Proposed Syllabus and Scheme of Examination

for

B.Sc. / B.A./B.Com (General)
Mathematics

Submitted to

Dhanamanjuri University
Manipur

under the

Choice Based Credit System

May 2020

A
PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B. Sc. MATHEMATICS

	CORE COURSE (12)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill Enhancement Course (SEC) (2)**	**Discipline Specific Elective DSE (6)**
1	Calculus	(English/Hindi/MIL Communication)/ Environmental Science		
	C2A			
	C3A			
II	Differential Equations	Environmental Science /(English/Hindi/MIL Communication)		
	C2B			
	C3B			
III	Real Analysis		SEC-1	
	C2C			
	C3C			
IV	Algebra		SEC-2	
	C2D			
	C3D			
V			SEC-3	DSE-1A
				DSE-2A
				DSE-3A
VI			SEC-4	DSE-1B
				DSE-2B
				DSE-3B

A

Details of Courses Under Undergraduate (B.Sc. Mathematics)

Course	***Credits**	
	Theory+ Practical	Theory+Tutorials
I. Core Course (6 Credits)		
(12 Papers)	12X4= 48	12X5=60
04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the 03 Disciplines of choice		
II. Elective Course (6 Credits)		
(6 Papers)	6x4=24	6X5=30
Two papers from each discipline of choice including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice including paper of interdisciplinary nature		

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses

1**. Ability Enhancement Compulsory Courses (AECC)**		
(2 Papers of 4 credits each)	2 X 4=8	2X4=8
Environmental Science		
English/Hindi/MIL Communication		
2**. Skill Enhancement Courses (SEC)**	4 X 4=16	4 X 4=16
(4 Papers of 4 credits each)		
	Total credit= 132	**Total credit= 132**

Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

***wherever there is practical there will be no tutorials and vice -versa**

B

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN B.A. MATHEMATICS

	CORE COURSE (12)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill Enhancement Course (SEC) (2)**	**Discipline Specific Elective DSE (6)**	
1	Calculus C2A English/MIL-1	(English/Hindi/MIL Communication)/ Environmental Science			
II	Differential Equations C2B MIL/English-1	Environmental Science /(English/Hindi/MIL Communication)			
III	Real Analysis C2C English/MIL-2		SEC-1		
IV	Algebra C3D MIL/English-2		SEC-2		
V			SEC-3	DSE-1A DSE-2A	GE-1
VI			SEC-4	DSE-1B DSE-2B	GE-2

B

Details of Courses Under Undergraduate (B.A. Mathematics)

Course	***Credits**	
	Paper+ Practical	Paper + Tutorial
I. Core Course (6 Credits)		
(12 Papers)	12X4= 48	12X5=60
Two papers – English Two papers – Hindi/MIL Four papers – Discipline 1. Four papers – Discipline 2.		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practicals)		
II. Elective Course (6 Credits)		
(6 Papers)	6x4=24	6X5=30
Two papers- Discipline 1 specific Two papers- Discipline 2 specific Two papers- Inter disciplinary Two papers from each discipline of choice and two papers of interdisciplinary nature.		
Elective Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical/ Tutorials*)		
Two papers- Discipline 1 specific Two papers- Discipline 2 specific Two papers- Generic (Inter disciplinary) Two papers from each discipline of choice including papers of interdisciplinary nature.		

- **Optional Dissertation or project work in place of one elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses		
1**. Ability Enhancement Compulsory Courses (AECC)**		
(2 Papers of 4 credits each)	2 X 4=8	2 X 4=8
Environmental Science **English/Hindi/MIL Communication**		
2**. Skill Enhancement Courses (SEC)**	4 X 4=16	4 X 4=16
(4 Papers of 4 credits each)		
	Total credit= 132	**Total = 132**

Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

***wherever there is a practical there will be no tutorial and vice-versa.**

MATHEMATICS

Discipline Specific Electives (DSE)
DSE 1A (choose one)

1. Metric Spaces and Complex Analysis
2. Mechanics

DSE 1B (choose one)

1. Linear Programming and applications
2. Linear Algebra

Skill Enhancement Course (SEC)

SEC 1 (choose one)

1. Transportation and Game Theory
2. Analytical Geometry

SEC 2 (choose one)

