SYLLABUS FOR B.Sc. (GENERAL)

IN

MATHEMATICS

Under Choice Based Credit System (CBCS)

University of Gour Banga
Malda-732103
West Bengal

B.Sc (General) in Mathematics Course Structure under CBCS

Academic Semesters	COURSES				Total Credits	Total Marks
	Discipline Core (DC)	Discipline Specific Elective (DSE)	Ability Enhancement Compulsory (AEC)	Skill Enhancement Course (SEC)		
SEM-I	DC1 (A1) DC2 (B1) DC3 (C1) (6x3=18)		AEC1 (2)		20	200
SEM-II	DC4 (A2) DC5 (B2) DC6 (C2) (6x3=18)		AEC2 (2)		20	200
SEM-III	DC7 (A3) DC8 (B3) DC9 (C3) (6x3=18)			SEC01 (2)	20	200
SEM-IV	DC10 (A4) DC11 (B4) DC12 (C4) (6x3=18)			SEC02 (2)	20	200
SEM-V		DSE1 (A1) DSE2 (B1) DSE3 (C1) (6x3=18)		SEC03 (2)	20	200
SEM-VI		DSE4 (A2) DSE5 (B2) DSE6 (C2) (6x3=18)		SEC04 (2)	20	200

UNIVERSITY OF GOUR BANGA, MALDA

Draft /Guidelines of UG CBCS Curriculum

Meaning of the Courses and their Abbreviations

A. **Discipline Core (DC) Course:** A course that should compulsorily be studied by a candidate as a core requirement of the Honours and General courses of study.

B. **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. These are of three types:

   (i) **Discipline Specific Elective (DSE) Course:** A course, which may be offered by the main discipline/subject of study.

   (ii) **Dissertation/Project (DP)**: An elective course designed to acquire special/advanced knowledge with an advisory support by a teacher/faculty member. A Project/Dissertation work may be given in lieu of a DSE.

   (iii) **Generic Elective (GE) Course:** An elective course, chosen from an unrelated discipline/subject of study, with an intention to seek exposure beyond discipline/s of choice

C. **The Ability Enhancement (AE) Courses:** These are of two kinds:

(i) **Ability Enhancement Compulsory (AEC) Course**: The course designed for knowledge enhancement consisting of Environmental Studies, English Communication/ Modern Indian Language (**MIL**) communication.

(ii) **Skill Enhancement Course (SEC):** The course designed to provide value-based and/or skill-based knowledge relating to the main discipline.

7. Students have to opt 2 different disciplines as core disciplines in SEM – I. Core Disciplines once selected in SEM I should be continued up to semester –VI without any alternation or change.

Semester wise Course Structure under CBCS
For B.Sc. General Program

ACADEMIC SEMESTERS	COURSES				Credits	Marks
	Discipline Core (DC)	Discipline Specific Elective (DSE)	Ability Enhancement Compulsory (AEC)	Skill Enhancement (SEC)		
SEM-I	DC1 (A1) DC2 (B1) DC3 (C1) (6x3=18)	--	ENVS (2)	--	20	200
SEM-II	DC4 (A2) DC5 (B2) DC6 (C2) (6x3=18)	--	Communicative Bengali/Communicative English/MIL* (2)	--	20	200
SEM-III	DC7 (A3) DC8 (B3) DC9 (C3) (6x3=18)	--	--	SEC-1 (2)	20	200
SEM-IV	DC10 (A4) DC11(B4) DC12 (C4) (6x3=18)	--	--	SEC-2 (2)	20	200
SEM-V	--	DSE1 (A1) DSE2 (B1) DSE3 (C1) (6x3=18)	--	SEC-3 (2)	20	200
SEM-VI	--	DSE4 (A2) DSE5 (B2) DSE6(C2) (6x3=18)	--	SEC-4 (2)	20	200
Total	--	--	--	--	120	1200

Notes:

1. Each course is of 50 marks for examination.
2. **DC/DSE**: Each course is of 6 credits for course work per week
   (Theory - 4 credits + Practical- 2 credit)
   1 Credit = 1 hour duration of teaching (lecture/tutorial) or 2 hour duration of practical period.
3. **SE**: Covering any two Discipline Cores (DC) out of A, B & C with two courses each, 2x2= 4 SEs

4. **DSE:** A student has to select two DSE courses out of at least three options provided by the main discipline in SEM-V and SEM- VI.

