

# ***North East University Bangladesh (NEUB)***

*Teli Haor, Sylhet, Bangladesh*

## ***School of Natural Science & Engineering***

### ***Curriculum of:***

***B.Sc Hon's (Math & Information)***

***Department of Mathematics & Information Science***

*NORTHEAST UNIVERSITY BANGLADESH*

*SYLHET, BANGLADESH*

The curriculum of Bachelor of Science (Honours) was developed by the committee comprised of eleven academics who have been teaching Environmental Science & Chemistry in country's leading universities. Professor Dr. M. Khalilur Rahman (NEUB) Chemistry, Professor Dr. Rashed Talukder (Math), Professor Md. Ashraful Alam (Chemistry), Professor Dr. M. A. Majid (Chemistry), Professor Shahidur Rahman (CSE), Professor Dr. E. U. Chowdhury (Statistics), Professor Dr. Nazia Chowdhury (Physics), Dr. Ahmed Jalal F. Samed (Env. Chemistry), Dr. A. M. Chowdhury (Math), Dr. Abul Kalam Azad (GEB) and Dr. Syed Hasanuzzaman (Economic) were the expert members of the committee.

**Northeast University Bangladesh**

**Sylhet, Bangladesh**  
**School of Natural Science and Engineering**  
**Department of Mathematics and Information Science**

Syllabus of B.Sc.(Hons) degree (4 years) for the session 2012 (summer) to 2015  
(Spring)

The department of Mathematics and Information Science offers a program of study leading to the degree of Bachelor of Science with Hon's (B.Sc.(Hon's)) in Mathematics and Information Science under the School of Natural Science and Engineering. The program is of four academic years comprising of 12 semesters. The students are required to complete at least 150 credit hours of courses successfully to obtain the B.Sc. (Hon's.) degree.

A student having minimum 60% class attendance will be eligible to take semester examinations. There will be a distribution of marks for a course in class participation, assignments and mid-semester examination and final examination for which the distribution of marks is as follows:

|                               |
|-------------------------------|
| Class participation: 10%      |
| Assignment & Presentation 10% |
| mid-semester examination: 20% |
| Final examination: 60%        |

The grading system consists of letter grading, corresponding Grade Point Average (GPA) will be awarded as follows:

| Numerical Grade      | Letter Grade | Grade Point |
|----------------------|--------------|-------------|
| 80% and above        | A+           | 4.00        |
| 75% to less than 80% | A            | 3.75        |
| 70% to less than 75% | A-           | 3.50        |
| 65% to less than 70% | B+           | 3.25        |
| 60% to less than 65% | B            | 3.00        |
| 55% to less than 60% | B-           | 2.75        |
| 50% to less than 55% | C+           | 2.50        |
| 45% to less than 50% | C            | 2.25        |
| 40% to less than 45% | C-           | 2.00        |
| 36% to less than 40% | D            | 1.00        |
| Below 36%            | F            | 0.00        |
| Incomplete           | I            | Incomplete  |

Absence from the final examination will be considered incomplete. The distribution of courses for respective academic years and semesters is given below along with the detail of the courses.

**First Year 1<sup>st</sup> Semester (11 Credits)**

| Course Code No. | Course Title                          | Hours/Week<br>Theory+Lab | Credits |
|-----------------|---------------------------------------|--------------------------|---------|
| MIS 111         | Fundamentals of Mathematics           | 3+0                      | 3.0     |
| MIS 113         | Introduction to Computer Language     | 2+0                      | 2.0     |
| MIS 114         | Introduction to Computer Language Lab | 0+3                      | 2.0     |
| ENG 101         | English Language                      | 3+0                      | 3.0     |
| GED101          | Bangladesh Studies                    | 3+0                      | 3.0     |
| Total           |                                       | 11+3                     | 13.0    |

