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 – 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
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
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 – 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.) Applied Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – II
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – III
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – IV
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-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.) Applied Mathematics
Semester – VI
Syllabus

Code	Title of Paper	Period per week	Internal Assessment	Semester Examination
BAM-616 (DS-4) C2	**Coding Theory**	**4L**	**25**	**75**

Unit-I The communication channel, The coding problem, Block codes, Hamming metric, Nearest neighbour decoding, Linear codes, Generator and Parity-check matrices, Dual code, Standard array decoding, Syndrome decoding.

Unit-II Hamming codes, Golay codes, Reed-Muller codes, Codes derived from Hadamard matrices. Bounds on codes: Sphere packing bound, Perfect codes, Gilbert-Varshamov bound, Singleton bound, MDS codes, Plotkin bound.

Unit-III Weight distributions of codes, Mac Williams identities. Algebra of polynomials, Residue class rings, Finite fields, Cyclic codes, Generator polynomial and check polynomial, Defining set of a cyclic code.

Unit-IV BCH bound, Encoding and decoding of cyclic codes, Hamming and Golay codes as cyclic codes, BCH codes, Reed-Solomon codes, Quadratic residue codes, Graphical codes, Convolutional codes.

Books Recommended:

1. F.J. Mac Williams and N.J.A.Sloane: *The Theory of Error Correcting Codes*, North Holland, 1977.
2. S. Ling and C. Xing, *Coding Theory: A First Course*, Cambridge University Press, 2004.
3. R.M. Roth: *Introduction to Coding Theory*, Cambridge University Press, 2006.
4. V. Pless: *Introduction to the Theory of Error Correcting Codes*, 3rd Ed., John Wiley, 1999.
5. W.C. Huffman, and V. Pless: *Fundamentals of Error Correcting Codes*, Cambridge University Press, 2003.
6. J. H. Van Lint: *Introduction to Coding Theory*, 3rd Ed., Springer, 1998.
7. T. K. Moon: *Error Correction Coding*, John Wiley and Sons, 2005.

M.Sc. Mathematics with Computer Science, Semester – I

MTM-1.4	Computer Fundamentals & C Programming	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Introduction to Computers, Program, Software, Algorithms, Flow Charts, Introduction to C, Character Set, C Token, Identifier & Keyword, Constants, Variables, Data Types, Data Declaration & Definition, Operators & Expression - Arithmetic, Relational, Logical, Increment & Decrement, Bit wise, Assignment, Conditional.

Unit-II Precedence & Associativity of Operators, Type Conversions - Implicit and Explicit, Console I/O, Control and Selection Statements - If, Nested if, if-else-if, The Alternative -Conditional Expression, Switch, Nested Switch, Iteration Statements for loop, while loop, do-while loop, break, continue, goto statements, Single dimensional and Multi-dimensional Arrays - Accessing array elements, Initializing an array, Strings using arrays.

Unit-III Pointers ï Introduction, Declaration of Pointer, Initializing Pointer, De-referencing Pointer, Pointer to Pointer, Array of Pointers, Strings using pointers.

User-Defined Function, Function Prototype, Definition of Function, Arguments & local variables, Returning and Calling Function by reference & Call by value, Passing Arrays & Strings to Function, Returning Multiple Values, Recursive Functions.

Unit-IV Storage Class & Scope, Structures, Declaration and Initializing Structure, Accessing Structure members, Structure, Assignments, Arrays of Structure, Passing Structure to function, Structure Pointer, Unions, Enumeration, File handling: Introduction, Opening a File, Closing a File, Input/Output Operations on Files, Command Line Arguments.

Books Recommended:

1. P. K Sinha & Sinha, Priti, *Computer Fundamentals*, BPB, 2007.
2. V., Rajaraman, *Fundamentals of Computers*, PHI, 2010.
3. E. Balagruswamy, *Programming in ANSI C*, Tata McGraw Hill, 2011.
4. Gottfried, Byron S., *Programming with C*, Tata McGraw Hill, 2011.
5. Yashwant Kanetker, *Let us C*, BPB, 2007.
6. Yashwant Kanetker, *Pointers in C*, BPB, 2007.
7. R. G. Dromey, *How to Solve by Computer*, Pearson Education, 2007.
8. Deitel & Deitel, *C: How to Program*, Pearson Education, 2003.