1. Vector Calculus, Laplace transform and Trigonometry
2. Probability and Statistics

SEC 3 (choose one)

1. Theory of Equations and Matrices

2. Number Theory

SEC 4 (choose one)

1. Logic and Boolean Algebra

2. Numerical methods

SYLLABUS
B.A/B.SC (GENERAL)
MATHEMATICS
FIRST YEAR

MATG101: SEMESTER-I
[CALCULUS]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Derivatives **(Lectures: 15)**

Limit and Continuity (using $\varepsilon - \delta$ definition) of the functions, Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's Theorem and its application. Rolle's Theorem, Lagrange's and Cauchy's Mean Value theorems, Taylor's and Maclaurin's theorem with Lagrange's and Cauchy's form of remainders, Indeterminate forms, L – Hospital's rule, Expansion of standard functions: $e^x, \sin x, \cos x$, $\log(1+x), (1+x)^m$.

Unit – II: Partial derivatives **(Lectures: 10)**

Function of Two and three variables, Limit and Continuity for functions of two and three variables, Partial differentiation, successive partial differentiations, Euler's theorem on Homogeneous functions of two and three variables, Maxima and Minima of functions of two variables.

Unit – III: Tracing of curves **(Lectures: 15)**

The first-derivative test for relative extrema, Concavity and inflection points, Second derivative test for relative extrema, Curve sketching using first and second derivative tests, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, Tangents and normals, Curvature, radius of curvature for the Cartesian, parametric, implicit and polar equations.

Unit – IV: Integration **(Lectures: 30)**

Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations. Evaluation of double integrals, Change of the order of integration, Change of variables in double integrals, Areas and lengths of curves in the plane, volumes and surfaces of solids of revolution.

Books Recommended

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd., 2002.
3. **Das** and **Mukherjee** – *Differential Calculus*, U.N.Dhur & Sons, Kolkata
4. **Das and Mukherjee**-*Integral Calculus*, U.N. Dhur and Sons Pvt. Ltd, Kolkata.
5. **Maity** and **Gosh** – *Differential Calculus*, An Introduction to Analysis, New Central Book Agency, Calcutta.
6. **Shanti Narayan and Dr P.K. Mittal** – *Integral Calculus*, S. Chand & Co. Pvt. Ltd., New Delhi
7. **Gorakh Prasad** – *Differential Calculus*, Pothisala Pvt.Ltd., Allahabad.

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MATG 202 : SEMESTER-2
[DIFFERENTIAL EQUATIONS]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit – I: Ordinary Differential Equations and Applications (Lectures: 15)

Exact equations and integrating factors (Rules), Linear equations and equations reducible to linear form, Equations solvable for x, y, p and Clairaut's equation, Singular solutions

Unit – II: Solving of Higher-Order Linear Differential Equations (Lectures: 25)

Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order. Second order linear differential equations with constant coefficients, Homogeneous linear equations, Complementary functions and particular integrals, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Solutions of simultaneous equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, total differential equations of the form: $Pdx + Qdy + Rdz = 0$, method of solutions and their geometrical interpretations, orthogonal trajectory

Unit – III: First and Second Order Partial Differential Equations (Lectures: 20)

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations,Linear partial differential equation of first order, Lagrange's method, Charpit's method.

Unit – IV: Application of Partial differential equation (Lectures: 10)

Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended:

1. Piaggio – *An Elementary Treatise on Differential Equation and Their Applications,* C.B.S.Publishers &

Distributors, New Delhi

2. M.D. Raisinghania- Ordinary and Partial Differential Equations, S.Chand, New Delhi

3. R.K.Gosh and K.C. Maity-An introduction to Differential Equations NCBA (P) Ltd Kolkata

4. Coddington - *An Introduction to Ordinary Differential Equations and their Applications*, Prentice Hall of India.,

New Delhi

5. G.F.Simmons - *Differential Equations,* Tata McGraw Hill

6. D.A.Murray - *Introductory Course in Differential Equations*, Orient Longman(India).

MATHEMATICS

SECOND YEAR

MATG 303: SEMESTER-III

[Real Analysis**]**

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Real number system **(Lectures: 15)**

Finite and infinite sets, definition and examples of countable and uncountable sets, Real line, Definition and types of intervals, bounded and unbounded sets, supremum and infimum of a non-empty set, order completeness property in R (statement only), Archimedean property of R,

Neighbourhood of a point, Limit point of a set , Bolzano-Weierstrass theorem on set, Open and closed sets, their related properties. Concept of Compactness, Heine Borel Theorem.

