Department of Mathematics
Faculty of Natural Science, Jamia Millia Islamia, New Delhi-25

Course Structure of U.G. under CBCS
(For Honours Only)

Semester – I

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BHM-1.3C	Bio-Mathematics	4	4	25	75	100

Semester – II

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BHM-2.3C	Geometry of Two and Three Dimensions	4	4	25	75	100

Semester – IV

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BHM-4.4C_1	Mathematical Modelling	4	4	25	75	100
2	BHM-4.4C_2	Logic and Sets	4				

Semester – V

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BHM-5.4C_1	Probability and Statistics	4	4	25	75	100
2	BHM-5.4C_2	Industrial Mathematics	4				

Semester – III (Ability Enhancement)

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BHM-3.4AE	Programming in C *	4	4	25	75	100

** practical to be performed in Lab.*

Semester – VI (Skills Enhancement)

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BHM-6.4SE_1	Object Oriented Programming Using C++ *	4	4	25	75	100
2	BHM-6.4SE_2	Applications of Algebra	4				

** practical to be performed in Lab.*

U.G. - CBCS (Hons.), Semester – I

BHM-1.3C	**Bio-Mathematics**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Mathematical Biology and the modelling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, Bacterial growth in a Chemostat, Harvesting a single natural population.

Unit-II Epidemic Models (SI, SIR, SIRS, SIC), Activator-Inhibitor system, Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria, Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

Unit-III Spatial Models: One species model with diffusion, Two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population. Discrete Models: Overview of difference equations, steady state solution and linear stability analysis.

Unit-IV Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting, Host-Parasitoid systems (Nicholson-Bailey model), Numerical solution of the models and its graphical representation. Case Studies: Optimal Exploitation models, Models in Genetics, Stage Structure Models, Age Structure Models.

Books Recommended:

1. L.E. Keshet, *Mathematical Models in Biology*, SIAM, 1988.
2. J.D., Murray, *Mathematical Biology*, Springer, 1993.
3. Y.C. Fung, *Biomechanics*, Springer-Verlag, 1990.
4. F. Brauer, P.V.D. Driessche, and J. Wu, *Mathematical Epidemiology*, Springer, 2008.
5. M. Kot, *Elements of Mathematical Ecology*, Cambridge University Press, 2001.

U.G. - CBCS (Hons.) , Semester – II

BHM-2.3C	Geometry of Two and Three Dimensions	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I General equation of second degree, Pair of lines, Parabola, Tangent, normal. Pole and polar and their properties. Ellipse, Hyperbola, Tangent, normal, pole and polar. Conjugate diameters, Asymptotes, Conjugate hyperbola and rectangular hyperbola.

Unit-II Polar equation of a conic, Polar equation of tangent, normal, polar and asymptotes, General equation of second degree, Tracing of parabola, Ellipse and hyperbola.

Unit-III Equation of sphere, Tangent plane, Plane of contact and polar plane, Intersection of two spheres, radical plane, Coaxial spheres, Conjugate systems, Equation of a cone, Intersection of cone with a plane and a line, Enveloping cone, Right circular cone

Unit-IV Equation of cylinder, Enveloping and right circular cylinders, Equations of central conicoids, Tangent plane, Normal, Plane of contact and polar plane, Enveloping cone and enveloping cylinder, Conjugate diameters and diametral planes, Equations of paraboloids and its simple properties.

Books Recommended:

- S. L. Loney: *The elements of coordinate geometry*, by Michigan Historical Reprint Series.
- Ram Ballabh: *Text book of Coordinate Geometry*.
- Shanti Narayan, *Analytical Solid Geometry,* S. Chand and Company.
- P.K. Jain and Khalil Ahmad: *Textbook of Analytical Geometry,* New Age International (P) Ltd. Publishers.

U.G. - CBCS (Hons.) , Semester – IV

BHM-4.4C$_1$	**Mathematical Modelling**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Introduction- Definition & Simple situations for Mathematical Modelling, Technique of Mathematical Modelling, Classification of Mathematical Models, Some characteristic of Mathematical Models. Mathematical models based on Geometry, Algebra and Calculus. Limitations of Mathematical Modelling.

Unit-II Mathematical Models through ODE: Linear Growth and Decay Models, Non-linear Growth and Decay Models, Compartmental Models, M.M. in Population Growth, Epidemics through Systems, Compartment Models through system of ODE, Modelling in Economics through systems of ODE. MM for planetary motions, MM for Circular motion and motion of satellites.