**First Year 2<sup>nd</sup> Semester (12 Credits)**

| Course Code No. | Course Title         | Hours/Week<br>Theory+Lab | Credits |
|-----------------|----------------------|--------------------------|---------|
| MIS 121         | Analytic Geometry    | 3+0                      | 3.0     |
| MIS 123         | Calculus I           | 3+0                      | 3.0     |
| MIS125          | Discrete Mathematics | 3+0                      | 3.0     |
| PHY101          | Physics              | 3+0                      | 3.0     |
| Total           |                      | 12+0                     | 12.0    |

**First Year 3<sup>rd</sup> Semester (11 Credits)**

| Course Code No. | Course Title       | Hours/Week<br>Theory+Lab | Credits |
|-----------------|--------------------|--------------------------|---------|
| MIS 131         | Linear Algebra     | 3+0                      | 3.0     |
| MIS 133         | Calculus II        | 3+0                      | 3.0     |
| MIS135          | Data Structure     | 3+0                      | 3.0     |
| MIS136          | Data Structure Lab | 0+3                      | 2.0     |
| MIS 100         | Viva/Presentation  | 0+0                      | 2.0     |
| Total           |                    | 9+3                      | 13.0    |

**Second Year 1<sup>st</sup> Semester (11 Credits)**

| Course Code No. | Course Title                             | Hours/Week<br>Theory+Lab | Credits |
|-----------------|------------------------------------------|--------------------------|---------|
| MIS211          | Differential Equations                   | 3+0                      | 3.0     |
| MIS213          | Calculus III                             | 3+0                      | 3.0     |
| MIS 215         | Object Oriented Programming Language     | 3+0                      | 3.0     |
| MIS216          | Object Oriented Programming Language Lab | 0+3                      | 2.0     |
| MIS218          | Math Lab                                 | 0+3                      | 2.0     |
| Total           |                                          | 9+6                      | 13.0    |

**Second Year 2<sup>nd</sup> Semester (12 Credits)**

| Course Code No. | Course Title                      | Hours/Week<br>Theory+Lab | Credits |
|-----------------|-----------------------------------|--------------------------|---------|
| MIS221          | Real Analysis                     | 3+0                      | 3.0     |
| MIS223          | Vector Analysis                   | 3+0                      | 3.0     |
| MIS225          | Algorithm Design and Analysis     | 3+0                      | 3.0     |
| MIS226          | Algorithm Design and Analysis Lab | 0+3                      | 2.0     |
| STA201          | Mathematical Statistics           | 3+0                      | 3.0     |
| Total           |                                   | 12+3                     | 14.0    |

**Second Year 3<sup>rd</sup> Semester (11 Credits)**

| Course Code No. | Course Title                                     | Hours/Week<br>Theory+Lab | Credits |
|-----------------|--------------------------------------------------|--------------------------|---------|
| MIS231          | Complex Analysis                                 | 3+0                      | 3.0     |
| MIS233          | Dynamics                                         | 3+0                      | 3.0     |
| MIS 235         | Theory of Computation                            | 2+0                      | 2.0     |
| ENV 201         | Fundamentals of Environment Chemistry and Energy | 3+0                      | 3.0     |
| MIS200          | Viva/Presentation                                | 0+0                      | 2.0     |
| Total           |                                                  | 11+0                     | 13.0    |

**Third Year 1<sup>st</sup> Semester (11 Credits)**

| Course Code No. | Course Title                  | Hours/Week<br>Theory+Lab | Credits |
|-----------------|-------------------------------|--------------------------|---------|
| MIS311          | Theory of Numbers             | 3+0                      | 3.0     |
| MIS313          | Mathematical Methods          | 3+0                      | 3.0     |
| MIS 315         | Information Theory and Coding | 3+0                      | 3.0     |
| MIS 317         | Computational Complexity      | 3+0                      | 3.0     |
| Total           |                               | 12+0                     | 12.0    |

**Third Year 2<sup>nd</sup> Semester (12 Credits)**

| Course Code No. | Course Title           | Hours/Week<br>Theory+Lab | Credits |
|-----------------|------------------------|--------------------------|---------|
| MIS321          | Abstract Algebra       | 3+0                      | 3.0     |
| MIS323          | Hydrodynamics          | 3+0                      | 3.0     |
| MIS325          | Numerical Analysis     | 3+0                      | 3.0     |
| MIS326          | Numerical Analysis Lab | 0+3                      | 2.0     |
| MIS327          | Data Communication     | 3+0                      | 3.0     |
| Total           |                        | 12+3                     | 14.0    |