Unit-II: Sequence and Series in R (Lectures: 25)

Real Sequence, Bounded sequence, Convergence sequence, Cauchy sequence, Cauchy convergence criterion, order preservation and squeeze theorem, monotonic sequence and their convergence, monotonic convergence theorem(statement only),subsequence, limit point of a sequence, Bolzano-Weierstrass theorem of sequence , Limit superior and limit inferior of a sequence(definition and examples only), nested interval theorem, Infinite series,a necessary condition for convergence of infinite series, convergence and divergence of geometric series and p- series, Comparison test, limit comparison test, D'Alembert's ratio test, Cauchy's root test, alternating series, Leibnitz's test, Definition and examples of absolute and conditional convergence.

Unit-III: Continuity and Riemann integration (Lectures: 22)

Properties of continuous functions in a closed interval, uniform continuity, Upper and lower Riemann integrals, Darboux's theorems, Integrability conditions , Integrability of continuous and monotonic functions.

Unit-IV: Improper Integrals (Lectures: 08)

Different types of improper integrals, Evaluation, Convergence of improper integrals, convergence of Beta function and Gamma function.

Books Recommended 1. R.G. Bartle and D. R Sherbert, Introduction to Real Analysis, 1John Wiley and Sons (Asia) P. Ltd., 2000.

2. K.A. Ross, Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

3. E. Fischer, Intermediate Real Analysis, Springer Verlag, 1983.

4. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International (P) Limited.

5. K.C. Maity & R.K. Ghosh, An Introduction to Analysis, Differential Calculus Part-I , Integral Calculus,

6. Shanti Narayan and M.D. Raisinghania, Elements of Real Analysis, S. Chand & Company

Skill Enhancement Course (SEC): SEC-1: SEMESTER-III

SEC- 1 (choose one)

1. Transportation and Game Theory
2. Analytical Geometry

MATGSEC-3(i):305(Mathematics)

[Transportation and Game Theory]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Transportation problem (Lectures: 20)

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit-II: Network Problem (Lectures: 20)

Definition, examples and basic properties of graphs, pseudographs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, Flows in networks, Maximal flow, Shortest path , Construction of minimal spanning tree and its applications. Project management through PERT/CPM,

Unit-III: Game Theory (Lectures: 16)

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

Books Recommended:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.

2. A. Ravindran, D.T. Phillips and James J. Solberg, Operations Research- Principles and Practice, John Wiley and Sons, 2005.

3. R.K. Ahuja T. L. Magnanti, B. Orlin, Network Flows-Theory, Algorithm and Applications, Prentice Hall, NJ, 1993. 4. J.D. Wist, F.K. Levy, A Management Guide to PERT/CPM, 2nd Ed., PHI, 1967 (Reprint 2007).

Referrence: Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.

MATGSEC-1(ii): 305(Mathematics)

[Analytical Geometry**]**

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Two Dimensional Geometry: (Lectures: 16)

Change of axes: Change of Origin without changing the direction of axes, Change of Direction of axes of co-ordinates without changing the origin. Pair of straight lines: Homogeneous equation of second degree, Angle between pair of lines given by homogeneous equation, Bisectors of angles between the pair of lines, Condition for the general equation of second degree to represent a pair of straight lines, Point of intersection, Equation of the pair of straight lines joining the origin to the point of intersection of lines and a curve.

Unit- II: Conic Sections, Parametrized Curves, and Polar Coordinates (24 Lectures)

Conic sections and quadratic equations: Circle, Parabola, Ellipse, and hyperbola; Techniques for sketching: Parabola, Ellipse, and Hyperbola; Reflection properties of parabola, ellipse, and hyperbola, Classifying conic sections by eccentricity, Classification of quadratic equations representing lines, parabola, ellipse, and hyperbola; Parameterization of plane curves, Conic sections in polar coordinates and their sketching.

