B.Sc.(Hons.) Mathematics
(2016-17)

Course Structure		
Semester- I	Semester- II	Semester- III
Semester- IV	Semester- V	Semester- VI

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

COURSE STRUCTURE

Code	Title of Paper	Unit	Credit	Maximum Marks
Semester – I				
BHM-111	Calculus	4	4	100
BHM-112	Analytical Geometry	4	4	100
BHM-113 (GE-1) *#	C1. Set Theory and Number Theory C2. Computer Fundamentals	4	4	100
BHM-114 (AE-1)	English/MIL Communication	4	4	100
Semester – II				
BHM-211	Differential Equations	4	4	100
BHM-212	Statistical Techniques	4	4	100
BHM-213 (GE-2) *#	C1. Programming in C (P) C2. Econometrics	4	4	100
BHM-214 (AE-2)	English/MIL Communication	4	4	100
Semester – III				
BHM-311	PDE and System of ODE	4	4	100
BHM-312	Numerical Methods	4	4	100
BHM-313	Group Theory	4	4	100
BHM-314 (GE-3) *#	C1. Information Security C2. OOPs in C++ (P)	4	4	100
BHM-315 (SE-1) *#	C1. Latex & Web Designing C2. Computer Graphics	4	4	100
Semester – IV				
BHM-411	Real Analysis	4	4	100
BHM-412	Ring Theory	4	4	100
BHM-413	Linear Programming	4	4	100
BHM-414 (GE-4)*#	C1. Mathematical Modelling C2. Data Structures (P)	4	4	100
BHM-415 (SE-2) *#	C1. Graph Theory C2. Fuzzy Sets and Logics	4	4	100
Semester – V				
BHM-511	Riemann Integration and Series of Functions	4	4	100
BHM-512	Multivariate Calculus	4	4	100
BHM-513	Metric Spaces	4	4	100
BHM-514	Linear Algebra	4	4	100
BHM-515 (DS-1)*#	C1. Modelling and Simulation C2. Discrete Mathematics	4	4	100
BHM-516 (DS-2) *#	C1.Mathematical Finance C2. Dynamical Systems	4	4	100
Semester – VI				
BHM-611	Integral Equations and Calculus of Variations	4	4	100
BHM-612	Complex Analysis	4	4	100
BHM-613	Differential Geometry	4	4	100
BHM-614	Mechanics	4	4	100
BHM-615 (DS-3) *#	C1. Boolean Algebra and Automata Theory C2. Bio-Mathematics	4	4	100
BHM-616 (DS-4) *#	C1. Industrial Mathematics C2. Applications of Algebra	4	4	100

GE- Generic Elective, AE- Ability Enhancement, SE- Skill Enhancement, DS- Discipline Specific

***Choose any one. # Subject to the availability of teacher.**

B.Sc. (Hons.) Mathematics
Semester – I
Course Structure

Code	Title of Paper	Unit	Credit	Maximum Marks
BHM-111	**Calculus**	**4**	**4**	**100**
BHM-112	**Analytical Geometry**	**4**	**4**	**100**
BHM-113 (GE-1)	C1. **Set Theory and Number Theory** C2. **Computer Fundamentals**	**4**	**4**	**100**
BHM-114 (AE-1)	**English/MIL Communication**	**4**	**4**	**100**

B.Sc. (Hons.) Mathematics
Semester – I
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-111	**Calculus**	**4L**	**25**	**75**

Unit-I Limit and Continuity by $\varepsilon - \delta$ approach, Differentiability, Successive differentiation, Leibnitz Theorem, Rolle's Theorem, Mean Value Theorems, Taylor and Maclaurin series.

Unit-II Indeterminate forms, Curvature, Cartesian, Polar and parametric formulae for radius of curvature, Partial derivatives, Euler's theorem on homogeneous functions.

Unit-III Asymptotes, Test of concavity and convexity, Points of Inflexion, Multiple points, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves.

Unit-IV Derivations and illustrations of reduction formulae of the various types. Volumes by slicing; disks and washers methods, volumes by cylindrical shells, parametric equations, arc length, arc length of parametric curves, surfaces of solids of revolution.

Books Recommended

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. (Pearson Education), 2007.
3. H. Anton, I. Bivens and S. Davis: *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. Gorakh Prasad: *Differential Calculus*, Seventeenth Edition, Reprint 2007
5. Khalil Ahmad: *Text Book of Calculus*, World Education Publishers, 2012.

B.Sc. (Hons.) Mathematics
Semester – I
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-112	**Analytical Geometry**	**4L**	**25**	**75**

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.

Unit-II Asymptotes, Conjugate hyperbola and Rectangular hyperbola, Polar equation of a conics, Polar equation of tangent, normal, polar and asymptotes, Tracing of parabola, Ellipse and hyperbola.

Unit-III Review of straight lines and planes, Equation of sphere, Tangent plane, Plane of contact and polar plane, Intersection of two spheres, radical plane, Coaxial spheres, 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, Equations of paraboloids and its simple properties.

Books Recommended:

1. Ram Ballabh: *Textbook of Coordinate Geometry*, Prakashan Kendra.
2. S. L. Loney: *The elements of Coordinate Geometry*, Michigan Historical Reprint Series.
3. P.K. Jain and Khalil Ahmad: *Textbook of Analytical Geometry*, New Age International (P) Ltd. Publishers, 1986.
4. R. J. T. Bell: *Elementary Treatise on Coordinate Geometry of Three Dimensions*, Macmillan India Ltd., 1994.
5. E. H. Askwith: *A Course of Pure Geometry*, Merchant Books, 2007.

B.Sc. (Hons.) Mathematics
Semester – I
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-113 (GE-1) C1	**Set Theory and Number Theory**	**4L**	**25**	**75**

Unit-I Cartesian products of sets, equivalence relations and partition, fundamental theorem of equivalence relation, equivalent set, countable sets and uncountable sets, cantor's theorem

Unit-II Cardinal numbers, power of continuum, cardinal arithmetic, inequalities in cardinals, Schoeder-Bernstein theorem, partially and totally ordered sets

Unit-III Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruencies, complete set of residues, Algebraic congruencies Chinese Remainder theorem, Fermat's Little theorem, Lagrange theorem, Wilson's theorem.

Unit-IV Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruencies with composite moduli.

Books Recommended:

1. David M. Burton: *Elementary Number Theory*, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robinns: *Beginning Number Theory, 2nd Ed*., Narosa Publishing House Pvt. Ltd., Delhi, 2007.
3. Seymour Lipschutz : *Set Theory and related topics.* McGraw-Hill Education; 2nd edition, 1998.
4. J. Hunter: *Number Theory*, Oliver & Boyd, Edinburgh and London, 1964.

B.Sc. (Hons.) Mathematics
Semester – I
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-113 (GE-1) C2	**Computer Fundamentals**	**4L**	**25**	**75**

Unit-I Introduction to Computers, Characteristics of Computers, Generations of Computer, Block Diagram of a Computer, Functions of the Different Units - Input unit, Output unit, Memory unit, CPU (Control Unit , ALU). Data vs Information, Hardware vs Software, flowcharts, algorithms.

Unit-II Number Systems: Introduction, Types of Number System: Binary, Octal, Decimal, Hexadecimal, Conversions from One Base to Another, r's complement, (r-1)'s complement, Addition and Subtraction operations in different number system, Binary-coded Decimals (BCD), Gray Code.