***MIL:** Modern Indian Language

Distribution of Credits for B.A/B.Sc./B.Com. General Program

Course type and credit	Number of Courses x Credit (With practical) [Theory:04+Practical:02]		Number of Courses x Credit (Without practical) [Theory:05+Tutorial:01]	
	Theory	Practical	Theory	Tutorial
Discipline Course (DC) for B.Sc. (6)	12x4=48	12x2=24	12x5=60	12x1=12
Discipline Specific Elective (DSE) for B. Sc (6)	6x4= 24	6x2=12	6x5=30	6x1=06
Discipline Course (DC) for B. A. (6)	8x4=32	8x2=16	8x5=40	8x1=08
Discipline Course (DC) For B.Com. (6)	10x4=40	10x2=20	10x5=50	10x1=10
Language Core (LC1 &LC2) for B.A. (6)	...	....	2x5=10	2x1=02
Language Core (LC2) for B.Com. (6)	...	...	1x5=05	1x1=01
Generic Elective (GE) for B.A. & B.Com. (6)	2x4=08	2x2=04	2x5=10	2x1=02
Ability Enhancement Course (AEC) (2)	...	...	4x2=08	...
Skill Enhancement (SE) (2)	...	...	4x2=08	...

B. Marks & Question Type Distribution for General Program

Courses	Credit of each course	Distribution of marks of each course				
		Full marks of each course	Internal Assessment (IA)	End Semester Examination (ESE)		
				Theoretical		Practical
				Descriptive	MCQ	
DC,LC, DSE and GE	06	50 (Non practical bases course	10	40	nil	nil
		50 (practical based course)	10	25	nil	15
02 SE	02	50	10	40	nil	nil
AEC-1 (ENVS)	02	50	10 (Project)	nil	40	nil
AEC-2 (Communicative Bengali/English)	02	50	10	nil	40	nil

C. Groups of Disciplines/Subjects

A candidate is required to choose not more than one discipline/subject from any of the groups mentioned below.

Group-I	Physics, Zoology, Education, Women Studies
Group-II	History, Mathematics
Group-III	Chemistry, Sociology, Arabic, Sanskrit, Urdu
Group-IV	Botany, Economics, Food & Nutrition
Group-V	Political Science, Defense Studies
Group-VI	Geography, Philosophy, Mass Communication and Journalism
Group-VII	English, Home Science, Physical Education
Group-VIII	Computer Science, Bengali, Hindi

Note: Choice of the discipline will be in compliance with the availability in the particular college

D. Divisions of (Honours and General) disciplines for B.A. /B.Sc. / B.Com degree:

Degree	Streams	Disciplines/ Subjects
B.A.	**Humanities**	Bengali, English, Hindi, Sanskrit, Arabic, Urdu, History, Political Science, Philosophy, Sociology, Economics, Education, Mass Communication & Journalism, Women Studies, Defense Studies, Physical Education
B. Sc	**Science**	Physics, Chemistry, Zoology, Botany, Mathematics, Geography, Physiology, Computer Science, Food and Nutrition, Home Science
B.Com.	**Commerce**	Commerce, Economics, Management Banking

E. Notes regarding B.A. and B.Sc. Degree:

1. **A candidate taking up Honours in B.A. Degree Course shall study: (i)** Honours in any one discipline of the Humanities Division and any two other Generic Elective (GE) disciplines taking at least one from the Humanities Division.

   However, that other things remaining the same, a candidate may take up Honours Course in the B.A. in the discipline like Geography without taking any Generic elective Subject/discipline from the Division of Science.

2. **A candidate taking up General Course of Studies for the B.A. Degree shall study:** **(i)** any three disciplines from the Humanities Division in addition to Language cores - English & MIL.

   Or

   (ii) any two disciplines from the Humanities Division in addition to Language cores - English & MIL and any one from the Science Division.

3. **A candidate taking up Honours Course for B. Sc. Degree shall study:** Honours in any one discipline from the Division of Science and any two other Generic elective (GE) disciplines taking at least one from the Science Division.

4. **A Candidate taking up General Course for the B. Sc. Degree shall study:**

   (i) Any three disciplines from the Science Division.

   Or

   (ii) Any two disciplines from the Science Division and any one discipline from the Humanities Division.

F. Feedback from the Department of Geography:

The Head along with all faculty members of the Department of Geography, UGB, proposed to add the following:

(i) There shall be no B.A. Honours in Geography degree, there shall be only B.Sc. Honours in Geography degree even in case of taking Honours in Geography + two Generic elective disciplines from the Humanities Division.

(ii) But in General Course there shall be B.Sc. as well as B.A. degree with Geography. The case in which taking up Geography + 2 Generic elective disciplines from the Humanities Division is to be entitled as B.A. with Geography and the case when there is Geography + 1 Generic elective from the Science Division or 2 Generic electives from the Science Division is to be called B.Sc. with Geography degree.