Unit-III Difference Equations with Applications: Formation of diff. equations. First order difference equations: Homogeneous, Non-homogeneous, The equations of the form $xx_{n+1} - bx_n = a$, method of Undetermined Coefficients. Second order linear difference equations: Homogeneous equations, Auxiliary equation, non-homogeneous equations. Applications of difference equations (Models)

Unit-IV Integral Equations: Definition of Integral equation. Fredholm and Volterra integral equations. Conversion of linear diff. equation to an integral equation and vice versa with examples. Conversion of boundary value problems to integral equations using Green's Function. Integral equations of the convolution type. Integro-diff. equations. Solution of Fredholm equations with separable kernels.

References:

1. Mathematical Modelling by J.N.Kapur New Age Publications
2. UMAP-Module 322: Published in cooperation with the Society for Industrial and Applied Mathematics
3. Higher Engineer Mathematics by B.S.Grewal, Khanna Publication.

BHM-4.4C$_2$	**Logic and Sets**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Introduction, Propositions, Truth table, Negation, Conjunction and Disjunction, Implications, Bi-conditional propositions, Converse, Contra positive and Inverse propositions and Precedence of logical operators.

Unit-II Propositional equivalence: Logical equivalences, Predicates and Quantifiers: Introduction, Quantifiers, Binding variables and Negations, Sets, Subsets, Set operations and the laws of set theory and Venn diagrams, Examples of finite and infinite sets.

Unit-III 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.

Unit-IV Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-ary relations.

References:

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.

U.G. - CBCS (Hons.) , Semester – IV

BHM-5.4C$_1$	**Probability and Statistics**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Sample space and events, algebra of events, axiomatic approaches, conditional probability, basic laws of total probability and compound probability, Bayes' theorem, Prior probabilities (priori) and posterior probabilities.

Unit-II Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function, Binomial, Poisson, Normal and Rectangular distributions.

Unit-III Two-dimensional random variables, joint distribution functions, marginal distributions, covariance, linear regression and correlation, rank correlation, least square method of fitting regression lines.

Unit-IV Sampling, random sampling, large sample tests of means and proportion. t-student, χ^2 (chi square) and F distributions (without derivation) and testing of hypothesis based on them.

References

1. Irwin Miller and Marylees Miller**,** *John E. Freund's Mathematical Statistics with Applications*, Pearson Education.
2. Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean, *Introduction to Mathematical Statistics*, Pearson Education
3. Sheldon M. Ross, *Introduction to probability and statistics for engineers and scientists*, Elsevier Academic Press.
4. J.N. Kapur and H.C. Saxena, *Mathematical Statistics*, S. Chand.
5. P.N.Arora, *Comprehensive Statistical Methods*, S.Chand.

U.G. - CBCS (Hons.) , Semester – IV

BHM-5.4C$_2$	**Industrial Mathematics**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Medical Imaging and Inverse Problems: The content is based on Mathematics and X-ray and CT scan based on knowledge of calculus differential equations, complex numbers and matrices.

Unit-II Introduction to Inverse Problems: Why should we teach inverse problems? Illustration of inverse problems through pre-calculus, calculus, Matrices and differential equations. Geological anomalies in Earth's interior from measurements and its surface(Inverse problems for Natural disaster) and Tomography.

Unit-III X ray introduction, X ray behaviour and Beers Law (The fundamental question and image construction) Lines in the place. Random Transform: Definition and examples, Linearity, Phantom(Shepp-Logan Phatom-Mathematical phantoms) Back Projection: Definition, Properties and examples

Unit-IV CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.

References

1. Timothy G. Feeman, The Mathematics for medical imaging. A beginner's guide, Springer Under graduate Text in Mathematics and Technology, Springer 2010.
2. C.W. Groetsch. Inverse problems. Activities for undergraduates, the Mathematical Association of America, 1999.
3. Andreas Kirsch. An Introduction to the Mathematical Theory of Inverse Problems, 2nd Edn. Springer, 2011

Semester – III (Ability Enhancement)

BHM-3.4AE	**Programming in C**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Number system – binary, octal, decimal, hexadecimal, conversions among different number systems, Programming languages, low and high level programming languages, compiler, interpreter, algorithms and flowcharts

Unit-II Character set, Identifiers and Keywords, Constants, Variables, Declaration & Definition, Data Types, Operators, basic structure of C programming, If, Nested if, if-else-if, Switch, for loop, while loop, do-while loop, break, continue, goto statement.