**Third Year 3<sup>rd</sup> Semester (11 Credits)**

| Course Code No. | Course Title             | Hours/Week<br>Theory+Lab | Credits |
|-----------------|--------------------------|--------------------------|---------|
| MIS331          | General Topology         | 3+0                      | 3.0     |
| MIS 333         | Mathematical Programming | 3+0                      | 3.0     |
| MIS335          | Database System          | 3+0                      | 3.0     |
| MIS336          | Database System Lab      | 0+3                      | 2.0     |
| MIS300          | Viva/Presentation        | 0+0                      | 2.0     |
| Total           |                          | 9+3                      | 13.0    |

**Fourth Year 1<sup>st</sup> Semester (12 Credits)**

| Course Code No. | Course Title                   | Hours/Week<br>Theory+Lab | Credits |
|-----------------|--------------------------------|--------------------------|---------|
| MIS411          | Functional Analysis            | 3+0                      | 3.0     |
| MIS413          | Partial Differential Equations | 3+0                      | 3.0     |
| MIS415          | Operations Research            | 3+0                      | 3.0     |
| MIS417          | Computer Networks              | 3+0                      | 3.0     |
| MIS 418         | Computer Networks Lab          | 0+3                      | 2.0     |
| Total           |                                | 12+3                     | 13.0    |

**Fourth Year 2<sup>nd</sup> Semester (12 Credits)**

| <b>Course Code No.</b> | <b>Course Title</b>        | <b>Hours/Week<br/>Theory+Lab</b> | <b>Credits</b> |
|------------------------|----------------------------|----------------------------------|----------------|
| MIS421                 | Theory of Rings and Fields | 3+0                              | 3.0            |
| MIS423                 | Advance Hydrodynamics      | 3+0                              | 3.0            |
| MIS 425                | Software Engineering       | 3+0                              | 3.0            |
| MIS 426                | Software Engineering Lab   | 0+3                              | 2.0            |
| MIS402                 | Thesis / Project I         | 0+3                              | 2.0            |
| Total                  |                            | 9+6                              | 13.0           |

**Fourth Year 3<sup>rd</sup> Semester (12 Credits)**

| <b>Course Code No.</b> | <b>Course Title</b>                     | <b>Hours/Week<br/>Theory+Lab</b> | <b>Credits</b> |
|------------------------|-----------------------------------------|----------------------------------|----------------|
| MIS431                 | Theory of Groups                        | 3+0                              | 3.0            |
| MIS433                 | Fuzzy Mathematics                       | 3+0                              | 3.0            |
| MIS435                 | Theory of Lattices and Boolean Algebras | 3+0                              | 3.0            |
| MIS437                 | Mathematical Modeling in Biology        | 3+0                              | 3.0            |
| MIS404                 | Thesis / Project II                     | 0+3                              | 2.0            |
| MIS400                 | Viva/Presentation                       | 0+0                              | 2.0            |
| Total                  |                                         | 12+3                             | 16.0           |

Students have to be completed minimum 12 credits in Fourth Year 3<sup>rd</sup> Semester by the approval of the department.

# Detailed Syllabus

## MIS 111 FUNDAMENTALS OF MATHEMATICS

Theory: 3 Hours/Week, 3 Credits

**Sets:** Elementary idea of set; subsets; power set of a set; product set; basic set operations and related theorems on sets; Venn diagrams; countable and uncountable sets; cardinality of a set.

**Real number system:** Set of natural numbers; rational numbers, irrational numbers, real numbers and intervals along with their geometrical representation; absolute value of real number; axioms of real number system.

**Equation and Inequality:** algebraic equations and its solutions, inequality and solution of equations and inequalities.

**Relations and Functions:** Binary relations; reflexive, symmetry anti-symmetry and transitive relations; functions and their domain and range; polynomial, exponential, logarithmic, trigonometric functions and their graphs; algebra of functions; inverse of functions and its graph.