Discipline Core Courses (6 credit)

- **MATH-G-DC01** - Classical Algebra & Analytic Geometry
- **MATH-G-DC02** - Calculus & Differential Equations I
- **MATH-G-DC03** - Vector Algebra & Multivariate Calculus
- **MATH-G-DC04** - Numerical Methods & Probability Theory

Department Specific Elective Courses (6 credit)

- **DSE1** (Choose any one)
  - **MATH-G-DSE1(1)** Abstract & Linear Algebra
  - **MATH-G-DSE1(2)** Differential Equations II & Mechanics
- **DSE2** (Choose any one)
  - **MATH-G-DSE2(1)** Real & Complex Analysis
  - **MATH-G-DSE2(2)** Linear Programming Problems & Game Theory

Skill Enhancement Courses (2 credit)

- **MATH-G-SEC01** - Number Theory & Boolean Algebra
- **MATH-G-SEC02** - Discrete Mathematics
- **MATH-G-SEC03** - Mathematical Statistics & Its Applications
- **MATH-G-SEC04** - Basic Computer Programming (C)

Ability Enhancement Courses (2 credit)

- **SEM-I** - Environmental Science
- **SEM-II** - Communicative English/Communicative Bengali/Modern Indian Language

Detailed Syllabus

Discipline Core Courses Syllabus

MATH-G-DC01

Classical Algebra & Analytic Geometry

End Semester Examination 40 marks & Internal Assessment 10 marks

Algebra

Unit-1

Integers, well ordering principle, principle of mathematical induction. Division algorithm ($a = bq + r, b \neq 0, 0 \leq r < b$), greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers, Euler's φ-function. Prime numbers, Euclid's theorem, fundamental theorem of arithmetic.

Congruence relation, linear congruence and simple problems related to linear congruence, congruence class, Chinese Remainder Theorem and simple problems.

Complex Numbers: De Moivre's Theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of $a^z (a \neq 0)$. Inverse circular and Hyperbolic functions.

Unit-2

Polynomials with real coefficients, Fundamental Theorem of Algebra (Statement only): The n-th degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occur in pairs). Existence of real roots, Descarte's rule of sign and application of intermediate value theorem. Relation between roots and coefficients, symmetric functions of roots. Cardan's method of solution of a cubic equation.

Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skew symmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal matrices.

Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants.

Analytic Geometry

Unit-3

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 conic.

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.

Unit-4
Equations of pair of tangents from an external point, chord of contact, poles and polers in case of General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola.

Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal.

Three dimensional coordinate system. Straight line, direction cosine, problems on straight lines. Equation of plane and elementary properties. Sphere and its tangent plane. Right circular cone.

Reference Books:

1. S. L. Loney, The Elements of Coordinate Geometry, Macmillan and Co., 1895.
2. S. Bernard and J.M. Child, Higher Algebra, Macmillan and Co., 1952.
3. T. Andreescu and D. Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
4. D.C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. K.B. Dutta, Matrix and Linear algebra, Prentice-Hall of India Pvt.Ltd., 2004.
6. W.S. Burnside and A.W. Panton, The Theory of equations, Dublin University Press, 1954.
7. R.J.T. Bell, An elementary treatise on coordinate geometry of three dimensions, Macmillan and Co.

MATH-G-DC02

Calculus & Differential Equations I

End Semester Examination 40 marks & Internal Assessment 10 marks

Calculus
Unit-1
Set, relation, mapping. Real number system, the algebraic and order properties of $\mathbb{R}$. The least upper bound property of real numbers, the Archimedean property.

Sequence of real numbers: Definition of bounds of a sequence and monotone sequence. Limit of a sequence. Statements of limit theorems. Concept of convergence and divergence of monotone sequences-applications of the theorems, in particular, definition of e. Statement of Cauchy's general principle of convergence and its application.

Infinite series of constant terms, Convergence and Divergence (definitions). Cauchy's principle as applied to infinite series (application only). Series of positive terms: Statements of comparison test. D. AIembert's Ratio test. Cauchy's nth root test and Raabe's test and their applications. Alternating series. Statement of Leibnitz test and its applications.

Unit-2
Real function, the limit of a function, basic limit theorems. Definition of continuity, composite function and continuity, intermediate value property, the process of inversion, the extreme value theorem for continuous function.

Derivative of a function, algebra of derivatives, geometric interpretation of derivative as a slope, chain rule. Successive differentiation.