M.Sc. Mathematics with Computer Science, Semester – II

MTM-2.3	Differential Equations and Applications	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Existence & uniqueness theorem, General theory of homogenous and nonhomogeneous equations with constant coefficients, Theory of equations with variable coefficients, Method of variation parameter and the formula for particular integral in terms of Wronskian.

Unit-II Series solution of second order linear differential equations near ordinary point, Singularity and the solution in the neighbourhood of regular singular point, Euler equation and Frobenious method, Solution of Legendre, Bessel, Hermite and Lagurre differential equations.

Unit-III Formulation of heat conduction equation and its solution by the method of separation of variables, Steady state condition and the solution of heat conduction problem with non-zero end conditions, Formation of wave equation and its solution by the method of separation of variables.

Unit-IV Linear homogeneous boundary value problems, Eigen values and Eigen functions, Sturm Liouville boundary value problems, Non-homogeneous boundary value problems, Greenôs functions and the solution of boundary value problems in terms of Greenôs functions.

Books Recommended

1. Earl A. Coddington, *An Introduction to Ordinary Differential Equation*, Dover Publications, INC., 2012.
2. Boyce and Diprime, *Elementary Differential Equations and Boundary Value Problems*, Wiley, 2008.
3. H. F. Weinberger, *A First Course in Partial Differential Equations: with Complex Variables and Transform Methods (Dover Books on Mathematics),* Dover Publications, 1995.

M.Sc. Mathematics with Computer Science, Semester – II

MTM-2.5SE	Object Oriented Programming using Java (Skill Enhancement)	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	3+1	3L + 2P

Unit-I Paradigms of Programming Languages, Basic Concepts of Object Oriented Approach, Comparison of Object Oriented and Procedure Oriented Approach, Benefits and Applications of Object Oriented Programming. Introduction to Java, Basic Features of Java, Java Virtual Machine, Java Runtime Environment, Primitive Data Type and Variables, Expressions, Statements and Arrays, Operators, Control Statements.

Unit-II Encapsulation, Classes and Objects, Class Members: Data Members and Member Functions. Class Member Visibility, Understanding Static, Constructors, Argument Passing, Object Initialisation, Garbage Collection. Polymorphism: Ad hoc and Universal Polymorphism. Inheritance Basics: Access Control, Use of Super, Types of Inheritance, Method Overriding, Dynamic Method Dispatching, Preventing Inheritance and Overriding.

Unit-III Defining and Implementing an Interface, Applying Interface, Accession of Interface Variable, Abstract Class. Java API Packages, Using System Packages, Naming Conventions, Creating Packages, Accessing a Package, Adding a Class to a Package. Exception Types, Exception Handling, Catching Multiple Exceptions, Java Built-in Exception, Creating Exception Subclasses.

Unit-IV Multithreading, Main Thread, Creating Threads, Thread Priorities, Life Cycle of Thread, Synchronization in Java, Thread Exceptions, String: Fundamental of Characters and Strings, String and StringBuffer Classes, Introduction to Applet Programming.

Books Recommended:

1. Cay Horstmann, *Computing Concepts with Java Essentials*, 2nd Edition, Wiley India, 2006.
2. Bruce Eckel, *Thinking in Java*, Pearson Education, 2006.
3. H. Schildt, *Java 2: The Complete Reference* (5th ed.), Tata McGraw Hill, 2002.
4. Richard Johnson, *An Introduction to Java Programming and Object-Oriented Application Development*, Thomson Learning, 2006.
5. Deitel & Deitel, *Java-How to Program* (7th ed.), Prentice Hall, 2007.
6. Daniel Liang, *Introduction to Java Programming* (5th ed.), Prentice Hall, 2011.