**Complex number system:** Geometrical representation and properties, De Moivre's Theorem and its applications.

**Summation of Series:** algebraic and trigonometric series, Gregory's series.

### Books Recommended:

1. Seymour Lipschutz: *Set Theory*
2. R. David Gustafson and Peter D. Frisk: *Functions and Graphs*
3. Karl J. Smith: *Algebra and Trigonometry with analytic Geometry*

## MIS 113 Introduction to Computer Language

Theory: 2 Hours/Week, 2 Credits

**Programming Language:** Basic concepts, overview of programming languages, problem solving techniques and data flow diagram.

**C-Language:** preliminaries, program constructs, variables and data types in C, input and output, character and formatted I/O, arithmetic expressions and assignment statements, loops and nested loops, decision making, arrays, functions, arguments and local variables, calling functions and arrays, recursion and recursive functions, structures with in structure, files, file functions for sequential and random I/O.

**Pointers:** pointers and structures, pointer and functions, pointer and arrays, operation and pointer, pointer and memory addresses.

**Operations on Bits:** Bit operation, bit field, advanced features, standard and library.

### Books Recommended:

- 1.
- 2.

## MIS 114 Introduction to Computer Language Lab

Theory: 3 Hours/Week, 2 Credits

Syllabus will be designed by the course teacher on the basis of MIS 113.

## ENG 101 English Language

Theory: 3 Hours/Week, 3 Credits

Main verbs, tense, modals and modal-related patterns, causatives, conditionals, subjunctives, infinitives, participle, auxiliary verbs, pronouns, relative pronouns, nouns and adjectives, comparatives, prepositions and prepositional idioms, point of view for syntactical pattern, agreement of verbs, introductory verbal modifier, sentences and clauses, word choice-vocabulary, punctuations, proofreading, comprehensions, paragraph.

**Books Recommended:**

1. *Barron's TOEFL.*
2. *Standard Grammar book of instructor's choice.*

**GED 101 Bangladesh Studies**

**Theory: 3 Hours/Week, 3 Credits**

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**Fundamental concepts:** state, power, sovereignty, law, liberty government, institution, nationalism, constitution, democracy, dictatorship, unity and federal government, society and politics, war of liberation, nature of leadership, political process, constitutional framework of public administration, public service commission, ministry, secretariat, bureaucracy and local government.

**Economy of Bangladesh:** Socio-economic indicators of Bangladesh-GDP, Savings and Investment-Prices, wages and employment-agriculture-industry-power & Energy-transport & Communication-Human Resource Development-Poverty Alleviation-Population-economic planning.

**Books Recommended:**

1. Banglapedia
2. Economic Review of Bangladesh

**MIS 121 Analytic Geometry**

**Theory: 3 Hours/Week, 3 Credits**

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**Two dimensional geometry:** Coordinate system, straight line in a plane; distance of two lines; slope of a line; tangent and normal on a curve; pair of straight lines; basic properties of circle, parabola, ellipse and hyperbola; change of coordinates and axes; general equation of second degree; reduction of general equation of second degree to standard form and identification of conic; polar and parametric equations of conic; poles, polar and chords in terms of middle points.

**Coordinates in three dimensions:** Different systems of coordinates and transformations of coordinates; direction cosines; direction ratios; planes and straight lines in three dimensions; general equation of second degree in three variables, reduction to standard forms and identification of conicoids; sphere, cylinder, cone, ellipsoid, paraboloid and hyperboloid.

**Books Recommended:**

1. *Smith, C.: An Elementary Treatise on Solid Geometry.*
2. *Thomas and Finney: Calculus and Analytic Geometry*
3. *Bell, R. J. T.: An Elementary Treatise on Coordinate Geometry of Three Dimension.*

**MIS 123 Calculus I**

**Theory: 3 Hours/Week, 3 Credits**

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**Functions:** Functions of single variable, domain and range of a function, graph of simple functions such as polynomials, exponential functions, logarithmic function and trigonometric functions, inverse function.