Mean value theorems for derivatives, Rolle's theorem and Lagrange's mean value theorem. Statements of Taylor's and Maclaurin's Theorems with Lagrange's and Cauchy's from of remainders. Taylor's and Maclaurin's Infinite series of functions like e^x, $\sin x$, $\cos x$, $(1+x)^n$, $\log(1+x)$ with restrictions wherever necessary.Indeterminate Forms: L'Hôspital's Rule: Statement and Problems only. Application of the principle of local extrema for a function of single variable in geometrical, physical and to other problems.

Unit -3
Evaluation of definite integrals.Integration as the limit of a sum (with equally spaced as well as unequal intervals), Riemann's definition for definite integrals. Fundamental theorem of calculus and its applications.

Reduction formulae of $\int \sin^n x \cos^m x\, dx$, $\int \frac{\sin^n x}{\cos^m x}\, dx$, $\int \tan^n x\, dx$ and associated problems (m and n are non-negative integers).

Definition of Improper Integrals: Statements of (i) μ-test (ii) Comparison test (Limit from excluded) - Simple problems only. Use of Beta and Gamma functions (convergence and important relations being assumed).

Differential Equations I
Unit-4
Order, degree and solution of an ordinary differential equation (ODE) in presence of arbitrary constants, Formation of ODE. Solution of first order ODE, exact and non exact equations.

First order linear equations, Euler's and Bernoulli's equations. Nonlinear equations: Clairaut's equations, general and singular solutions.

Second order linear equations: Linear homogeneous equations with constant coefficients, Linear non-homogeneous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. G.F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw Hill.
3. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
4. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) Pte. Ltd., Singapore, 2002.

5. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
6. T.M. Apostol, Calculus, Volume I and II, Wiley.
7. R.R. Goldberg, Methods of Real Analysis, Oxford and Ibh, 2012.
8. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2nd ed., 2013.
9. D. Murray, Introductory Course in Differential Equations, Longmans Green and Co.
10. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
11. S. Lang, A First Course in Calculus, Springer.

MATH-G-DC03

Vector Algebra & Multivariate Calculus

End Semester Examination 40 marks & Internal Assessment 10 marks

Vector Algebra

Unit-1

Vectors and Scalars, addition and scalar multiplication of a vectors, concept of vector spaces. Linear dependence and independence of vectors, co-linear and co-planer vectors. Linear span and basis vectors, dimension. Simple applications to problems of Geometry. Vector equation of plane and straight line, volume of Tetrahedron.

Scalar and Vector products of two and three vectors. Triple product of vectors. Orthogonal and orthonormal vectors, Euclidean space.

Linear transformation on Euclidean space and its characterisation. Matrix representation of linear transformations.

Multivariate Calculus

Unit-2

Function of several variables, Scalar and vector fields (functions from $\mathbb{R}^n$ to $\mathbb{R}$ and functions from $\mathbb{R}^n$ to $\mathbb{R}^m$). Limit and continuity of scalar fields. Directional and Partial derivatives, gradient of a scalar field, Euler's theorem.

Differentiability and its sufficient condition. Total derivative and its representation, Jacobian. Implicit function theorem (simple applications only), Chain rule.

Maxima and minima for functions of several variables. Lagrange's method of undetermined multipliers, simple applications.

Unit-3

Curves, parametrisation of basic curves. Line integral, basic properties of line integrals. The concept of work as a line integral.

Evaluation of double integral by repeated one dimensional integration. Geometric interpretation of double integral as volume. Double integral extended over more general regions, changing

the order of integration.

Multiple integral and its simple applications, changing the order of integration.

Unit-4
Vector Differentiation: Curl and divergence of vector fields, properties of the curl and divergence.

Green's theorem and its simple applications.

Parametric representation of surface, surface integrals. The Stoke's theorem and Gauss divergence theorem and its applications.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. J.E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. J. Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.
5. T.M. Apostol, Mathematical Analysis, Narosa Publishing House.
6. T.M. Apostol, Calculus, Vol. I & II, Wiley.
7. R. Courant and F. John, Introduction to Calculus and Analysis, Vol II, Springer.
8. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill.
9. J.E. Marsden and A.J. Tromba, Vector Calculus, McGraw-Hill.
10. T. Tao, Analysis II, Hindustan Book Agency, 2006.
11. G.F. Simmons, Calculus with Analytic Geometry, McGraw-Hill.
12. M.R. Speigel, Schaum's outline of Vector Analysis.