M.Sc. Mathematics with Computer Science, Semester – III

MTM-3.5C$_1$ Software Engineering	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.	4	4	4

Unit-I Definition, Program Vs Software, Overview of S/W Engineering Process, Software life cycle Models: Build and Fix, Waterfall, Prototype, Iterative Enhancement Model, Evolutionary, Spiral Model, RAD Model.

Unit-II Requirements Engineering Process, Requirements Elicitation & Analysis Techniques, Problem Analysis, Data Flow Diagrams, Data Dictionaries, Software Requirement and Specifications (SRS), Characteristics of good quality SRS, Components of SRS - Functional & Non-Functional Requirements, Requirements Validation, Use Cases, Decision Table, Decision Tree.

Unit-III Software Project Planning Objectives, Project Size Estimation, Cost Estimation - COCOMO Estimation Model. Software Risks, Risk Identification, Risk Refinement, Risk Monitoring & Management. Introduction to Software Design, Principles, Abstraction, Modularity, Information Hiding, Functional Independence, Module Level Concepts: Cohesion, Coupling, Types of Cohesion and Coupling.

Unit-IV Design components - Data Design, Architectural Design, User Interface Design, Component Design, Activity Diagrams. Introduction to Software Testing, Error, Faults, Failure, Software Reliability, Functional and Structural Testing, Basis Path Testing, Cyclomatic complexity, Testing Levels: Unit, Integration, Validation and System Testing, Alpha and Beta Testing, Quality Assurance.

Books Recommended:

1. R.S. Pressman, *Software Engineering: A Practitioner's Approach*, McGraw-Hill, 2014.
2. Pankaj Jalote, *An Integrated Approach to Software Engineering*, Narosa Publishing, 2015.
3. K. K. Aggarwal and Yogesh Singh, *Software Engineering*, New Age International Publishers, 2008.
4. W. S. Jawadekar, *Software Engineering: Principles and Practice*, McGraw-Hill, 2004.
5. Douglas Bell, *Software Engineering for Students*, Addison-Wesley, 2007.

M.Sc. Mathematics with Computer Science, Semester – III

MTM-3.5C$_2$	Object Oriented Analysis & Design	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Introduction to Object Oriented Modelling, Characteristics of Object Oriented Modelling, Differences between Structured Analysis and Object Oriented Analysis, Importance of Modelling, Introduction to UML, Conceptual Model of the UML.

Unit-II Object Modelling, Class and Object, Class Diagram, Object Diagram, Link and Association, Types and Roles, Aggregation, Generalization and Inheritance, Abstract Classes, Interfaces, Generalization as an Extension and Restriction, Multiple Inheritance, Metadata, Candidate keys, Constraints.

Unit-III Dynamic Modelling, Events and States, Signals, State Machine Diagram, Nested State Diagrams, Advanced Dynamic Modelling Concepts, Behaviour Analysis, Interaction Diagram, Use Cases, Activity and Interaction Diagrams.

Unit-IV Functional Modelling, Data Flow Diagrams, Features of a DFD, Architecture Modelling, Packages, Component and Deployment Diagram, Case Study ï Web Application, Vacation Tracking System.

Books Recommended:

1. Grady Booch, *The Unified Modeling Language User Guide*, 2nd Edition, Pearson Education, 2015.
2. Rumbaugh, Blaha, Premerlani, Eddy, Lorensen, *Object-Oriented Modelling and Design*, PHI, 2002.
3. Booch, Maksimchuk, Engle, Young, Conallen, Houston, *Object - Oriented Analysis and Design with Applications*, 3rd Edition, Pearson, 2012.
4. Atul Kahate, *Object Oriented Analysis & Design*, Tata McGraw-Hill, 2004.