Unit-III: Sphere, Cone and Cylinder: (Lectures: 16)

Sphere: Equations of sphere, Condition for the general equation of second degree to represent a sphere, Plane section of a sphere, Intersection of two spheres, Equation of a tangent plane, Condition for a plane to be a tangent plane to a sphere. Cone: Equation of a cone with a conic as guiding curve, Enveloping cone of a sphere, Quadratic cones with vertex at origin, Condition for

the general equation of second degree to represent a cone, Reciprocal cone, Right circular cone. Cylinder: Equation of cylinder, Enveloping cylinder, Right circular cylinder. Paraboloids & Central Conicoids: Equations and their properties.

Books Recommened :

1. B Das, Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. Ghosh and Maity, Vector Analysis, New Central Book Agency.
3. Shanti Narayan and P K Mittal, Analytical Solid Geometry, S Chand & Co.
4. S L Loney, Co-Ordinate Geometry of Two Dimensions, Macmillan and Co.
5. S L Loney, Co-Ordinate Geometry of Three Dimensions, Macmillan and Co.
6. R J T Bell, An Elementary Treatise on Co-Ordinate Geometry of Three Dimensions, Macmillan and Co.

MATG 404: SEMESTER-IV
[Algebra]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-II: Definition and examples of groups (Lectures: 15)

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n.

Unit-II: Cyclic groups (Lectures: 20)

Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions.

Unit-III: Subgroup and properties (Lectures: 20)

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

Unit-IV: Definition and examples of rings (Lectures: 15)

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.

Books Recommended

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

3. Joseph A Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999. 4. George E Andrews, Number Theory, Hindustan Publishing Corporation, 1984.

4 I.N.Herstein, Topics in Algebra, John Wiley & Sons, New Delhi.

5.V.K. Khanna & S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House, New Delhi.

6.Surjeet Singh and QaziZameerudin, Modern Algebra, Vikas Publishing House.

7.P.B. Bhattacharya, S.K. Jain and S. R. Nagpaul: Basic Abstract Algebra, CUP.

Skill Enhancement Course (SEC-2): SEMESTER-IV

SEC 2 (choose one)

1. Vector Calculus, Laplace Transform and Trigonometry
2. Probability and Statistics

MATGSEC-2(i): 406(Mathematics)

[Vector Calculus, Laplace Transform and Trigonometry**]**

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit -1: Vector Calculus and its Applications (Lectures: 20)

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions. Differentiation of Vectors, Gradient, Divergence and Curl

of a vector. Integration of vector functions, tangent and normal components of acceleration, Ordinary integrals of vectors. Line integrals, Surface integrals and Volume integrals,

Unit-II: Laplace Transforms **(Lectures: 20)**

Definition of Laplace Transformations, Kernel of the Integral transformation, Existence of Laplace Transformation Transformations of some elementary functions such as $f(t) = e^{-at}$, cos at, sin at, cosh at, sinh at, t^n etc. Properties of Laplace Transformation, First Translation or Shifting Theorem, Second Translation or Heaviside's shifting Theorem, Differentiation property, Change of scale property with examples, Laplace Transformation of Derivatives of order n with Theorems, Inverse Laplace transformations, Theorems on multiplication by s and 1/s, First and Second Shifting properties with examples, Convolution Theorem, Properties of Convolution, Examples and Application of Laplace Transformation in solving PDE.

Unit-III: Trigonometry **(Lectures: 16)**

De Moivre's theorem and its applications, Expansion of trigonometric functions, Exponential values for circular functions, Complex argument, Gregory's series, Hyperbolic functions, Summation of series including C+iS method, Infinite product-sin *x* and cos *x*.

Books Recommended

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) P. Ltd. 2002.

3. P.C. Matthew's, Vector Calculus, Springer Verlag London Limited, 1998.

4.B Das, Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.

5.Ghosh and Maity, Vector Analysis, New Central Book Agency.

6.J.k.Goyal, K.P.Gupta (2019). Integral Transforms (28^{th} ed.),Pragati Prakashan, Meerut

7.Das and Mukherjee-Higher Trigonometry, U.N. Dhur and Sons Pvt. Ltd. Kolkata.