MATH-G-DC04

Numerical Methods & Probability Theory

End Semester Examination 40 marks & Internal Assessment 10 marks

Numerical Methods
Unit-1
Approximate numbers, Significant figures, Rounding off numbers. Error: Absolute, Relative and percentage. Operators: Δ, ∇ and E (Definitions and some relations among them).

Polynomial approximations, the problem of interpolation. Difference Tables, Newton's forward and backward interpolation formula, remainder term (equi-spaced arguments . Lagrange's Interpolation Formula (unequi-spaced arguments). Numerical problems on Interpolation with both equally and unequally spaced arguments.

To find a real root of an algebraic or transcendental equation. Location of root (tabular method), Bisection method, Newton-Raphson method with geometrical significance, Numerical Problems. (Note: Emphasis should be given on problems).

Unit-2
Numerical Integration: Trapezoidal and Simpson's $\frac{1}{3}$-rd formula (statement only). Problems on Numerical Integration.

Solving initial value problems using numerical methods: Euler's method, R-K method of order 2 and order 4.

Numerical solution of system of linear equations: Gauss elimination, Gauss-Seidal and L-U factorisation methods.

Probability Theory
Unit-3
Elements of probability Theory: Random experiment, outcome, sample space, event. Classical definition of probability and its limitations. Simple problems using classical definition.

Axiomatic definition of probability and elementary properties. Conditional probability and Independence.

Baye's theorem and its proof. Miscellaneous exercises on probability.

Unit-4
Random variable: Discrete and continuous. Probability distribution functions. Discrete distributions, probability mass function. Continuous distribution, probability density function. Cumulative distribution and its properties. Joint distribution function of two random variables.

Expectation and variance, elementary properties. Moment about the origin, moment about the mean, moment generating functions. Covariance and correlation coefficient.

Special discrete distribution function: Binomial and Poisson distribution, their mean and variance, simple problems. Special continuous distribution function: Normal, standard normal distributions and their properties, exponential and beta-gamma distributions. Chebyshev's inequality and laws of large numbers.

Text Books:
Reference Books:

1. K.E. Atkinson, An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
2. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International, India, 2007.

4. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.

5. U.M. Ascher and C. Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

6. J.H. Mathews and K.D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

7. J.B. Scarborough, Numerical Mathematical Analysis, Oxford and IBH publishing co.

8. I. Miller and M. Miller, John E. Freund's Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.

9. S. Ross, A First Course in Probability, 9th Ed., Pearson Education India, 2013.

10. R.V. Hogg, J.W. McKean and A.T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.

11. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007

12. A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers.

Discipline Specific Elective Courses Syllabus

MATH-G-DSE1(1)

Abstract & Linear Algebra

End Semester Examination 40 marks & Internal Assessment 10 marks

Abstract Algebra

Unit-1

Set, relation, mapping, definition and elementary problems. Equivalence relation and equivalence classes. Binary operation.

Definition and examples of Groups: additive groups of integer, rational, real and complex numbers, multiplicative group of nonzero rational, real and complex numbers, congruence modulo group ($\mathbb{Z}_n$ and $U(n)$), group of roots of unity, general linear group of order n, symmetric group (give stress to S_3). Elementary properties of Group, order of a group and order of an element in a group, their interrelation.

Definition and examples of subgroup, necessary and sufficient condition and its applications. Cyclic group and its elementary properties.

Unit-2

Definitions and examples of Ring. Subring and ideals, unit elements, zero divisor, integral domains.

Definition and example of fields and their elementary properties. Proof of every finite integral domain is a field. Examples of finite field, characteristic of a field.

Linear Algebra

Unit-3

Definition of vector space over a field, examples. Subspace and necessary and sufficient condition for being a subspace.

Concepts of Linear combinations, linear dependence and independence of vectors. Linear span, basis and dimension of vector spaces. Elementary problems related to these concepts.

Linear transformation, kernel and image of a linear transformation. Definition of rank and nullity, rank-nullity theorem (statement & applications). Matrix representation of a linear transformation.

Unit-4

Eigenvalue and eigenvectors. Characteristic equation.

Cayley-Hamilton theorem (statement only) and its simple applications.

Inner product space and various examples.

Reference Books:

1. J.B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M.K. Sen, S. Ghosh, P. Mukhopadhyay and S. Maiti, Topics in Abstract Algebra, University Press, 2019.

3. J.A. Gallian, Contemporary Abstract Algebra, 4th Ed., 1999.

4. J.J. Rotman, An Introduction to the Theory of Groups, 4th Ed., 1995.

5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

6. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill, 1997.