**Limit and continuity** of single variable functions.

**Differentiation:** Derivative of a function, derivative of algebraic, trigonometric and hyperbolic functions, parametric functions, implicit functions, Intermediate forms and L'Hospital rules; successive differentiations and Leibnitz's Theorem.

**Applications of derivatives:** The significance of the first derivative; Rolle's theorem; mean value theorem; Taylor's theorem in different forms; Maclaurin's series and their application for the expansion of functions; increasing and decreasing functions; concavity and point of inflection; asymptotes and symmetry; maxima and minima; involute; evolutes; envelope.

**Polar coordinates:** Polar coordinate systems, graphs of polar equations; polar equations of conic and other curves.

**Curve tracing:** Tracing the curves using the ideas of calculus.

**Books Recommended:**

1. *Thomas and Finney:* Calculus and Analytic Geometry
2. *Swokowski, E. W.:* Calculus with Analytic Geometry

**MIS125 Discrete Mathematics**

**Theory: 3 Hours/Week, 3 Credits**

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**Number systems:** Numbers with different bases; their conversions and arithmetic operations; normalized scientific notation. **Logic:** Introduction to logic; elements of logic; conditional propositions and logical equivalence; quantifiers; method of proofs; mathematical induction; recursion and iteration. **Boolean functions and expressions,** Logic gates; minimization of Boolean expressions; Karnaugh maps; Karnaugh map algorithm. **Graphs:** Introduction; the bridges of Königsberg; representing graphs and graph isomorphism; connected graph; planar graph; path and circuit; shortest path algorithm; Eulerian path; Euler's theorem; graph coloring. **Application of graphs:** Trees; tree traversal; trees and sorting; cryptology coding; decoding; encoding. Huffman code; error correcting codes; Hamming code; spanning tree; minimum spanning trees; Kruskal's algorithm. **Modeling computation:** Languages and grammars; finite state machine; language of finite state machine; accepted and non-accepted finite state machine; Turing machine.

**Books Recommended:**

1. *Rosen, K.H.:* Discrete Mathematics and its application, *McGraw-Hill International edition (4<sup>th</sup> edition)* 1999
2. *Biggs, N. L.:* Discrete Mathematics, Clarendon press, Oxford (2<sup>nd</sup> Print.) 1987
3. *Cameron, P. J. and J. H. Van Kint:* Graph Theory, Coding Theory and Block Designs C.U.P 197
4. *Bose, R. C. and B. Manvel:* Introduction to Combinatorial Theory J. Willey 1984

**PHY101 Physics**

**Theory: 3 Hours/Week, 3 Credits**

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**Properties of matter and waves:** Elasticity, Surface Tension, Traveling Waves, Stationary waves, sound waves.

**Heat and Thermodynamics:** concept of temperature and zeroth law of thermodynamics, first law and its application, isothermal and adiabatic relations, kinetic theory of gases, Vander Waal's equation of state, second law, Carnot cycle, concept of entropy.

**Electricity and Magnetism:** electric field and potential, current, resistance, electromotive force and circuits, magnetic field, ampere's law, magnetic induction.

**Books Recommended:**

1. *Mathur, D.S.,* Elements of Properties of Matter
2. *Duckworth, H.E.,* Electricity and Magnetism.
3. *Ferrard, V.C.A.,* electromagnetism

**MIS 131 Linear Algebra**

**Theory: 3 Hours/Week, 3 Credits**

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**Matrices:** Introduction to matrices, matrix algebra, inverse of a matrix; elementary row operations and echelon forms of matrix; rank of a matrix; use of rank and echelon form in solving system of homogeneous and non-homogeneous equations.

**Vector space** and subspace over real numbers, direct sum; linear combination; linear dependence and independence of vectors; basis and dimension of vector space.

**Linear transformations;** kernel, rank and nullity; matrix representation; change of basis; eigenvalues and eigenvectors; characteristic equations; Cayley-Hamilton theorem; diagonalization of matrices; similar matrices; canonical forms; orthogonal and Hermitian matrices.

**Inner product space;** orthogonal vectors and orthonormal basis; Gram-Schmidt orthogonalization process. Bilinear and quadratic forms.