Unit-III Pre-processor directives, Library functions, need for user define functions, Function prototyping, Definition of Function, Passing arguments to a function using Call by reference & Call by value, Returning multiple values, Recursion, Recursive Functions, Concept of Scope & lifetime, Storage classes - auto, register, static, extern.

Unit-IV Declaring Defining and Initializing array, Accessing elements of array, passing arrays to functions, Introduction to multidimensional arrays, strings, Pointers Declarations, Initializing Pointer, De-referencing Pointer, Structures, Overview of File handling.

References

1. E. Balagurusamy , Programming in ANSI C, McGraw-Hill.
2. Yashavant Kanitkar, Let Us C, BPB Publications.
3. Gottfried, Byron S., Programming with C, McGraw Hill.

Semester – VI (Skills Enhancement)

BHM-6.4SE$_1$	**Object Oriented Programming Using C++**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	3(T) + 1(P)	4

Prerequisite: Knowledge of C Language.

Unit-I Object Oriented Paradigm: Comparison of Programming Paradigms, Characteristics of Object-Oriented Programming Languages, Object-Based programming Languages, Brief History of C++, Structure of a C++ Program, Difference between C and C++ , cin, cout, new, delete operators, ANSI/ISO Standard C++.

Unit-II Implementing OOPS concepts in C++, Objects and Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, using Reference Variables with Functions, Abstract Data Types, Constructors - Default and Copy Constructor, Assignment Operator Deep and Shallow Copying, Concepts of Name Spaces, This Pointer.

Unit-III Access Modifiers – Private, Public and Protected. Implementing Class Functions within Class declaration or outside the Class declaration, Instantiation of objects, Scope Resolution Operator, Working with Friend Functions, using Static Class Members. Understanding Compile Time Polymorphism, Function Overloading.

Unit-IV Operator Overloading as Member Function and Friend Function. Inheritance Basics, Types of Inheritance – Simple, Multilevel, Multiple, Hierarchical and Hybrid, Virtual Class, Upcasting & Downcasting, Virtual Function, Pure Virtual Function.

References

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, **M*astering C*++**, TMH, 1997.
2. S. B. Lippman and J. Lajoie, ***C++ Primer***, 3rd Ed., Addison Wesley, 2000.
3. Bruce Eckel, ***Thinking in C++***, 2nd Ed., President, Mindview Inc., Prentice Hall.
4. D. Parasons, ***Object Oriented Programming with C++***, BPB Publication.
5. Bjarne Stroustrup , ***The C++ Programming Language***, 3rd Ed., Addison Welsley.
6. Steven C. Lawlor, ***The Art of Programming Computer Science with C++***, Vikas
1. Publication.
7. Schildt Herbert, ***C++: The Complete Reference***, 4th Ed., Tata McGraw Hill, 1999.

Semester – VI (Skills Enhancement)

BHM-6.4SE$_2$	**Applications of Algebra**	**Unit**	**Credit**	**Lecture/ week**
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Balanced incomplete block designs (BIBD): definitions and results, Incidence matrix of BIBD, Construction of BIBD from difference sets, Construction of BIBD using quadratic residues, Difference set families, Construction of BIBD from finite fields, Coding Theory: introduction to error correcting codes, Linear codes, Generator and parity check matrices, Minimum distance, Hamming codes, Decoding and cyclic codes.

Unit-II Symmetry groups and Color patterns: Review of permutation groups, Groups of symmetry and action of a group on a set, Colouring and colouring patterns, Polya theorem and pattern inventory, Generating functions for non–isomorphic graphs, Projection tri diagonal matrices, Circulant matrices, Vandermonde matrices, Hadmard matrices, Permutation and doubly stochastic matrices

Unit-III Frobenius – Konig theorem, Birkhoff theorem, Positive semi-definite matrices , Square root of a positive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous Diagonalization, Diagonalization of symmetric matrices, Quadratic forms, constrained optimization, Singular value decomposition, and applications to image processing and statistics.

Unit-IV Applications of linear transformations: Fibonacci numbers, Incidence models, and differential equations, Least square models: Approximate solution of system of linear equations, Approximate inverse of m x n matrix, Solving a matrix equation using its normal equation, Finding functions that approximate data.

References

1. I. N. Herstein and D. J. Winter, primer on Linear Algebra, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S.K. Jain, Topics in Applied Abstract Algebra, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, Applications of Abstract Algebra with Maple, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, Linear Algebra and its Applications. 3rd Ed., pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, Matrix theory, Springer-Verlag New York, Inc., New York, 1999.