7. S.H. Friedberg, A.J. Insel, L.E. Spence, Linear Algebra, 4th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

8. G. Strang, Linear Algebra and Its Applications, Cengage Learning, 2005.

9. T. M. Apostol, Calculus, Vol. II, Wiley, 2007.

10. S. Axler, Linear Algebra Done Right, Springer, 2014.

MATH-G-DSE1(2)

Differential Equations II & Mechanics

End Semester Examination 40 marks & Internal Assessment 10 marks

Differential Equations II
Unit-1
Power series solution of differential equation about an ordinary point.

Eigenvalue problem of ODE.

Unit-2
Formation of partial differential equations. Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations.

Solution of partial differential equation of first order, Lagrange's method, Charpit's method.

Mechanics
Unit-3
Center of gravity. Virtual work, principle of virtual work.

Stable and unstable equilibrium. Force field and conservative field. Moment of a force.

Velocity and Acceleration of a particle. Expressions for velocity and acceleration in rectangular Cartesian and polar co-ordinates for a particle moving in a plane. Tangential and normal components of velocity and acceleration of a particle moving along a plane curve. Concept of Force: Statement and explanation of Newton's laws of motion. Work, power and energy. Principles of conservation of energy and momentum. Motion under impulsive forces. Equations of motion of a particle (i) moving in a straight line, (ii) moving in a plane.

Unit-4
Study of motion of a particle in a straight line under (i) constant forces, (ii) variable forces (S.H.M., Inverse square law, Damped oscillation, Forced and Damped oscillation, Motion in an

elastic string). Equation of Energy. Conservative forces.

Motion in two dimensions: Projectiles in vacuum and in a medium with resistance varying linearly as velocity. Motion under forces varying as distance from a fixed point.

Central orbit. Kepler's laws of motion. Motion under inverse square law.

Reference Books:

1. I.N. Sneddon, Elements of Partial Differential Equations, McGraw Hill.
2. S.L. Loney, An Elementary Treatise on the Dynamics of particle and of Rigid Bodies, University Press.
3. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
4. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
5. M.L. Abell and J.P. Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.
6. D. Murray, Introductory Course in Differential Equations, Longmans Green and Co.
7. W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley.
8. G.F. Simmons, Differential Equations, Tata McGraw Hill.
9. T. Myint-U and L. Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Birkhäuser, 2007.
10. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
11. F.H. Miller, Partial Differential Equations, John Wiley and Sons.
12. F. Chorlton, Textbook of Dynamics.
13. S.L. Loney, Elements of Statics and Dynamics I and II.
14. I.H. Shames and G.K.M. Rao, Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
15. R.C. Hibbeler and A. Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.
16. A.S. Ramsay, Statics, CBS Publishers & Distributors.
17. A.S. Ramsay, Dynamics, CBS Publishers & Distributors.

MATH-G-DSE2(1)

Real & Complex Analysis

End Semester Examination 40 marks & Internal Assessment 10 marks

Real Analysis

Unit-1

Concept of Point-wise and Uniform convergence of sequence of functions and series of functions with special reference of Power Series. Statement of Weierstrass M-Test for Uniform convergence of sequence of functions and of series of functions. Simple applications.

Statement of important properties like boundedness, continuity, differentiability and integrability of the limit function of uniformly convergent sequence of functions and of the sum function of uniformly convergent series of functions. Determination of Radius of convergence of Power Series.

Statement of properties of continuity of sum function power series. Term by term integration and Term by term differentiation of Power Series. Statements of Abel's Theorems on Power Series. Convergence of Power Series. Expansions of elementary functions such as e^x, $\sin x$, $\log(1+x)$, $(1+x)^n$. Simple problems.

Unit-2

Periodic Fourier series on $(-l, l)$: Periodic function. Determination of Fourier coefficients. Statement of Dirichlet's conditions of convergence and statement of the theorem on convergence of Fourier Sine and Cosine series.

Unit-3

Laplace Transform and its application to ordinary differential equation. Laplace Transform and Inverse Laplace Transform. Statement of Existence theorem. Elementary properties of Laplace Transform.

Inverse Laplace transform, convolution. Application to the solution of ordinary differential equation of second order with constant coefficients.

Complex Analysis

Unit-4

Complex numbers and its algebra. Modulus, amplitude and polar representation of complex numbers. Regions in the complex plane, functions of complex variable, mappings and its representation.

Limits, limits involving the point at infinity, continuity. Complex differentiation, Cauchy-Riemann equations, sufficient conditions for differentiability and related problems.

Analytic functions. Harmonic function, evaluation of Harmonic conjugates.