**Books Recommended:**

1. *Hamilton, A. G.:* Linear Algebra
2. *Anton, H. and Rorres, C.:* Elementary Linear algebra with Applications.
3. *Lipschutz, S.:* Linear Algebra

**MIS 133Calculus II**

**Theory: 3 Hours/Week, 3 Credits**

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**Integration:** Introduction; indefinite integrals; basic integration formulas; integration by parts; products and powers of trigonometric functions; even powers of sine's and cosines trigonometric substitutions; partial fractions; definite integrals; calculating areas as limits; the fundamental theorems of integral calculus; integration by substitution; rules for approximating definite integrals, improper integrals; reduction formulae; Gamma and Beta functions.

**Applications of definite integrals:** Area between two curves; calculating volumes by slicing; volumes modeled with shells and washers; length of a plane curve; area of a surface of revolution; average value of a function.

**Books Recommended:**

1. *Thomas and Finney:* Calculus and Analytic Geometry
2. *Swokowski, E. W.:* Calculus with Analytic Geometry

**MIS135Data Structure**

**Theory: 3 Hours/Week, 3 Credits**

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Internal data representation, specification, representation and manipulation of basic data structures: arrays, records, and pointers, linked lists, stacks, queues, recursion, trees, optimal search trees, heaps, graph and their application, string processing, searching, sorting and hashing techniques.

**Books Recommended:**

1. *Lipschutz, S.,* Data Structures.

**MIS136Data Structure Lab**

**Theory: 3 Hours/Week, 2 Credits**

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Syllabus will be designed by the course teacher on the basis of MIS 135.

**MIS211Differential Equations**

**Theory: 3 Hours/Week, 3 Credits**

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**Introduction** to differential equations. **Ordinary differential equations and their solutions:** Ordinary differential equations of first order and first degree; ordinary differential equations of 1st order but of higher degree; initial value problem; orthogonal trajectories; general solution of linearordinary differential equations (homogeneous and non-homogeneous) with constant coefficients; methods of undetermined coefficients and variation of parameters; reduction of order; solution in series; simple cases of non-linear differential equations; system of linear ordinary differential equations.

**Books Recommended:**

1. Ayres, F.: Differential Equations
2. Ross, L.: Introduction to Differential Equations

**MIS213Calculus III****Theory: 3 Hours/Week, 3 Credits**

**Partial derivatives:** Functions of two or more variables; limits and continuity; partial derivatives; chain rule; gradients; directional derivatives and tangent planes; higher order derivatives; partial differentials; linear approximation and increment estimation; maxima, minima and saddle points; Lagrange multipliers; exact differentials; Taylor's theorem. **Multiple integrals:** Double integrals; areas and volumes; physical applications; changing to polar coordinates; triple integral in rectangular coordinates; physical application in three dimensions.

**Books Recommended:**

1. Stewart, J.: Calculus
2. Thomas and Finney: Calculus and Analytic Geometry
3. Swokowski, E. W.: Calculus with Analytic Geometry

**MIS215Object Oriented Programming Language****Theory: 3 Hours/Week, 3 Credits**

**Introduction to Java:** History of Java, Java Class Libraries, Introduction to Java Programming, A simple Program. **Developing Java Application:** Introduction, Algorithms, Pseudo code, Control Structure, The If /Else Selection Structure, The While Repetition Structure, Assignment Operators, Increment and Decrement Operators, Primitive Data Types, Common Escape Sequence, Logical Operator

**Control Structure:** Introduction, The For Structure, The Switch Structure, The Do/While Structure, The Break and Continue Structure. **Methods:** Introduction, Program Module in Java, Math Class Methods, Method Definitions, Java API Packages, Automatic Variables, Recursion, Method Overloading, Method of the Applet Class. **Arrays :** Introduction, Arrays, Declaring and Allocating Arrays, Passing Arrays to Methods, Sorting Arrays, Searching Arrays, Multiple-Subscripted Arrays