M.Sc. Mathematics with Computer Science, Semester – III

MTM-3.6AE	Web Designing (Ability Enhancement)	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	3+1	3L + 2P

Unit-I Brief History of Internet, World Wide Web, Communication on the Internet, Internet Domains, Internet Server Identities, Establishing Connectivity on the Internet, Protocol used in Internet ï TCP/IP, SMTP, PPP, HTTP, Services on the Internet - E-mail, Usenet, FTP, Search Engines, Web Browsers, Web Servers, Design Templates.

Unit-II Introduction to HTML, Basic Structure of a HTML Document, Document Head and Body, Titles and Footers, Working with Texts ï Texts Formatting, Text Styles, Text Effects, Ordered & Unordered Lists, Table ï TR & TD Tags, Cell Spacing, Cell Padding, Colspan, Rowspan, Frames ï FRAME and FRAMESET Tags, Hyperlinks, Forms ï FORM and INPUT Tags, Text Box, Radio Button, Checkbox, SELECT Tag and Pull Down Lists, Hidden, Submit and Reset.

Unit-III Introduction to DHTML, Benefit of CSS, CSS Properties, CSS Styling ï Background, Text Format, Controlling Fonts, Working with Lists and Tables, CSS ID and Class, Web Page Layout and Editing with CSS, Writing JavaScript into HTML, Basic Programming using JavaScript, JavaScript Client Validations, Dialog Boxes, Overview of Document Object Model, Event Handling.

Unit-IV Introduction to Server-Side Programming, Overview of Server-Side Programming Languages, Introduction to Servlets, Servlet Life Cycle, Servlet Implementation and Configuration, Servlet Exception, Requests & Responses, Deployment Descriptor, Session Tracking, Introduction to JSP, JSP Tags, Implicit Objects, Working with Session Objects, Database Connection using JSP/Servlet, Overview of Tomcat Sever ï Configuration and Web Application Deployment.

Books Recommended:

1. Robert W. Sebesta, *Programming the World Wide Web*, (4th ed.), Addison Wesley, 2007.
2. Dick Oliver, Michael Morrison, *Sams Teach Yourself HTML and CSS in 24 Hours*, Pearson Education, 2005.
3. Danny Goodman, *JavaScript & DHTML Cookbook: Solutions and Example for Web Programmers*, O'Reilly Media, 2003.
4. Ivan Bayross, *HTML 5 and CSS 3 Made Simple*, BPB, 2012.
5. Jim Keogh, *J2EE: The Complete Reference*, TMH, 2015.
6. Wrox Press, *Professional JSP J2EE 1.3 Edition*, Shroff Publishers, 2005.

M.Sc. Mathematics with Computer Science, Semester – IV

MTM-4.4	Database Management System	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

Unit-I Introduction to Databases and Database Management System (DBMS), Characteristics of DBMS Approach, Advantages, Disadvantages & Applications of DBMS, Role of DBA, Data Integrity, Entity Integrity, Domain Integrity, Referential Integrity, Keys: Super key, candidate key, alternate key, Introduction to Transactions and Serializability, ACID properties.

Unit-II Three Schema Architecture of DBMS, Data Independence, Classifications of DBMS. Data Model, Types, Data Modelling Using E-R Diagram, Entity Types, Relationship Types, Role names & Recursive relationship, relationship degree, Attributes, Key attributes, Weak Entity, Owner Entity, Identifying relationship, Partial Key, Cardinality and Participation constraint, Characteristics of Hierarchical & Network Model.

Unit-III Relational Model Concepts, Conversion of ER Diagram to Relational Model, Relational Algebra- Select, Project, Cartesian Product, Joins, Division & Set operations, Aggregate Functions, Introduction to Tuple and Domain Relational Calculus, Functional dependency.

Unit-IV Design Guidelines for Relational Schemas, Normalisation, Types of Normal Forms, De-normalization. SQL: DDL, DML, DCL, Queries for Table Creation, Deletion and Modification in SQL, Defining Constraints, Select query for Data Extraction, group by, having, order by clauses, Insert, Delete & Update Statements in SQL, Views in SQL, types of Joins, Aggregate Functions, Nested Queries, Introduction of PL/SQL, Programming Constructs, Procedures, Functions, Exception handling, Cursors.