8.Murray R. Spiegel,Schaum's outlines of Theory and Problems on Laplace Transforms,Mcgraw-Hill, New Delhi

MATGSEC-2(ii):406 (Mathematics)

[Probability and Statistics]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) , Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit -I: Probability Functions and Moment Generating Function (Lectures: 20)

Sample space, Probability set function, Real random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions, Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Discrete distributions: Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions: Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit II: Bivariate Distribution (Lectures: 16)

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Unit -III: Correlation, Regression and Central Limit Theorem (Lectures: 20)

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Books recommended:

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). Introduction to Mathematical Statistics (7th ed.). Pearson Education, Inc.
2. Miller, Irwin & Miller, Marylees. (2014).John E. Freund's Mathematical Statistics with Applications (8th ed.). Pearson. Dorling Kindersley (India).
3. Ross, Sheldon M. (2014). Introduction to Probability Models (11th ed.). Elsevier Inc.
4. P. Mukhopadhyay, Theory of Probability, New Central Book Agency, Kolkata.
5. Lai Lai Chung, A Course in Probability Theory, Academic Press, 2001.

6. Probability & Statistics (Vol. I), D. Biswas, New Central Book Agency (P) Ltd.

MATHEMATICS

THIRD YEAR

Skill Enhancement Course (SEC-3): SEMESTER-V

SEC 3 (choose one)

1. Theory of Equations and Matrices
2. Number Theory

MATGSEC-3(ii):507(Mathematics)

[Theory of Equations and Matrices]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: General properties of equations (Lectures: 20)

General properties of polynomials, Graphical representation of a polynomials, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule,

Relation between the roots and the coefficients of equations. Symmetric functions, Applications symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

Unit-II: Convergence of Series **(Lectures: 16)**

Infinite series-Definitions, Geometric series, Theorems on series of positive terms, Comparison test of convergence, Convergence and Divergence of p-series, Cauchy's root test, D' Alembert's ratio test, Raabe's test, Logarithmic test, Leibnitz's test for alternating series, Conditional and Absolute convergence.

Unit III: Theory of Matrices and its Applications (Lectures: 20)

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation AX = b, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.

Books Recommended:

1 W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954. 2. C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc., 1954.

2. Dickson, Leonard Eugene (2009). First Course in The Theory of Equations. The Project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)

3. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its Applications (5th ed.). Pearson Education.

References:

1. Chandrika Prasad- Algebra and Theory of Equations, Pothisala Private Limited.
2. Shanti Narayan and P.K. Mittal- A text Book of Matrices, S. Chand and Co. New Delh
3. Bhattacharya, Jain and Nagpaul-First Course in Linear Algebra, Wiley Eastern, N. Delhi

MATGSEC-3(ii):507 (Mathematics)

[Number Theory]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit -I: Distribution of Primes and Theory of Congruencies (Lectures: 16)

Linear Diophantine equation, Prime counting function, Prime number theorem, Goldbach conjecture, Fermat and Mersenne primes, Congruence relation and its properties, Linear congruence and Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

Unit-II: Number Theoretic Functions (Lectures: 20)

Number theoretic functions for sum and number of divisors, Multiplicative function, The Mobius inversion formula, The greatest integer function. Euler's phi-function and properties, Euler's theorem.

Unit -III: Quadratic Reciprocity Law and Public Key Encryption (Lectures: 20)

The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots; Definition of quadratic residue of an odd prime, and Euler's criterion.

The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruencies with composite moduli; Public key encryption, RSA encryption and decryption.

Books recommended: 1. Burton, David M. (2012). Elementary Number Theory (7th ed.). Mc-Graw Hill Education Pvt. Ltd. Indian Reprint.

2. Jones, G. A., & Jones, J. Mary. (2005). Elementary Number Theory. Undergraduate Mathematics Series (SUMS). First Indian Print.

Referrence: Neville Robinns. (2007). Beginning Number Theory (2nd ed.). Narosa Publishing House Pvt. Limited, Delhi.

Discipline Specific Electives (DSE): SEMESTER-V

DSE 1A (choose one)

1. Metric Spaces and Complex Analysis
2. Mechanics

MATGDSE 1A(i): 509(Mathematics)

[Metric Spaces and Complex Analysis]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit -I: Basic Concepts and Topology of Metric Spaces (Lectures: 20)

Metric spaces: Definition and examples, Sequences in metric spaces, Cauchy sequences, Complete metric space.

Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.

Unit -II: Continuity & Uniform Continuity in Metric Spaces (Lectures: 15)

Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping, Banach fixed point theorem. Connectedness, Connected subsets of, Connectedness and continuous mappings,

Unit -III: Analytic Functions and Cauchy-Riemann Equations (Lectures: 15)

Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability;

Unit-IV: Elementary Functions and Integrals (Lectures: 20)

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals.