Unit-III Input Devices: Keyboard, Point and draw devices-mouse, joystick, track ball, light pen; Data Scanning devices-image scanner, OCR, OMR, MICR, Bar code reader, card reader. Output Devices: Monitor, Printers: laser printer, dot-matrix printer, ink jet printer. Levels of Memories: Registers, Cache Memory, Primary Storage, Secondary Storage. Primary Memory: RAM, ROM and types. Secondary Memories: Floppy drive, CD/DVD, Flash drive, Hard disk, Structure of a hard disk, concept of tracks, sectors, cylinders.

Unit-IV Classifications of Software: System Software, Application Software, Embedded Softwares etc… Programming languages- Machine language, Assembly language, High level language, types of high level languages, Translators – Compiler, Interpreter. Operating System, Functions of Operating System, Types of Operating Systems. Introduction to Computer Networks, Internet and World Wide Web, FTP, Electronic Mail.

Books Recommended:

1. P. K. Sinha and Priti Sinha: *Computer Fundamentals*, BPB, 2007.
2. V. Rajaraman and N.Adabala: *Fundamentals of Computers*, *6th Revised Edition*, PHI, 2014.
3. E. Balagurusamy: *Fundamentals of Computers*, McGraw Hill Education, 2009.
4. Anita Goel: *Computer Fundamentals*, Pearson Education, 2010.

B.Sc. (Hons.) Mathematics
Semester – I
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-114 (AE-1)	**English/MIL Communication**	**4L**	**25**	**75**

Unit-I

Unit-II

Unit-III

Unit-IV

B.Sc. (Hons.) Mathematics
Semester – II
Course Structure

Code	Title of Paper	Unit	Credit	Maximum Marks
BHM-211	**Differential Equations**	**4**	**4**	**100**
BHM-212	**Statistical Techniques**	**4**	**4**	**100**
BHM-213 (GE-2)	**C1. Programming in C (P)** **C2. Econometrics**	**4**	**4**	**100**
BHM-214 (AE-2)	**English/MIL Communication**	**4**	**4**	**100**

B.Sc. (Hons.) Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-211	**Differential Equations**	**4L**	**25**	**75**

Unit-I Formulation of differential equations, Order and degree of a differential equation, equations of first order and first degree, solutions of equations in which variables are separable, Homogeneous equations, Linear equations and Bernoulli equations, Exact differential equations, integrating factors, Change of variables.

Unit-II Equations of the first order and higher degree, Equations solvable for *p, y* and *x,* Clairaut equation, Lagrange's equation, Trajectories.

Unit-III Linear differential equations with constant coefficient, Complementary function and particular integral. Particular integral of the forms e^{ax}, $\sin ax$, $\cos ax$, x^m and $e^{ax}V$, Homogeneous linear equations.

Unit-IV Linear differential equations of second order, Complete solution in terms of known integral belonging to the complementary function, Normal form, Change of independent variable, Method of undetermined coefficients, Method of variation of parameters, Simultaneous equations with constant coefficients, Simultaneous equations of form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$.

Books Recommended:

1. C. H. Edwards and D. E. Penny: *Differential Equations and Boundary Value Problems: Computing and Modelling*, Pearson education, India 2005.
2. Dennis G. Zill: *A First Course in Differential Equations with Modeling Applications,* Cengage Learning; 10 edition, 2012.
3. S. L. Ross: *Differential equations*, John Wiley and Sons, 2004.
4. Zafar Ahsan: *Textbook of Differential Equations and their Applications*, Prentice Hall of India, 2004.
5. Khalil Ahmad: *Textbook of Differential Equations*, World Education Publishers, 2012.

B.Sc. (Hons.) Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-212	**Statistical Techniques**	**4L**	**25**	**75**

Unit-I Probability: Basic concepts and definitions (Classical and Axiomatic definition), 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. Various discrete and continuous probability distributions: Uniform (continuous and discrete), Binomial, Negative Binomial, Poisson, Exponential, 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 Statistical Testing and Estimation Techniques: Properties of good estimator-unbiasedness, Minimum variance unbiased estimators, Method of Maximum likelihood, Confidence Intervals for mean, variance and proportions. Large sample tests for mean and proportion, chi square test for goodness of fit, Tests based on t and F-distributions.

Reference Books

1. Irwin Miller and Marylees Miller**,** *John E. Freund's: Mathematical Statistics with Applications*, Pearson Education, 2012
2. Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean: *Introduction to Mathematical Statistics*, Pearson Education, 2012.
3. Sheldon M. Ross: *Introduction to Probability and Statistics for Engineers and Scientists*, Elsevier Academic Press, 2009.
4. V.K Rohtagi and A.K. Saleh: *An Introduction to Probability and Statistics*, 2nd Ed., John Wiley & Sons, 2005.
5. A.M. Goon, M.K. Gupta and T.S. Dasgupta: *Fundamentals of Statistics* (Vol. I), 7th Ed., The World Press Pvt. Ltd., 2000.
6. Neil A. Weiss: *Introductory Statistics*, 7th Ed., Pearson Education, 2007.

B.Sc. (Hons.) Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-213 (GE-2) C1	**Programming in C (P)**	**4L**	**25**	**75**

Unit-I Number system – binary, octal, decimal, hexadecimal, conversions among different number systems, addition and subtraction of binary numbers, 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 value & Call by reference, 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.

Books Recommended:

1. Gottfried, Byron S: *Programming with C*, Tata McGraw Hill, 2006.
2. E. Balagurusamy, *Programming in ANSI C*, McGraw-Hill Education, 2002.
3. Y. Kanitkar, *Let Us C*, BPB Publications, 2006.

B.Sc. (Hons.) Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-213 (GE-2) C2	**Econometrics**	**4L**	**25**	**75**

Unit-I Statistical Concepts Normal distribution; chi-square, t- and F-distributions; estimation of parameters; properties of estimators; testing of hypotheses: defining statistical hypotheses; distributions of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples.

Unit-II Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting.

Unit-III Multiple Linear Regression Model Estimation of parameters; properties of OLS estimators; goodness of fit - R2 and adjusted R2; partial regression coefficients; testing hypotheses – individual and joint; functional forms of regression models; qualitative (dummy) independent variables.

Unit-IV Violations of Classical Assumptions: Consequences, Detection and Remedies Multicollinearity; heteroscedasticity; serial correlation. Specification Analysis Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.

Books Recommended:

1. Jay L. Devore: *Probability and Statistics for Engineers*, Cengage Learning, 2010.
2. John E. Freund: *Mathematical Statistics*, Prentice Hall, 1992.
3. Richard J. Larsen and Morris L. Marx: *An Introduction to Mathematical Statistics and its Applications*, Prentice Hall, 2011.
4. D.N. Gujarati and D.C. Porter: *Essentials of Econometrics*, 4th Ed., McGraw Hill, International Edition, 2009.
5. Christopher Dougherty: *Introduction to Econometrics*, 3rd Ed., Oxford University Press, Indian edition, 2007.

B.Sc. (Hons.) Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-214 (AE-2)	**English/MIL Communication**	**4L**	**25**	**75**

Unit-I

Unit-II

Unit-III

Unit-IV

B.Sc. (Hons.) Mathematics
Semester – III
Course Structure

Code	Title of Paper	Unit	Credit	Maximum Marks
BHM-311	**PDE and System of ODE**	**4**	**4**	**100**
BHM-312	**Numerical Methods**	**4**	**4**	**100**
BHM-313	**Group Theory**	**4**	**4**	**100**
BHM-314 (GE-3)	**C1. Information Security** **C2. OOPs in C++ (P)**	**4**	**4**	**100**
BHM-315 (SE-1)	**C1. Latex & Web Designing** **C2. Computer Graphics**	**4**	**4**	**100**

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-311	**PDE and System of ODE**	**4L**	**25**	**75**

Unit-I Total differential equations, Simultaneous total differential equations, Equations of the form $dx/P = dy/Q = dz/R$, Methods of grouping and multipliers, Solution of a system of linear differential equation with constant coefficients, An equivalent triangular system.