Reference Books:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. G.G. Bilodeau , P.R. Thie and G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. B.S. Thomson, A. M. Bruckner and J.B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.

5. T.M. Apostol, Mathematical Analysis, Narosa Publishing House.
6. R. Courant and F. John, Introduction to Calculus and Analysis, Vol I, Springer.
7. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill.
8. T. Tao, Analysis I, Hindustan Book Agency, 2006
9. R.R. Goldberg, Methods of Real Analysis, Oxford and Ibh, 2012.
10. P.P.G. Dyke, An Introduction to Laplace Transforms and Fourier Series, Springer, 2001.
11. J. Bak and D.J. Newman, Complex Analysis, Springer.
12. D. Zill, A first course in Complex Analysis with Applications, Jones & Bartlett, 2003.
13. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill International Edition, 2009.
14. S. Ponnusamy, Foundations of complex analysis, Narosa Publishing House.
15. E.M. Stein and R. Shakrachi, Complex Analysis, Princeton University Press.

MATH-G-DSE2(2)

Linear Programming Problems & Game Theory

End Semester Examination 40 marks & Internal Assessment 10 marks

Linear Programming Problems

Unit-1

Motivation of Linear Programming problem. Statement of L.P.P. Formulation of L.P.P. Slack and Surplus variables. L.P.P. is matrix form. Graphical method of solving LPP.

Convex set, Hyperplane, Extreme points, convex Polyhedron, Basic solutions and Basic Feasible Solutions (B.F.S.). Degenerate and Non-degenerate B.F.S. The set of all feasible solutions of an L.P.P. is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme print of the convex set of feasible solutions, A B.F.S. to an L.P.P. corresponds to an extreme point of the convex set of feasible solutions.

Unit-2

Fundamental Theorem of L.P.P. (Statement only) Reduction of a feasible solution to a B.F.S. Standard form of an L.P.P. Solution by simplex method and method of penalty.

Concept of Duality. Duality Theory. The dual of the dual is the primal. Relation between the objective values of dual and the primal problems. Dual problems with at most one unrestricted variable, one constraint of equality.

Unit-3

Transportation problem their optimal solutions.

Assignment problem.

Game Theory
Unit-4
Concepts of game theory, rectangular game, pure and mixed strategy.

Principal of dominance. Finding out optimal strategy.

Graphical method of solving game theory problems.

Reference Books:

1. M.S. Bazaraa, J.J. Jarvis and H.D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. H.A. Taha, Operations Research, An Introduction, 8th Ed., Prentice Hall India, 2006.
4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
5. P.K. Dutta, Strategies and games: theory and practice, MIT Press, 1999.
6. L.F. Fernandez and H.S. Bierman, Game theory with economic applications, Addison-Wesley, 1998.
7. R.D. Gibbons, Game theory for applied economists, Princeton University Press, 1992.

Skill Enhancement Courses Syllabus

MATH-G-SEC01

Number Theory & Boolean Algebra

End Semester Examination 40 marks & Internal Assessment 10 marks

Number Theory

Unit-1

Integers: Principle of Mathematical Induction. Division Algorithm. Representation of integer in an arbitrary base. Prime Integers. Fundamental theorem of Arithmetic. Euclid's Theorem. Linear Diophantine equations.

Congruences: Congruence relation on integers, Basic properties of this relation. Linear Congruence. Chinese Remainder Theorem, System of Linear Congruences.

Unit-2

Application of Congruences: Divisibility test. Computer file, Starage and Hashing functions. Round-Robin Tournaments. Check-digit in an ISBN, in Universal Product code, in Major Credit Cards. Error detecting capability.

Congruence Classes: Addition and Multiplication of Congruence Classes. Fermat's little Theorem. Euler's Theorem. Wilson's Theorem. Some simple applications.

Boolean Algebra

Unit-3

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

Unit-4

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

Reference Books

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, 1990.
2. E.G. Goodaire and M.M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. R. Lidl and G. Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. D.M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.

5. N. Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007

6. G.A. Jones and J.M. Jones, Elementary Number Theory, Springer International Edition.

7. N. Koblitz, A course in number theory and cryptography, Springer-Verlag, 2nd edition.

8. K.H. Rosen, Elementary Number Theory & Its Applications, AT&T Bell Laboratories, Addition-Wesley Publishing Company, 3rd Edition.

9. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, 2nd edition, Springer-verlag.

10. R.A. Mollin, Advanced Number Theory with Applications, CRC Press, A Chapman & Hall Book.

MATH-G-SEC02

Discrete Mathematics

End Semester Examination 40 marks & Internal Assessment 10 marks

Unit-1

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-2

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

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-4

Partial ordering relations, n- ary relations, Hasse diagram, greatest and least element in a poset. Lattice, distributive lattice, boolean algebra.