Cauchy Goursat theorem, Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.

Books recommend: 1. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.

1. Brown, James Ward, & Churchill, Ruel V. (2014). Complex Variables and Applications (9th ed.). McGraw-Hill Education. New York.

Referrences: i. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.

ii. Simmons, George F. (2004). Introduction to Topology and Modern Analysis. McGraw-Hill Education. New Delhi

iii. Bak, Joseph & Newman, Donald J. (2010). Complex Analysis (3rd ed.). Undergraduate Texts in Mathematics, Springer. New York.

iv. Zills, Dennis G., & Shanahan, Patrick D. (2003). A First Course in Complex Analysis with Applications. Jones & Bartlett Publishers, Inc.

MATGDSE 1A(i): 509(Mathematics)
[Mechanics]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Simple Harmonic Motions (Lectures: 20)

Simple Harmonic Motions. Motion in resisting medium including projectile, Motion of varying mass. Radial and Cross-Radial Components of velocities and accelerations. Tangential and Normal Components of velocities and accelerations.

Unit-II: Dynamics of a particle (Lectures: 15)

Dynamics of a particle: Motion of a particle on smooth and rough plane curves, Central orbit, Apses. Kepler's laws of planetary motion.

Unit-III: Frictions (Lectures: 20)

Equilibrium condition of coplanar forces, Frictions, Laws of Friction, Equilibrium of particle constrained to rest on a rough curve under any given forces.

Unit-IV: Centre of gravity (Lectures: 15)

Centre of mass, Centre of gravity, Centre of gravity of uniform lamina, Centre of gravity by integration, Centre of gravity of plane curves, plane areas, surface areas of revolution and volumes.

References:

1. S.L. Loney, An Elementary Treatise on Dynamics of a Particle and of Rigid Bodies, Cambridge University Press.
2. S.L. Loney, An Elementary Treatise on Statics, Cambridge University Press.
3. M. Ray, Dynamics, S. Chand & Co.
4. A.S. Ramsay, Statics, CBS Publication.
5. R.S. Verma,Text book on Statics, Pothisala Private Ltd.
6. A.S. Ramsay, Dynamics, Cambridge University Press.
7. B.C. Das, B.N. Mukherjee, Dynamics, U.N.Dhur & Sons (private Ltd.),Kolkata
8. B.C. Das, B.N. Mukherjee, Statics, U.N.Dhur & Sons (private Ltd.),Kolkata

Skill Enhancement Course (SEC-4): SEMESTER-VI

SEC 4 (choose one)

1. Logic and Boolean Algebra
2. Numerical Methods

. **MATGSEC-4(i): 608(Mathematics)**

[Logic and Boolean Algebra]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Logical equivalence (Lectures:16)

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Unit-II: Sets and properties (Lectures:20)

Sets, subsets, Set operations, 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, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Unit-III: Boolean Algebra (Lectures: 20)

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.

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.

Books Recommended:

1. B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.

2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

3. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.

4. P.R. Halmos, Naive Set Theory, Springer, 1974. 3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

MATGSEC-4(ii):608 (Mathematics)

[Numerical Methods]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Methods for Solving Algebraic and Transcendental Equations (Lectures: 16)

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method .System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Partial and scaled partial pivoting, LU decomposition and its applications, Iterative methods: Gauss-Jacobi, Gauss-Seidel and SOR methods.

Unit-II: Interpolation (Lectures: 20)

Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Piecewise linear interpolation.

Unit -III: Numerical Differentiation and Integration (Lectures: 20)

First order and higher order approximation for first derivative, Approximation for second derivative. Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Composite Trapezoidal rule, Composite Simpson's rule. Ordinary Differential Equations:

Books recommended: 1. Bradie, Brian. (2006). A Friendly Introduction to Numerical Analysis. Pearson Education, India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.

Referrences: 1. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). Numerical Methods for Scientific and Engineering Computation. (6th ed.). New Age International Publisher, India, 2016.

2. Gerald, C. F., & Wheatley, P. O. (2008). Applied Numerical Analysis (7th ed.). Pearson Education. India.

3.M.K. Jain, S.R.K. Iyenger, R.K. Jain, Numerical methods for scientific and engineering computation, New Age International (P) Ltd.

