. L. Insel, L. E. Spence, Linear Algebra, Prentice Hall of India.
7. Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill.
8. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, Prentice-Hall of India.
9. David C. Lay, Linear Algebra and its Applications, Pearson Education Asia.
10. S. Lang, Introduction to Linear Algebra, Springer.
11. Gilbert Strang, Linear Algebra and its Applications, Thomson.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-V
Course: MATH-G-DSE-T-1B
Course title: Complex Analysis
Discipline Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[30L]**

- Regions in the complex plane, functions of complex variables, limits, limits involving the point at infinity, continuity.
- Derivatives of functions, analytic functions, examples of analytic functions, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Unit 2. **[45L]**

- Definite integrals of functions.
- Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem (Statement only), Cauchy integral formula and applications.
- Liouville's theorem and the fundamental theorem of algebra.
- Convergence of sequences and series.
- Absolute and uniform convergence of power series. Taylor series and its examples.

SUGGESTED READINGS/REFERENCES:

1. J. W. Brown, R. V. Churchill, Complex Variables and Applications, McGraw-Hill.
2. J. Bak and D. J. Newman, Complex Analysis, Undergraduate Texts in Mathematics, Springer-Verlag.
3. L. Ahlfors, Complex Analysis, McGraw Hill Education.
4. R. Roopkumar, Complex Analysis, Pearson.
5. E. M. Stein and R. Shakrachi, Complex Analysis, Princeton University Press.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-V
Course: MATH-G-SEC-T-3A
Course title: Theory of Probability
Skill Enhancement Course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1: **[13L]**

- 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, continuous distributions: uniform, normal, exponential.

Unit 2: **[12L]**

- Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions.
- Expectation of function of two random variables, conditional expectations, independent random variables.

SUGGESTED READINGS/REFERENCES:

1. R. V. Hogg, J. W. McKean, Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education.
2. A. Gupta, Groundwork of Mathematical Probability and Statistics, Academic Publishers.
3. E. Rukmangadachari, Probability and Statistics, Pearson.
4. G. S. Rao, Probability and Statistics, University Press.
5. I. Miller, M. Miller, J.E. Freund, Mathematical Statistics with Applications, Pearson Education.
6. Sheldon Ross, Introduction to Probability Model, Academic Press.
7. V.K. Rohatgi, A.K. Saleh, An Introduction to Probability and Statistics, Wiley.
8. S. Lipschutz, Probability: Schaum's Outlines Series, McGraw Hill Education.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-V
Course: MATH-G-SEC-T-3B
Course title: Boolean Algebra
Skill Enhancement Course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1: **[12L]**

- Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, maximal and minimal elements.
- Lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms.

Unit 2: **[13L]**

- Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials.
- Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

SUGGESTED READINGS/REFERENCES:

1. B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press.
2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, Undergraduate Texts in Mathematics, Springer.
3. S. Givant, P. Halmos, Introduction to Boolean Algebras, Springer.
4. E. Mendelson, Boolean Algebra and Switching Circuits, McGraw-Hill.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-VI
Course: MATH-G-DSE-T-2A
Course title: Dynamics of a Particle
Discipline Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit-1: **[25L]**

- Motion in a straight line, motion under attractive and repulsive forces, motion under acceleration due to gravity.
- Simple Harmonic Motion, Horizontal Oscillation, Composition of two S.H.M.'s, damped harmonic motion, forced oscillation, damped forced oscillation.
- Motion in a resisting medium: Vertical and curvilinear motion in a resisting medium.
- Motion of varying mass: Equations of motion.

Unit-2: **[25L]**

- Work, Power and Energy: Definitions. Work done in stretching an elastic string.
- Conservative forces. Conservation of energy.
- Impulse and impulsive forces: Impulse of a force. Impulsive forces. Conservation of linear momentum.

- Collision of elastic bodies: Elasticity. Impact of smooth bodies. Impact on a fixed plane. Direct and oblique impact of two smooth spheres. Loss of kinetic energy. Angle of deflection.

Unit-3: **[25L]**

- Motion in a Plane: Velocity and acceleration of a particle moving on a plane in Cartesian and polar coordinates. Motion of a particle moving on a plane refers to a set of rotating rectangular axes. Angular velocity and acceleration. Circular motion. Tangential and normal accelerations.
- Central orbit: Characteristics of central orbits. Areal velocity. Law of force for elliptic, parabolic and hyperbolic orbits. Velocity under central forces. Orbit under radial and transverse accelerations. Stability of nearly circular orbits.
- Planetary motion: Newtonian law. Orbit under inverse square law. Kepler's laws of planetary motion. Time of description of an arc of an elliptic, Parabolic and hyperbolic orbit. Effect of disturbing forces on the orbit. Artificial satellites: Orbit round the earth. Parking orbits. Escape velocity.