Unit-II Formation and solution of partial differential equations, Equations easily integrable. Linear partial differential equations of first order- Lagrange's equation, Non-linear partial differential equation of first order- Solution of some standard type of equations, Charpit's method.

Unit-III Homogeneous linear partial differential equations of second and higher orders with constant coefficients, Different cases for complimentary functions and particular integrals, Non-homogeneous partial differential equations with constant coefficients, Classification of second order linear partial differential equations, Partial differential equations reducible to equations with constant coefficients.

Unit-IV Variation of a functional, Variational problems, Euler's equations and its various cases, Externals, Functional depending on n unknown functions, Functionals depending on higher order derivatives, Variational problems in parametric form, Isoperimetric problem.

Books Recommended:

1. Dennis G. Zill: *A First Course in Differential Equations with Modeling Applications*, Cengage Learning; 10th edition, 2012.
2. Tyn Myint-U and Lokenath Debnath: *Linear Partial Differential Equations for Scientists and Engineers*, Birkhäuser; 4th ed. 2007.
3. D.A. Murray: *Introductory Course on Differential Equations*, Orient Longman (India), 1967.
4. A.S. Gupta: *Calculus of Variations with Applications*, Prentice Hall of India, 1997.
5. I.N. Sneddon*: Elements of Partial Differential Equations*, McGraw Hill Book Company, 1988.
6. Zafar Ahsan: *Differential Equations and their Applications*, Prentice Hall of India, 2nd Edition, 2012.

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-312	**Numerical Methods**	**4L**	**25**	**75**

Unit-I Absolute, relative and percentage errors, General error formula. Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method, Newton's method and its convergence, Chebyshev method. Solution of system of non-linear equations by Iteration and Newton-Raphson method.

Unit-II Direct methods to solve the system of linear equations: Gauss elimination method, Gauss Jordan method, LU decomposition method. Indirect methods: Gauss-Jacobi and Gauss-Seidal methods. The algebraic Eigen value problems by Householder and Power method.

Unit-III Finite difference operators and finite differences, Interpolation and interpolating polynomials: Newton's forward and backward difference formulae, Central differences: Sterling's and Bessel's formula. Lagrange's interpolation formula, Divided Differences, their properties and Newton's general interpolation formula. Inverse interpolation.

Unit-IV Numerical differentiation of tabular and non-tabular functions. Numerical integration using Gauss quadrature formulae: Trapezoidal rule, Simpson's rules, Romberg formula and their error estimation. Numerical solution of ordinary differential equations by Picard's method, Taylor series, Euler's method and Runge-Kutta methods. Multi step method: Adams-Moulton method

Books Recommended:

1. B. Bradie: *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain: *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India, 5th edition, 2007
3. C. F. Gerald and P. O. Wheatley: *Applied Numerical Analysis*, Pearson Education, India,7th edition, 2008.
4. S. S. Sastry: *Introductory Methods of Numerical Analysis (Fifth Ed.),* Prentice Hall of India (Ltd.) 2012.
5. M. Pal, *Numerical Analysis for Scientists and Engineers*, Narosa Publisher, 2007.
6. N. Ahmad, *Fundamental Numerical Analysis with Error Estimation*, Anamaya Publisher, 2009.

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-313	**Group Theory**	**4L**	**25**	**75**

Unit-I Sets, Relations, Functions, Binary operations, Definition of groups with examples and its properties, Subgroups, Order of an element of a group, Cyclic groups, Cosets, Lagrange's theorem and its consequences, Normal subgroup and Commutator subgroups, Factor groups.

Unit-II Group Homomorphism, Isomorphisms, Kernel of a homomorphism, The homomorphism theorems, The Isomorphism theorems, Permutation groups, Even and Odd permutations, Alternating groups, Cayley's theorem and Regular permutation group.

Unit-III Automorphism, Inner automorphism, Automorphism group of finite and infinite cyclic groups, Conjugacy relation, Normalizer and Centre, External direct products, definition and examples of Internal direct products.

Unit-IV Class equation of a finite group and its applications, Structure of finite Abelian groups, Cauchy's theorem, Sylow's theorem and consequences, Definition and example of Simple groups, Non-simplicity tests.

Books Recommended:

1. N. Herstein: *Topics in Algebra*, Wiley Eastern Ltd. (2^{nd} Edition), 1975.
2. Joseph A. Gallian: *Contemporary Abstract Algebra (4th Edition*), Narosa Publishing House, New Delhi, 2011.
3. N. Jacobson: *Basic Algebra Vol. I & II*, W. H. Freeman and Company, 1974.
4. Surjeet Singh and Qazi Zameeruddin: *Modern Algebra*, Vikas Publishing House Pvt. Ltd., New Delhi, 1994.
5. N. S. Gopalakrishan: *University Algebra* (3^{rd} Edition), New Age International (P) Limited, New Delhi, 2015.

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-314 (GE-3) C1	**Information Security**	**4L**	**25**	**75**

Unit-I Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book.

Unit-II Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy.

Unit-III Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data Encryption Standard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

Unit-IV Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.
Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

Books Recommended:

1. W. Stallings: *Cryptography and Network Security Principles and Practices,* 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger: *Security in Computing* , 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann: *Computer Security*, John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry: *Fundamentals of Computer Security*, Springer-Verlag Berlin, 2003.
5. J.M. Kizza: *Computer Network Security*, Springer, 2007.
6. M. Merkow and J. Breithaupt: *Information Security: Principles and Practices*, Pearson Education, 2006.

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-314 (GE-3) C2	**Object Oriented Programming Using C++ (P)***	**4L+2P**	**25**	**75**

*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.

Books Recommended:

1. A. R. Venugopal, Rajkumar, and T. Ravishanker: *Mastering 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., 2000.
4. D. Parasons: *Object Oriented Programming with C++*, BPB Publication, 1999.
5. Bjarne Stroustrup: *The C++ Programming Language*, 3rd Ed., Addison Welsley, 2000.
6. Steven C. Lawlor: *The Art of Programming Computer Science with C++*, Vikas Publication, 2002.
7. Schildt Herbert: *C++: The Complete Reference*, 4th Ed., Tata McGraw Hill, 1999.

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-315 (SE-1) C1	**Latex & Web Designing**	**4L**	**25**	**75**

Unit-I LaTeX: elements of LaTeX, typesetting mathematics, graphics in LaTeX, PSTricks, Beamer presentation.

Unit-II Introduction to World Wide Web, communication on the Internet, Internet domains, Internet server identities, establishing connectivity on the Internet, Internet protocols, Internet services - E-mail, FTP, search engines, web browsers.

Unit-III Introduction to HTML, basic structure of a HTML document, working with texts and tables, frames, images and links, forms, creating simple web pages.

Unit-IV Introduction to DHTML, benefit of CSS, CSS properties, CSS styling, working with lists and tables, web page layout and editing with CSS, writing JavaScript into HTML, basic programming using JavaScript.