4.James B. Scarborough, Numerical Mathematical Analysis, Oxford and IBH Publishing Co. Pvt. Ltd.

5.H.C. Saxena, Finite differences and numerical analysis, S Chand & Co. Ltd, New Delhi.

Discipline Specific Electives (DSE): SEMESTER-VI

DSE 1B (choose one)

1. Linear Programming and applications
2. Linear Algebra

MATGDSE 1B(i): 610(Mathematics)

[Linear Programming and applications]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Introduction to Linear Programming (Lectures: 15)

The Linear Programming Problem: Standard, Canonical and matrix forms, Graphical solution. Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.

Unit-II: Methods of Solving Linear Programming Problem (Lectures: 25)

Simplex Method: Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness;

Unit -III: Sensitivity analysis. **(Lectures: 15)**

Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method, Sensitivity analysis.

Unit-IV: Duality Theory of Linear Programming (Lectures: 15)

Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness, Dual simplex method

Books recommended: 1. Bazaraa, Mokhtar S., Jarvis, John J., & Sherali, Hanif D. (2010). Linear Programming and Network Flows (4th ed.). John Wiley and Sons.

2. Hadley, G. (1997). Linear Programming. Narosa Publishing House. New Delhi.

3. Taha, Hamdy A. (2010). Operations Research: An Introduction (9th ed.). Pearson.

Referrences: i. Hillier, Frederick S. & Lieberman, Gerald J. (2015). Introduction to Operations Research (10th ed.). McGraw-Hill Education (India) Pvt. Ltd.

ii. Thie, Paul R., & Keough, G. E. (2014). An Introduction to Linear Programming and Game Theory. (3rd ed.). Wiley India Pvt. Ltd.

iii. Kanti Swarup, P.k. Gupta and Man Mohan(2020), Operations research, Sultan chand & Sons, New Delhi

MATGDSE 1B (ii): 610 (Mathematics)
[Linear Algebra]

Total Marks: 100 (Theory: 75, Internal Assessment: 25) Workload: 5 Lectures, 1 Tutorial (per week) ,Credits: 6 (5+1) Duration: 14 Weeks (70 Hrs.) Examination: 3 Hrs.

Course Contents:

Unit-I: Vector Spaces (Lectures: 15)

Concept of Vector Space over a Field *K*, *n*-tuple spaces, Subspaces, Necessary and sufficient condition for being a Subspace, Subspace generated by a Subset, Sum as Direct sum of Subspaces, Linear Span, Linear Dependence, Linear Independence and their basic properties,

Unit-II: Vector Spaces (Lectures: 20)

Basis, Dimensions, Finite Dimensional Vector Spaces, Existence Theorem for Basis, Complement of a Subspace and Existence of a Complement of a Subspace of a Finite Dimensional Vector Space, Dimension of sum of Subspaces, Quotient Space and its Dimension,

Unit-III: Linear Transformation (Lectures: 20)

Linear Transformation, Kernel of a Linear Transformation, Isomorphism, Isomorphism Theorem, Representation of Linear Transformation as matrices, Algebra of Linear Transformations, Rank and

Nullity of a Linear Transformation, Rank-Nullity Theorem, Change of Basis, Dual Space, Annihilator of a Subspace, Quadratic and Hermitian Forms.

Unit-IV: Inner Product Spaces (Lectures: 15)

Inner Product Spaces, Cauchy-Schwarz Inequality, Orthogonal Vectors, Orthogonal Complements, Orthonormal sets and Orthonormal Basis, Bessel's inequality for Finite Dimensional Vector Spaces, Gram-Schmidth Orthogonalization process.

Recommended Books:

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

2. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

3. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005. 4. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

References:

1. I.N.Herstein, Topics in Algebra, John Wiley & Sons, New Delhi.
2. Kenneth Hoffman and Ray Kunze: Linear Algebra, Pearson.
3. V.K. Khanna & S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House, New Delhi.
4. S. Kumaresan, Linear Algebra, Prentice Hall of India.
5. Surjeet Singh and QaziZameerudin, Modern Algebra, Vikas Publishing House.
6. P.B. Bhattacharya, S.K. Jain and S. R. Nagpaul: Basic Abstract Algebra, CUP.