Reference Books

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

2. P.R. Halmos, Naive Set Theory, Springer, 1974.

3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

MATH-G-SEC03

Mathematical Statistics & Its Applications

End Semester Examination 40 marks & Internal Assessment 10 marks

Unit-1

Elements of Statistical Methods. Variables, Attributes. Primary data and secondary data, Population and sample. Census and Sample Survey. Tabulation Chart and Diagram, Graph, Bar diagram, Pie diagram etc. Frequency Distribution Un-grouped and grouped cumulative frequency distribution. Histogram, Frequency curve, Measures of Central tendencies. Averages: AM, GM, HM, Mean, Median and Mode (their advantages and disadvantages). Measures of Dispersions - Range, Quartile Deviation, Mean Deviation, Variance / S.D., Moments, Skewness and Kurtosis.

Unit-2

Meaning and objects of sampling. Some ideas about the methods of selecting samples, statistic and parameter, sample mean and sample variance. Distribution of mean, central limit theorem, distribution of variance, Chi-square distribution, F-distribution and t-distribution.

Unit-3

Estimation and Test of Significance. Statistical Inference. Theory of estimation Point estimation and Interval estimation. Confidence Interval / Confidence Limit. Statistical Hypothesis Null Hypothesis and Alternative Hypothesis. Level of significance. Critical Region. Type I and II error. Problems.

Unit-4

Bivariate Frequency Distribution. Scatter Diagram, Co-relation co-efficient, definition and properties. Simple regression models, ordinary least square method.

Reference Books:

1. W. Feller, An introduction to Probability Theory and its Application, Volume 1, 3rd Ed.
2. R.V. Hogg, J.W. McKean and A.T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
3. I. Miller, M. Miller and J.E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
4. S. Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
5. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw-Hill, Reprint 2007.
6. A.M. Goon, M.K. Gupta and B. Dasgupta, Fundamental of Statistics, Vol 1 & Vol 2, World Press.
7. A. Gupta, Ground work of Mathematical Probability and Statistics, Academic publishers.

MATH-G-SEC04

Basic Computer Programming(C)

End Semester Examination 40 marks & Internal Assessment 10 marks

Unit-1
An overview of theoretical computers, history of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language and importance of C programming.

Constants, Variables and Data type of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration.

Unit-2
Operation and Expressions: Arithmetic operators, relational operators, logical operators.

Decision Making and Branching: decision making with if statement, if-else statement, nested if-else statement, switch statement, break and continue statement.

Unit-3
Control Statements: While statement, do-while statement, for statement.

Arrays: One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.

Unit-4
User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, nested of functions, passing of arrays to functions, Recurrence of function.

Introduction to Library functions: stdio.h, math.h, string.h stdlib.h, time.h etc.

List of hands on examples

1. Calculate the sum $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{N}$
2. Calculate the sum of infinite series $x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots\cdots$
3. Calculate the sum of infinite series $1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \cdots\cdots$
4. Calculate the sum of infinite series $1 + \frac{x^1}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \cdots\cdots$
5. Find the factorial of a non-negative integer (Recursive function).
6. Print the Fibonacci numbers upto N-th term.
7. Find the maximum/minimum of N given numbers.
8. Enter N numbers into an array and sort them in an ascending/decending order.
9. HCF (Division Method) and LCM (Factorization Method) of two/three positive integers.
10. Separate even and odd numbers from first N natural numbers.
11. Find all the prime numbers between 1 and N (N being a positive integer).
12. Find the binary representation of a decimal number.
13. Find the decimal representation of a binary number.

14. Find the octal representation of a decimal number.
15. Find the decimal representation of a octal number.
16. Transpose of a matrix.
17. Addition, subtraction of two matrices.
18. By generating pseudo-random numbers find the probability of head of a unbiased coin.
19. By generating pseudo-random numbers find the probability of occurrence '6' of a die.

Reference Books:

1. B.W. Kernighan and D.M. Ritchi, The C-Programming Language, 2nd Edi.(ANSI Refresher), Prentice Hall, 1977.
2. P. Prinz and T. Crawford, C in a Nutshell, O'Reilly Media, 2005.
3. E. Balagurnsamy, Programming in ANSI C, Tata McGraw Hill, 2004.
4. Y. Kanetkar, Let Us C, BPB Publication, 1999.
5. C. Xavier, C-Language and Numerical Methods, New Age International.
6. V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India, 1980.