Books Recommended:

1. L. Lamport. LATEX: *A Document Preparation System, User's Guide and Reference Manual*, Addison-Wesley, New York, second edition, 1994.
2. Martin J. Erickson and Donald Bindner: *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*, CRC Press, Boca Raton, FL, 2011.
3. Robert W. Sebesta: *Programming the World Wide Web*, (4th ed.), Addison Wesley, 2007.
4. Dick Oliver, Michael Morrison: *Sams Teach Yourself HTML and CSS in 24 Hours*, Pearson Education, 2005.
5. Danny Goodman: *JavaScript & DHTML Cookbook: Solutions and Example for Web Programmers*, O'Reilly Media, 2003.
6. Ivan Bayross: *HTML 5 and CSS 3 Made Simple*, BPB, 2012.

B.Sc. (Hons.) Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-315 (SE-1) C2	**Computer Graphics**	**4L**	**25**	**75**

Unit-I Introduction of computer graphics and its applications, development of computer graphics, raster scan and random scan graphics storages, displays processors and character generators, colour display techniques, interactive input and output devices.

Unit-II Points, lines and curves: scan conversion, line drawing algorithms, circle and ellipse generation algorithms, conic-section generation, and polygon filling algorithms.

Unit-III Two-dimensional viewing, coordinate systems, linear transformations, clipping: point and line clipping, line and polygon clipping algorithms.

Unit-IV Three-dimensional concepts: basic transformation - translation, rotation, scaling, reflections, projections, three dimensional object representation: polygons, curved lines, splines, quadric surfaces, three dimensional line clipping algorithms.

Books Recommended:

1. D. Hearn and M.P. Baker: *Computer Graphics, 2nd Ed*., Prentice–Hall of India, 2004.
2. J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes: *Computer Graphics: Principals and Practices*, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers: *Procedural Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 2001.
4. D.F. Rogers and A. J. Admas: *Mathematical Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 1990.

B.Sc. (Hons.) Mathematics
Semester – IV
Course Structure

Code	Title of Paper	Unit	Credit	Maximum Marks
BHM-411	**Real Analysis**	**4**	**4**	**100**
BHM-412	**Ring Theory**	**4**	**4**	**100**
BHM-413	**Linear Programming**	**4**	**4**	**100**
BHM-414 (GE-4)	**C1. Mathematical Modelling** **C2. Data Structures (P)**	**4**	**4**	**100**
BHM-415 (SE-2)	**C1. Graph Theory** **C2. Fuzzy Sets and Logics**	**4**	**4**	**100**

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-411	**Real Analysis**	**4L**	**25**	**75**

Unit-I Bounded and unbounded sets, Infimum and supermum of a set and their properties, Order completeness property of R, Archimedian property of R, Density of rational and irrational numbers in R, Dedekind form of completeness property, Equivalence between order completeness property of R and Dedekind property. Neighbourhood, open set, Interior of a set, Limit point of a set, Closed set and related Theorems/results. Derived set, Closure of a set, Bolzano-Weierstrass theorem for sets.

Unit-II Sequence of real numbers, Bounded sequence, limit points of a sequence, Bolzano Weierstrass theorem for sequence, Limit inferior and limit superior, Convergent and non-convergent sequences, Cauchy's sequence, Cauchy's general principal of convergence, Algebra of sequences, Theorems on limits of sequences, Subsequences, Monotone sequences, Monotone convergence Theorem.

Unit-III Infinite series and its convergence and divergence, Cauchy's criterion for convergence of series, Test for convergence of positive term series, Comparison tests, Ratio test, Cauchy's n^{th} root test, Raabe's test, Logrithmic test, Integral test, Alternating series, Leibnitz test, Absolute and conditional convergence.

Unit-IV Continuous functions ($\varepsilon - \delta$ approach), Discontinuous functions, Types of discontinuities, Sequential criterion for continuity and discontinuity, Theorems on continuity, Uniform continuity, Relation between continuity and uniform continuity, Derivative of a function, Relation between continuity and differentiability, Increasing and decreasing functions, Darboux theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's theorem with Cauchy's and Lagrange's form of remainder.

Books Recommended:

1. R. G. Bartle and D. R. Sherbert: *Introduction to Real Analysis (3^{rd} Edition),* John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2003.
2. S. C. Malik and Savita Arora: *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 2009.
3. K. A. Ross, *Elementary Analysis: The Theory of Calculus, under graduate Texts in Mathematics,* Springer (SIE), Indian reprint, 2004.
4. Sudhir R. Ghorpade and Balmohan V. Limaye: *A course in Calculus and Real Analysis, Undergraduate Text in Maths.*, Springer (SIE), Indian reprint 2006.
5. T. M. Apostol: *Mathematical Analysis,* Addison-Wesley Series in Mathematics, 1974.
6. Gerald G. Bilodeau, Paul R. Thie, G. E. Keough: *An Introduction to Analysis,* 2^{nd} Ed., Jones & Bartlett, 2010.
7. Dipak Chatterjee: *Real Analysis*, 2^{nd} ed., PHI Learning Pvt. Ltd. , 2015.

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-412	**Ring Theory**	**4L**	**25**	**75**

Unit-I Rings and their properties, Boolean Ring, Integral domain, Division ring and Field, Subrings, Ideals and their properties, Operations on ideals, Ideal generated by a subset of a ring, Quotient rings.

Unit-II Homomorphism of rings and its properties, Kernel of a homomorphism, Natural homomorphism, Isomorphism and related theorems, Field of quotients.

Unit-III Polynomial rings over commutative rings, Properties of $R[X]$, Division algorithm and its consequences, Factorization of polynomials, Irreducibility test, Eisenstein's criterion for irreducibility.

Unit-IV Factorization in integral domains, prime and irreducible element, Principal Ideal Domain, Euclidean Domain, Unique Factorization Domain and its properties.

Books Recommended:

1. I. N. Herstein: *Topics in Algebra*, Wiley Eastern Ltd. (2^{nd} Edition), 1975.
2. N. Jacobson: *Basic Algebra*, Volume I and II. W. H. Freeman and Co., 1974.
3. Surjeet Singh and Qazi Zameeruddin: *Modern Algebra*, Vikas Publication, 1994.
4. J.A. Gallian: *Contemporary Abstract Algebra*, Narosa Publication, 2011.

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-413	**Linear Programming**	**4L**	**25**	**75**

Unit-I Linear Programming Problem: Definition, mathematical formulation, standard form, Solution space, solution – feasible, basic feasible, optimal, infeasible, multiple, redundancy, degeneracy, Solution of LP Problems - Graphical Method, Integer programming, Branch and Bound method.

Unit-II Simplex Method, Degeneracy in Simplex method, Duality in LP, Dual Simplex Method, Economic interpretation of Dual, Transportation Problem, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method), Stepping stone method, modified distribution method, Unbalanced transportation problem, Degeneracy in transportation problems.

Unit-III Assignment Problem, Hungarian Method for Assignment Problem, Elementary inventory models, EOQ model with or without shortages, Replacement models, Individual replacement policy, Group replacement problem.

Unit-IV Sequencing problem, *m* machines *n* jobs problem, Graphical method for sequence problem. Game Theory, pure and mixed strategies, Saddle point, Two-Persons-Zero-Sum Game, Game with mixed strategies, Dominance rule, Graphical Method, Inter - relation between the theory of games and linear programming, Solution of game using Simplex method.