Books Recommended:

1. Elmasri, Navathe, *Fundamentals of Database Systems*, Pearson Education, 2008.
2. Henry F. Korth, Abraham Silberschatz, S. Sudurshan, *Database System Concepts*, McGraw-Hill, 2005.
3. C. J. Date, *An Introduction to Database Systems*, Pearson, 2006.
4. Ramakrishna, Gehrke, *Database Management Systems*, Mcgraw-Hill, 2014.
5. S.K. Singh, *Database Systems Concepts, Design and Applications*, Pearson, 2011.
6. Jeffrey D. Ullman, Jennifer Widom, *A first course in Database Systems*, Pearson, 2014.

M.Sc. Mathematics with Computer Science, Semester – IV

MTM-4.5C$_2$ Operations Research	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.	4	4	4

Unit-I Convex sets and their properties, Graphical method, Integer Programming, Branch and Bound Technique, Theory of Simplex method, Two-Phase Simplex Method, Big-M method.

Unit-II Duality in LP, Conversion of primal to dual, Dual Simplex method, Sensitivity analysis, Discrete change in price vector, requirement vector and coefficient matrix, adding a new variable and new constraints.

Unit-III Queuing Theory, Distribution of arrival and departure pattern, (M/M/1):(Đ/FCFS), (M/M/1):(N/FCFS) and (M/M/S):(Đ/FCFS) queuing models, Network analysis, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT), Project management with CPM/PERT.

Unit-IV Dynamic programming, Bellmanôs Principle of Optimality, Nonlinear Programming (NLP), Graphical method for NLP, Kuhn-Tucker Conditions for Constrained Optimization, Quadratic Programming, Wolfeôs modified Simplex method, Separable Programming.

Books Recommended:

1. H. A. Taha, *Operations Research*, 9th edition, Pearson Education, 2014.
2. Hillier and Lieberman, *Introduction to Operations Research*, McGraw Hill, 1995.
3. S. D. Sharma, *Operations Research*, Kedar Nath Ram Nath Publishers.
4. J. K. Sharma, *Operations Research – Theory and Application*, Macmillian Publication, 2009.
5. S. M. Sinha, *Mathematical Programming*, Elsevier India Pvt. Ltd., 2005.

M.Sc. Mathematics with Computer Science, Semester – IV

MTM-4.5C$_3$ Lattice Theory	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.	4	4	4

Unit-I Partially ordered set, Least upper bound, Greatest lower bound, Lattice, Sublattice, their Characterizations, Ideals in a lattice, Properties of ideals, Interval, Homomorphism, Isomorphism and its characterization.

Unit-II Zero and all elements in a lattice, Complete lattice, Modular and distributive lattices, Characterization of a modular lattice, Isomorphic, Similar and projective intervals, Refinement of a chain, Schreierôs refinement theorem, Jordan-Holder theorem.

Unit-III A.C.C, and D.C.C., Fundamental dimensionality relation for modular lattice, Independent (join) elements in a lattice & their properties, Complemented modular lattices, Points, Properties of complemented modular lattices with chain condition, Boolean Algebra, Boolean rings, Conversion of a Boolean algebras into Boolean rings and vice-versa.

Unit-IV Algebras, Different types of algebras including Quarternions, Caley, Endomorphism, Derivation of a ring and algebra, Lie ring, Lie ring of endomorphism of an additive abelian group, Inner derivations, Inner derivation for associative and Lie rings.

Books Recommended:

1. N. Jacobson, *Lectures in Abstract Algebra*, Springer, 1951.
2. George Gratzer, *General Lattice Theory*, Springer, 2011.
3. Garrett Birkhoff, *Lattice Theory*, Colloquium Publications, 1940.
4. A. G. Kurosh, *Lectures on General Algebra*, Chelsea Pub. Co, 1963.