SUGGESTED READINGS/REFERENCES:

1. J. L. Synge and B. A. Griffith, Principles of Mechanics, McGraw Hill Book Company, New York.
2. I. H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. F. Chorlton, Textbook of Dynamics, John Wiley & Sons.
5. S. L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, New Age International Private Limited.
6. S. L. Loney, Elements of Statics and Dynamics I and II, AITBS.
7. A. S. Ramsey, Dynamics (Part I), CBS Publishers & Distributors.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-VI
Course: MATH-G-DSE-T-2B
Course title: Numerical Methods
Discipline Specific Elective Course; Credit-6; Full Marks-75

COURSE CONTENT: 6 Credits (5+1) (Theory + Tutorial)

Unit 1. **[20L]**

- Errors, relative, absolute, round-off, truncation errors.
- Interpolation, Lagrange and Newton's methods. Finite difference operators. Gregory forward and backward difference interpolation.
- Numerical differentiation, Methods based on interpolations, methods based on finite differences.

Unit 2. **[20L]**

- Numerical Integration, Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, composite trapezoidal rule, composite Simpson's 1/3rd rule.

Unit 3. **[20L]**

- Transcendental and polynomial equations, Bisection method, Regula-Falsi method, Fixed point iteration, Newton-Raphson method, Rate of convergence of these methods.
- System of linear algebraic equations, Gaussian elimination and Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method.

Unit 4: **[15L]**

- The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta method of order two.

SUGGESTED READINGS/REFERENCES:

1. Scarborough, James B., Numerical Mathematical Analysis, Oxford and IBH publishing co.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering, New Age International Publishers.
3. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI.
4. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India.
5. Computation, New age International Publisher, India.
6. C. F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India.
7. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, PHI Learning Private Limited.
8. P. S. Das, C. Vijayakumari, Numerical analysis, Pearson.
9. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, PHI Learning Private Limited.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-VI
Course: MATH-G-SEC-T-4A
Course title: Programming in 'C'
Skill Enhancement course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1. **[7L]**

- Brief historical development. Computer generation. Basic structure and elementary ideas of computer systems, operating systems, hardware and software.
- Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic.
- BIT, BYTE, WORD. Coding of data -ASCII, EBCDIC, etc.
- Algorithms and Flow chart: Important features, Ideas about complexities of algorithms. Application in simple problems.

Unit 2. **[18L]**

- Programming language and importance of C programming.
- Constants, Variables and Datatype of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.
- Operation and Expressions: Arithmetic operators, relational operators, logical operators.
- Decision Making and Branching: decision making with if statement, if-else statement, Nesting if statement, switch statement, break and continue statement.
- Control Statements: While statement, do-while statement, for statement.
- Arrays: One-dimension, two-dimensional and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.
- User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function.

Programming in 'C'

1. Calculate the area of a triangle.
2. Solution of quadratic equation.
3. Sum of *n* numbers.
4. A.M. and G.M. of *n* numbers.
5. Find the magnitude of a Vector.
6. Arrange the numbers in ascending and descending orders.
7. Addition and Subtraction of two matrices.
8. Multiplication of two matrices.

SUGGESTED READINGS/REFERENCES:

1. Yashvant Kanetkar, Let us C, BPB Publications.
2. V. Krishnamoorthy, K. R. Radhakrishnan, Programming in C, Tata McGraw Hilll.
3. Noel Kalicharan, C by example, Cambridge Low price edition.
4. E. Balagurusamy, Programming in ANSI C, Tata McGraw Hill.
5. C. Xavier, C-Language and Numerical Methods, New Age International.
6. Byron S. Gottfried, Programming with C, McGraw Hill Education.
7. A. N. Kamthane, Programming in C, Pearson.

B.A./B.Sc. Mathematics (GENERAL)
SEMESTER-VI
Course: MATH-G-SEC-T-4B
Course title: Programming in Python
Skill Enhancement course; Credit-2; Full Marks-50

COURSE CONTENT: 2 Credits (Theory)

Unit 1. **[7L]**

- Brief historical development. Computer generation. Basic structure and elementary ideas of computer systems, operating systems, hardware and software.
- Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic
- BIT, BYTE, WORD. Coding of data -ASCII, EBCDIC, etc.
- Algorithms and Flow chart: Important features, Ideas about complexities of algorithms. Application in simple problems.

Unit 2. **[18L]**

- Overview of Programming: Structure of a Python Program, Elements of Python.
- Introduction to Python: Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment or Decrement operator).
- Creating Python Programs: Input and Output Statements, Control statements (Branching, Looping, Conditional Statement, Exit function, Difference between break, continue and pass.), Defining Functions, default arguments.

Programming in Python

1. Calculate the area of a triangle.
2. Solution of quadratic equation.
3. Sum of *n* numbers.
4. A.M. and G.M. of *n* numbers.
5. Find the magnitude of a Vector.
6. Arrange the numbers in ascending and descending order.
7. Addition and Subtraction of two matrices.
8. Multiplication of two matrices.

SUGGESTED READINGS/REFERENCES:

1. T. Budd, Exploring Python, McGraw Hill Education.
2. Kenneth A. Lambert, Fundamentals of Python, Cengage Learning, Inc.
3. Mark Lutz, Learning Python, O'Reilly Media, Inc.
4. Tony Gaddis, Starting Out with Python, Pearson.
5. T. Sheetal, K. Naveen, Python Programming: A modular approach, Pearson.
6. R. N. Rao, Core Python Programming, Dreamtech Press.