Books Recommended:

1. A. H. Taha: *Operations Research – An Introduction*. Prentice Hall, 2010
2. J. K. Sharma: *Operations Research – Theory and Application*, Macmillian Pub., 2007.
3. J. K. Sharma: *Operations Research – Problems and Solutions*, Macmillian Pub., 2007.
4. G. Hadley: *Linear Programming*, Narosa Publishing House, 2002
5. S. D. Sharma: *Operations Research*, KNRN Publications, 2013

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-414 (GE-4) C1	**Mathematical Modelling**	**4L**	**25**	**75**

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.

Books Recommended:

1. J. N. Kapur: *Mathematical Modelling*, 2nd Ed., New Age Publications, 2015
2. *UMAP-Module 322*: Published in cooperation with the Society for Industrial and Applied Mathematics
3. B. S. Grewal: *Higher Engineering Mathematics*, Khanna Publication, 2014.

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-414 (GE-4) C2	**Data Structures (P)**	**4L+2P**	**25**	**75**

Unit-I Definition of Data Structure, Types of Data Structures, Introduction to Arrays, Single and Multi-Dimensional Arrays, Row and Column Major Implementations of Multi-Dimensional Arrays, Recursion, Hashing.

Unit-II Concept of a Linked List, Linear Single and Double Linked Lists, Circular linked List, Operations on Linked Lists and implementation in C, Applications of Linked List. Introduction to Stack, Implementation of Stack in C using Array and Linked List, Applications of Stack.

Unit-III Introduction to Queue, Implementation of Queue in C using Array and Linked List, Applications of Queue. Concept of a Tree, Definitions and Examples of n-ary Tree, Binary Tree, Strictly Binary Tree, Complete Binary Tree, Almost Complete Binary Tree. Level of a Node, Height and Depth of a Tree, Binary Search Tree, Operation on Trees, Tree Traversal and Search Algorithm

Unit-IV Huffman Algorithm. Definitions of Vertex, Edge and Graph, Types of Graphs – Directed and Undirected, Connected and Disconnected, Cyclic and Acyclic. Representation of Graphs: Adjacency Matrix, Linked List. Incidence Matrix, Path Matrix. Graph Algorithms – Breadth First Search (BFS), Depth First Search (DFS), Minimum Spanning Tree, Kruskal's and Prim's Algorithm.

Searching Techniques - Linear Search and Binary Search. Sorting Techniques - Selection Sort, Insertion Sort, Bubble Sort, Quick Sort, and Heap Sort.

Books Recommended:

1. S. Lipshutz, *Data Structures:* Schaum Outline Series, Tata Mc-graw Hill, 2012.
2. D. Samanta, *Classic Data Structures*: PHI Publication, 2010.
3. Yashavant P. Kanetkar: *Data Structures through C,* Second Edition, BPB, 2003.
4. Yashavant P. Kanetkar: *Understanding Pointers in C,* BPB, 2003.

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-415 (SE-2) C1	**Graph Theory**	**4L**	**25**	**75**

Unit-I 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, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Unit-II Applications of paths and circuits: the Chinese postman problem, digraphs, the Bellman-Ford algorithm, tournaments, directed network, scheduling problems, definition, examples and basic properties of trees, spanning trees, minimum spanning tree algorithms, Kruskal's algorithm, Prim's algorithm, acyclic digraphs, Bellman's algorithm.

Unit-III Planar graphs, colouring of graphs, statement of the four-colour theorem, the five colour theorem, circuit testing, facilities design, flows and cuts, construction of flows, constructing maximal flows, rational weights, applications of directed networks, matchings.

Unit-IV

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. Rudolf Lidl and Günter Pilz: *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
3. C.L. Liu: *Elements of Discrete Mathematics,* 2nd Ed., Tata McGraw Hill Publishing Company Ltd., 2001

B.Sc. (Hons.) Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-415 (SE-2) C2	**Fuzzy Sets and Logics**	**4L**	**45**	**75**

Unit-I Fuzzy Sets and Uncertainty: Uncertainty and information, fuzzy sets and membership functions, chance versus fuzziness, properties of fuzzy sets, fuzzy set operations. Fuzzy Relations: Cardinality, operations, properties, fuzzy Cartesian product and composition, fuzzy tolerance and equivalence relations, forms of composition operation.

Unit-II Fuzzification and Defuzzification: Various forms of membership functions, fuzzification, defuzzification to crisp sets and scalars. Fuzzy Logic and Fuzzy Systems: Classic and fuzzy logic, approximate reasoning, Natural language, linguistic hedges, fuzzy rule based systems, graphical technique of inference.

Unit-III Development of membership functions: Membership value assignments: intuition, inference, rank ordering, neural networks, genetic algorithms, inductive reasoning. Fuzzy Arithmetic and Extension Principle: Functions of fuzzy sets, extension principle, fuzzy mapping, interval analysis, vertex method and DSW algorithm.

Unit-IV Fuzzy Optimization: One dimensional fuzzy optimization, fuzzy concept variables and casual relations, fuzzy cognitive maps, agent based models. Fuzzy Control Systems: Fuzzy control system design problem, fuzzy engineering process control, fuzzy statistical process control, industrial applications.

Books Recommended:

1. T.J. Ross: *Fuzzy Logic with Engineering Applications*, 3rd Ed., Wiley India Pvt. Ltd., 2011.
2. H.J. Zimmerman: *Fuzzy Set Theory and its Application*, 3rd Ed., Springer India Pvt. Ltd., 2006.
3. G. Klir and B. Yuan: *Fuzzy Set and Fuzzy Logic: Theory and Applications*, Prentice Hall of India Pvt. Ltd., 2002.
4. G. Klir and T. Folger: *Fuzzy Sets, Uncertainty and Information*, Prentice Hall of India Pvt. Ltd., 2002.

B.Sc. (Hons.) Mathematics
Semester – V
Course Structure

Code	Title of Paper	Unit	Credit	Maximum Marks
BHM-511	**Riemann Integration and Series of Functions**	**4**	**4**	**100**
BHM-512	**Multivariate Calculus**	**4**	**4**	**100**
BHM-513	**Metric Spaces**	**4**	**4**	**100**
BHM-514	**Linear Algebra**	**4**	**4**	**100**
BHM-515 (DS-1)	**C1. Modelling and Simulation** **C2. Discrete Mathematics**	**4**	**4**	**100**
BHM-516 (DS-2)	**C1.Mathematical Finance** **C2. Dynamical Systems**	**4**	**4**	**100**

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-511	**Riemann Integration and Series of Functions**	**4L**	**25**	**75**

Unit-I Definition, existence and properties of Riemann integral of a bounded function, Darboux theorem, Condition of integrability, Riemann integrability for continuous functions, monotonic function and theorems on function with finite or infinite number discontinuity (without proof). The Riemann integral through Riemann sums, Equivalence of two definitions, Properties of Riemann integral, Fundamental theorem of calculus, First Mean Value Theorems, Second Mean Value Theorems, Generalized Mean Value Theorems.

Unit-II Definition of improper integrals, Convergence of improper integrals, Test for convergence of improper integrals, Comparison test, Cauchy's test for convergence, Absolute convergence, Abel's Test, Dirichlet's Test, Beta and Gamma functions and their properties and relations.

Unit-III Pointwise and uniform convergence of sequences and series of functions, Cauchy's criterion for uniform convergence of sequence and series, Weierstrass M-test, Uniform convergence and continuity, Uniform convergence and differentiation, Uniform convergence and integration, Weierstrass Approximation Theorem.

Unit-IV Fourier Series, Fourier Series for even and odd functions, Half Range Series, Fourier Series on intervals other than $[-\pi, \pi]$.
Power Series, Radius of Convergence, Cauchy's Hadamard Theorem, Uniform and Absolute convergence, Abel's Theorem (without proof), exponential and logarithmic functions.

Books Recommended:

1. R. G. Bartle and D. R. Sherbert: *Introduction to Real Analysis (3^{rd} Edition)*, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2003.
2. S. C. Malik and Savita Arora: *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 2009.
3. K. A. Ross, *Elementary Analysis: The Theory of Calculus, Under graduate Texts in Mathematics*, Springer (SIE), Indian reprint, 2004.
4. Sudhir R. Ghorpade and Balmohan V. Limaye: *A course in Calculus and Real Analysis, Undergraduate Text in Maths.*, Springer (SIE), Indian reprint 2006.
5. T. M. Apostol: *Mathematical Analysis*, Addison-Wesley Series in Mathematics, 1974.
6. Gerald G. Bilodeau, Paul R. Thie, G. E. Keough: *An Introduction to Analysis,* 2^{nd} Ed., Jones & Bartlett, 2010.
7. A. Mattuck: *Introduction to Analysis*, Prentice Hall, 1990.
8. Charles G. Denlinger: *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.
9. Dipak Chatterjee: *Real Analysis*, 2nd ed., PHI Learning Pvt. Ltd. , 2015.

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-512	**Multivariate Calculus**	**4L**	**25**	**75**

Unit-I Functions of several variables. Domains and Range. Functional notation, Level curves and level surfaces. Limits and continuity. Partial derivatives. Total differential. Fundamental lemmas. Differential of functions of n variables and of vector functions. The Jacobian matrix. Derivatives and differentials of composite functions, The general chain rule.

Unit-II Implicit functions. Inverse functions. Curvilinear co-ordinates. Geometrical Applications. The directional derivatives. Partial derivatives of higher order. Higher derivatives of composite functions. The Laplacian in polar, cylindrical and spherical co-ordinates. Higher derivatives of implicit functions. Maxima and minima of functions of several variables.

Unit-III Vector fields and scalar fields. The gradient field. The divergence of a vector field. The curl of a vector field. Combined operations. Irrotational fields and Solenoidal fields. Double integrals, triple integrals and multiple integrals in general. Change of variables in integrals. Arc length and surface area.

Unit-IV Line integrals in the plane. Integrals with respect to arc length. Basic properties of line integrals. Line integrals as integrals of vectors. Green's Theorem. Independence of path, Simply connected domains, Extension of results to multiply connected domains. Line Integrals in space. Surfaces in space, orientability. Surface integrals. The divergence theorem, Stokes's theorem. Integrals independent of path.

Books Recommended:

1. Wilfred Kaplan: *Advanced Calculus*.,Adisson-Wasley Publishing Company,1973.
2. E.Swokowski: *Calculus with Analytical Geometry*, Prindle, Weber & Schmidt, 1994.
3. E.Kreyzig: *Advanced Engineering Mathematics*, John Wiley and Sons, 1999.
4. David Widder: *Advanced Calculus*, Prentice Hall of India, 1999.
5. S. C Malik and Savita Arora: *Mathematical Analysis*, New Age International(P) 2009

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-513	**Metrics Spaces**	**4L**	**25**	**75**

Unit-I Definition and examples of metric spaces, open spheres and closed spheres, Neighbourhood of a point, Open sets, Interior points, Limit points, Closed sets and closure of a set, Boundary points, diameter of a set, Subspace of a metric space.

Unit-II Convergent and Cauchy sequences, Complete metric space, Dense subsets and separable spaces, Nowhere dense sets, Continuous functions and their characterizations, Isometry and homeomorphism.

Unit-III Compact spaces, Sequential compactness and Bolzano-Weierstrass property, Finite Intersection property, Continuous functions and compact sets.

Unit-IV Disconnected and connected sets, connected subsets of R, Continuous functions and connected sets.

Books Recommended:

1. G.F. Simmons: *Introduction to Topology and Modern Analysis*, McGraw Hill, 1963.
2. E.T. Copson: *Metric Spaces*, Cambridge University Press, 1968.
3. P.K. Jain and Khalil Ahmad: *Metric Spaces*, Second Edition, Narosa Publishing House, New Delhi, 2003.
4. B. K. Tyagi: *First Course in Metric Spaces*, Cambridge University Press, 2010.

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-514	**Linear Algebra**	**4L**	**25**	**75**

Unit-I Definition examples and basic properties of a vector space, Subspaces, Linear Dependence Independence, Linear combinations and span, Basis and dimension, Sum and intersection of subspaces, Direct sum of subspaces.

Unit-II Definition and examples of linear transformations, Properties of linear transformations, Range and kernel, The rank and nullity of a linear transformation, Rank-Nullity Theorem and its consequence, The matrix representation of a linear transformation, Change of basis, Isomorphism.

Unit-III Scalar product in an Inner product spaces. Orthogonality in inner product Spaces, Normed linear spaces, Inner product on complex vector spaces, Orthogonal Complements, orthogonal sets and projections, Gram-Schmidt Orthogonalization process, Bessel's inequality.

Unit-IV Eigenvalues and eigenvectors, Characteristic equation and polynomial, Eigenvectors and eigenvalues of linear transformations and matrices, The Cayley-Hamilton Theorem. Similar matrices and Diagonalization, Eigenvalues and eigenvectors of symmetric and Hermitian matrices, Orthogonal Diagonalization, Quadratic forms and conic sections.

Books Recommended:

1. David C. Lay: *Linear Algebra and Its Applications (3rd Edition),* Pearson Education Asia, Indian Reprint, 2007.
2. Geory Nakos and David Joyner: *Linear Algebra with Applications*, Brooks/ Cole Publishing Company, International Thomson Publishing, Asia, Singapore, 1998.
3. Stephen H. Friedberg, Arnold J. Insel and L.E.Space: *Linear Algebra*, 4th Edition, PHI Pvt Ltd., New Delhi, 2004.
4. I. V. Krishnamurty, V.P. Mainra, J.L. Arora: *An Introduction to Linear Algebra*, East West Press , 2002.

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-515 (DS-1) C1	**Modelling and Simulation**	**4L**	**25**	**75**

Unit-I What is Mathematical Modeling? History of Mathematical Modeling, latest development in Mathematical Modeling, Merits and Demerits of Mathematical Modeling. Introduction to difference equations, Non-linear Difference equations, Steady state solution and linear stability analysis.

Unit-II Introduction to Discrete Models, Linear Models, Growth models, Decay models, Newton's Law of Cooling, Bank Account Problem and mortgage problem, Drug Delivery Problem, Harrod Model of Economic growth, War Model, Lake pollution model, Alcohol in the bloodstream model, Arm Race models, Linear Prey-Predator models, Density dependent growth models with harvesting, Numerical solution of the models and its graphical representation using EXCEL.

Unit-III Introduction to Continuous Models, Carbon Dating, Drug Distribution in the Body, Growth and decay of current in a L-R Circuit, Horizontal Oscillations, Vertical Oscillations, Damped Force Oscillation, Dynamics of Rowing, Combat Models, Mathematical Model of Influenza Infection (within host), Epidemic Models (SI, SIR, SIRS, SIC), Spreading of rumour model, Steady State solutions, Linearization and Local Stability Analysis, logistic and gomperzian growth, preypredator model, Competition models, Numerical solution of the models and its graphical representation using EXCEL.

Unit-IV Fluid flow through a porous medium, heat flow through a small thin rod (one dimensional), Wave equation, Vibrating string, Traffic flow, Theory of Car-following, Crime Model, Linear stability Analysis: one and two species models with diffusion, Conditions for diffusive instability with examples.

Books Recommended:

1. B. Albright: *Mathematical Modeling with Excel*, Jones and Bartlett Publishers, 2010.
2. F.R. Marotto: *Introduction to Mathematical Modeling using Discrete Dynamical Systems*, Thomson Brooks/Cole, 2006.
3. J.N. Kapur: *Mathematical Modeling*, New Age International, 2005.
4. B. Barnes and G. R. Fulford: *Mathematical Modelling with Case Studies*, CRC Press, Taylor and Francis Group, 2009.
5. L. Edsberg: *Introduction to Computation and Modeling for Differential Equations*, John Wiley and Sons, 2015.

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-515 (DS-1) C2	**Discrete Mathematics**	**4L**	**25**	**75**

Unit-I Sets - finite and Infinite sets, uncountably Infinite Sets; functions, relations, Properties of Binary Relations, Closure, Partial Ordering Relations; counting - Pigeonhole Principle, Permutation and Combination; Mathematical Induction, Principle of Inclusion and Exclusion.

Unit-II Recurrence Relations, generating functions, Linear Recurrence Relations with constant coefficients and their solution, Substitution Method, Recurrence Trees, Master Theorem

Unit-III Basic Terminology, Models and Types, multigraphs and weighted graphs, Graph Representation, Graph Isomorphism, Connectivity, Euler and Hamiltonian Paths and Circuits, Planar Graphs, Graph Coloring, Trees, Basic Terminology and properties of Trees, Introduction to Spanning Trees.

Unit-IV Logical Connectives, Well-formed Formulas, Tautologies, Equivalences, Inference Theory

Books Recommended:

1. C.L. Liu , D.P. Mahopatra: *Elements of Discrete mathematics*, 2nd Edition , Tata McGraw Hill, 1985,
2. Kenneth Rosen: *Discrete Mathematics and Its Applications*, Sixth Edition ,McGraw Hill 2006
3. T.H. Coremen, C.E. Leiserson, R. L. Rivest: *Introduction to Algorithms*, 3rd edition Prentice Hall on India, 2009
4. M. O. Albertson and J. P. Hutchinson: *Discrete Mathematics with Algorithms* , John wiley Publication, 1988
5. J. L. Hein: *Discrete Structures, Logic, and Computability*, 3rd Edition, Jones and Bartlett Publishers, 2009
6. D.J. Hunter: *Essentials of Discrete Mathematics*, Jones and Bartlett Publishers, 2008

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-516 (DS-2) C1	**Mathematical Finance**	**4L**	**25**	**75**

Unit-I Introduction, The accumulation and amount functions, The effective rate of interest, Simple interest, Compound interest, Present value, The effective rate of discount, Nominal rates of interest and discount, Forces of interest and discount, Varying interest. Equation of value, Unknown time, Unknown rate of interest, Determining time periods, Practical examples.

Unit-II Introduction, Annuity-immediate, Annuity-due, Annuity values on any date, Perpetuities, Unknown time, Unknown rate of interest, Varying interest, Annuities not involving compound interest. Differing payment and interest conversion periods, Annuities payable less frequently than interest convertible, Annuities payable more frequently than interest convertible, Continuous annuities, Payments varying in arithmetic progression, Payments varying in geometric progression.

Unit-III Introduction, Finding the outstanding loan balance, Amortization schedules, Sinking funds, Differing payment periods and interest conversion periods, Varying series of payments, Amortization with continuous payments, Step-rate amounts of principal.

Unit-IV Introduction, Types of securities, Price of a bond, Premium and discount, Valuation between coupon payment dates, Determination of yields rates, Callable and putable bonds, Serial bonds, some generalizations, other securities, Valuation of securities. Discounted cash flow analysis, Uniqueness of the yield rate, Reinvestment rates, Interest measurement of a fund

Books Recommended:

1. Stephen G. Kellison: *The Theory of Interest*, 3rd Edition. McGraw Hill International Edition (2009).
2. R. J. Elliott and P. E. Kopp: *Mathematics of Financial Markets*, Springer (1999).
3. S. Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani: *Financial Mathematics: An Introduction*, Narosa Publishing House, 2014.

B.Sc. (Hons.) Mathematics
Semester – V
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-516 (DS-2) C2	**Dynamical Systems**	**4L**	**25**	**75**

Unit-I Linear Dynamical Continuous Systems: First order equations, existence uniqueness theorem, growth equation, logistic growth, constant harvesting, Planar linear systems, equilibrium points, stability, phase space, n-dimensional linear systems, stable, unstable and center spaces.

Unit-II Nonlinear autonomous Systems: Motion of pendulum, local and global stability, Liapunov method, periodic solution, Bendixson's criterion, Poincare Bendixson theorem, limit cycle, attractors, index theory, Hartman Grobman theorem, nonhyperbolic critical points, center manifolds, normal forms, Gradient and Hamiltonian systems.

Unit-III Local Bifurcation: Fixed points, saddle node, pitchfork trans-critical bifurcation, Hopf bifurcation, co-dimension. Discrete systems: Logistic maps, equilibrium points and their local stability, cycles, period doubling, chaos, tent map, horse shoe map.

Unit-IV Deterministic chaos: Duffing's oscillator, Lorenz System, Liapunov exponents, routes to chaos, necessary conditions for chaos.

Books Recommended:

1. M.W. Hirsch, S. Smale, R.L. Devaney: *Differential Equations, Dynamical Systems and an Introduction to Chaos*, Academic Press, 2008.
2. S.H. Strogatz: *Nonlinear Dynamics and Chaos*, Westview Press, 2008.
3. M. Lakshmanan, S. Rajseeker: *Nonlinear Dynamics*, Springer, 2003.
4. L. Perko: *Differential Equations and Dynamical Systems*, Springer,1996.
5. J.H. Hubbard, B.H. West: *Differential equations: A Dynamical Systems Approach*, Springer-Verlag, 1995.
6. D. Kaplan, L. Gloss: *Understanding Nonlinear Dynamics*, Springer, 1995.
7. S. Wiggins: *Introduction to Applied Nonlinear Dynamical Systems and Chaos*, Springer-Verlag, 1990.

B.Sc. (Hons.) Mathematics
Semester – VI
Course Structure

Code	Title of Paper	Unit	Credit	Maximum Marks
BHM-611	**Integral Equations and Calculus of Variations**	**4**	**4**	**100**
BHM-612	**Complex Analysis**	**4**	**4**	**100**
BHM-613	**Differential Geometry**	**4**	**4**	**100**
BHM-614	**Mechanics**	**4**	**4**	**100**
BHM-615 (DS-3)	**C1. Boolean Algebra and Automata Theory** **C2. Bio-Mathematics**	**4**	**4**	**100**
BHM-616 (DS-4)	**C1. Industrial Mathematics** **C2. Applications of Algebra**	**4**	**4**	**100**

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-611	**Integral Equations and Calculus of Variations**	**5L+1T**	**25**	**75**

Unit-I Preliminary Concepts: Definition and classification of linear integral equations. Conversion of initial and boundary value problems into integral equations. Conversion of integral equations into differential equations. Integro-differential equations.
Fredholm Integral Equations: Solution of integral equations with separable kernels, Eigen values and Eigen functions. Solution by the successive approximations, Neumann series and resolvent kernel. Solution of integral equations with symmetric kernels, Hilbert-Schmidt theorem, Green's function approach.

Unit-II Volterra Integral Equations: Successive approximations, Neumann series and resolvent kernel. Equations with convolution type kernels.
Solution of integral equations by transform methods: Singular integral equations, Hilbert transform.

Unit-III Calculus of Variations: Basic concepts of the calculus of variations such as functionals, extremum, variations, function spaces, the brachistochrone problem.
Necessary condition for an extremum, Euler`s equation with the cases of one variable and several variables, Variational derivative. Invariance of Euler`sequations. Variational problem in parametric form.

Unit-IV General Variation: Functionals dependent on one or two functions, Derivation of basic formula, Variational problems with moving boundaries, Broken extremals: Weierstrass–Erdmann conditions.

Books Recommended:

1. Abdul J. Jerry: *Introduction to Integral Equations with Applications*, 2nd Ed., Clarkson University Wiley Publishers, 1999.
2. G. L. Chambers: *Integral Equations: A short Course*, International Text Book Company Ltd., 1976.
3. R. P. Kanwal: *Linear Integral Equations*, 2nd Ed., Birkhauser Bosten, 1997.
4. Hochstadt Harry: *Integral Equations*, John Wiley & Sons, 1989.
5. I. M. Gelfand, S.V. Fomin: *Calculus of Variations*, Dover Books, 2000.
6. Weinstock Robert: *Calculus of Variations with Applications to Physics and Engineering*, Dover Publications, INC., 1974.

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-612	**Complex Analysis**	**4L**	**25**	**75**

Unit-I Complex number system, Algebraic properties, Geometric interpretation, exponential forms, powers and roots, Properties of moduli, Regions in complex plane, Limit, continuity and derivatives.

Unit-II Analytic functions, CR equations, sufficient conditions, polar conditions, Harmonic functions, Construction of analytic function, Line integral.

Unit-III Cauchy Goursat theorem, Cauchy integral formula, Derivatives of analytic function, Fundamental theorem of calculus in the complex plane, Taylor's and Laurent series.

Unit-IV Definitions and examples of conformal mappings, Zeros of analytic function, Residues, Residue at poles, Residue theorem, Evaluation of Integrals involving sine and cosine series.

Books Recommended:

1. R.V. Churchill and J W Brown: *Complex Variable & Applications*. McGraw Hill, International Book Company, London., 2009.
2. Ponnuswamy: *An Introduction to Complex Analysis*, Narosa Publication, 2011.

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-613	**Differential Geometry**	**4L**	**25**	**75**

Unit-I Tensors: Summation convention, co-ordinate transformation, Scalar, contravariant and covariant vectors, Tensors of higher rank, Algebra of tensors and contraction, Metric tensor and 3-index christofell symbols, covariant derivative of contravariant, covariant vectors and higher rank tensors.

Unit-II Curves in R^3: Representation of curves, unit speed curves, tangent to a curve, principal vector and binormal vector , osculating plane, normal plane and rectifying plane, curvature and torsion, Serret - Frenet formula, Helix.

Unit-III Behaviors of curve near a point, osculating circle and osculating sphere, Necessary and sufficient condition for a curve to lie on a sphere, involutes and evolutes, Fundamental existence theorem for space curves.

Unit-IV Surface in R^3: Definition and examples of a smooth surface, tangent plane and unit surface normal, Surface of revolution, first fundamental form and its properties, Direction co-efficient on a surface, angle between tangential direction on a surface, second fundamental form, normal curvature, Principal curvature, Shape operator and its properties.

Books Recommended:

1. B.O. Neill: *Elementary Differential Geometry*, Academic Publishers, 2006.
2. Andrew Pressley: *Elementary Differential Geometry*, Springer, 2010.
3. M. P. Do Carmo: *Differential Geometry of Curves and Surfaces*, Prentice Hall, 1976.
4. T. G. Willmore: *Introduction to Differential Geometry*, Oxford University Press, 1959.
5. D. Somasundaram: *Differential Geometry*, Narosa Publishing House, 2005.

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-614	**Mechanics**	**4L**	**25**	**75**

Unit-I Moment of force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium, two point equivalent loading.

Unit-II Laws of friction, application to simple and complex surface contact friction problems, transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers, theorem of Pappus Guldinus, second moments and the product of area of a plane area, transfer theorem, relation between second moments and products of area, polar moment of area, principal axes.

Unit-III Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass, moment of momentum equation for a single particle and a system of particles.

Unit-IV Translation and rotation of rigid bodies, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references, motion of a particle relative to a rotating frame of reference, frame of reference in general motion.

Books Recommended:

1. I.H. Shames and G. Krishna Mohan Rao: *Engineering Mechanics: Statics and Dynamics*, (4th Ed.) Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta: *Engineering Mechanics: Statics and Dynamics*, 11th Ed. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2010.
3. A.S. Ramsey: *Statics*, Cambridge University Press, 2009.
4. John L. Synge Byron A. Griffith: *Principle of Mechanics*, Mc-GrawHill, International Student Edition, 2011.
5. S.L. Loney: *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*, G.K. Publisher; Second edition, 2016.

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-615 (DS-3) C1	**Boolean Algebra and Automata Theory**	**4L**	**25**	**75**

Unit-I 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.
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.

Unit-II Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: Deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

Unit-III Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

Unit-IV Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence. Undecidability: Recursively enumerable and recursive languages, undecidable problems about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems About CFGs.

Books Recommended:

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

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-615 (DS-3) C2	**Bio Mathematics**	**4L**	**25**	**75**

Unit-I **Continuous Population Models for Single Species 1:** Continuous Growth Models, Insect Outbreak Model: Spruce Budworm, Delay Models, Linear Analysis of Delay Population Models: Periodic Solutions, Delay Models in

Unit-II **Discrete Population Models for a Single Species :** Physiology: Periodic Dynamic Diseases, Harvesting a Single Natural Population, 7 Population Model with Age Distribution Introduction: Simple Models, Cobwebbing :A Graphical Procedure of Solution, Discrete Logistic- Stability, Periodic Solutions and Bifurcations

Unit-III **Models for Interacting Populations**
Type Model: Chaos: Discrete Delay Models. Fishery Management Model, Ecological Implications and Caveats., Tumour Cell Growth, Predator–Prey Models: Lotka– Volterra Systems, Complexity and Stability,

Unit-IV **Some Realistic Models:** Realistic Predator–Prey Models, Analysis of a Predator–Prey Model with Limit Cycle¸ Periodic Behaviour: Parameter Domains of Stability, Competition Models: Competitive Exclusion Principle , Mutualism or Symbiosis, Discrete Growth Models for Interacting Populations

Books Recommended:

1. J.D. Murray: *Mathematical Biology: An Introduction.* Springer Publication, 2002
2. Johannes Müller, Christina Kuttler: *Methods and Models in Mathematical Biology: Deterministic and Stochastic Approaches* (Lecture Notes on Mathematical Modelling in the Life Sciences)
3. Nicholas F. Britton: Essential Mathematical Biology, Ane Books Pvt. Ltd., 2007.

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-616 (DS-4) C1	**Industrial Mathematics**	**4L**	**25**	**75**

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 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.

Books Recommended:

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

B.Sc. (Hons.) Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BHM-616 (DS-4) C2	**Applications of Algebra**	**4L**	**25**	**75**

Unit-I Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

Unit-II Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes.
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.

Unit-III Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of a positive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: 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 squares methods: Approximate solutions of system of linear equations, approximate inverse of an $m \times n$ matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

Books Recommended:

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.