**Object-Based Programming:** Introduction, Implementing a Time Abstract DataType with a Class, Class Scope, Controlling Access to Members, Utility Methods, Constructors, Using Overload Constructor, Using Set and Get Method, Software Reusability, Friendly Members, Finalizers, Static Class Members, Data Abstraction and Information Hiding

**Object-Oriented Programming:** Introduction, Superclasses and Subclasses, Protected Members, Using Constructor and Finalizers in Subclasses, Composition vs. Inheritance, Introduction to polymorphism, Dynamic method building, Final Methods and Classes, Abstract Superclasses and Concrete Classes. **String and Characters, Graphics, Exception Handling, Files and Stream, Java API, Utility Classes, 2D Graphics, GUI, Swing, Events.**

**MIS216Object Oriented Programming LanguageLab****Theory: 3 Hours/Week, 2 Credits**

**Object-Oriented Programming:** Classes and objects, Constructors and destructor, Encapsulation of class members and methods, Manipulating objects. **Dynamic Memory Allocation:** Pointers to objects, Pointers and arrays, Call-by-reference and call-by-value. **Concept of Inheritance, Interface and Polymorphism:** Direct and indirect inheritance, Private and protected members of inherited class, Constructors and destructors under inheritance, Polymorphism, Abstract base classes. **Exceptions:** Error handling in program, Creating own exception. **Handling Files:** Input/Output streams, Processing files, Random access files. **Thread Programming:** Introduction to threads, Using threads to solve multi-tasking problems, Thread synchronization. **Client-Server programming:** Applet and Servlets, Introduction to JSP, Socket programming. **GUI:** Basic user interface design using Java swing.

**Understanding Java Enterprise Level Works.**

### MIS 218 Math Lab

#### Theory: 3 Hours/Week, 2 Credits

Using C: solutions of quadratic equations, area of different geometrical figures, summation of series, Fibonacci numbers, prime numbers, sorting, multiplication of two matrices, evaluation of determinant, determination of transpose, characteristic polynomial, eigenvalues, eigenvectors and inverse of a matrix, solutions of simultaneous linear and nonlinear equations, determination of positions of points and of straight lines in three dimensional space, constructions of models using hard-paper to locate the positions of planes and straight lines in three dimensional space, determination of maximum and minimum values of a function, curve tracing.

### MIS221 Real Analysis I

#### Theory: 3 Hours/Week, 3 Credits

**Real number system:** Bounded sets of real numbers; supremum and infimum; the completeness axiom and Dedekind's axiom; neighbourhoods; open and closed sets of real numbers; limit/cluster points of a set of real numbers; Bolzano-Weierstrass theorem; derived set and closure of a set. **Sequence of real numbers:** Definition of a sequence; convergence of a sequence; subsequence; monotonic sequence; bounded sequence; Cauchy sequence; Cauchy criteria for convergence of sequences. **Infinite series:** Concept of sum and convergence; series of positive terms; alternating series; absolute and conditional convergence; various tests for convergence. **Limit, continuity and differentiability of functions:** Limit and continuity of functions with their properties; uniform continuity; Heine-Borel theorem; differentiability of functions; Rolle's theorem; mean value theorem; Darboux theorem; intermediate value theorem for derivatives; Taylor's theorem with remainder in Lagrange's and Cauchy's forms; Maclaurin's series; expansions of functions. **Power series:** Interval and radius of convergence; differentiation and integration of power series; identity theorem; Abel's continuity theorem. **Riemann integrals:** Riemann sum and Riemann integral; Darboux sums and Darboux integrals, Darboux integrability and Riemann integrability; properties of integrals; fundamental theorem of integral calculus.

#### Books Recommended:

1. *Rudin, W.:* Principle of mathematical analysis
2. *Apostol, I.:* Mathematical Analysis
3. *Marsden, J.E. and Hoffman, M.J.:* Elementary Classical Analysis
4. *Chowdhury, F. and Chowdhury, M.R.:* Essentials of Real Analysis

### MIS223 Vector Analysis

#### Theory: 3 Hours/Week, 3 Credits

**Vectors:** Vector and scalar quantities, vector algebra, dot and cross products of vectors, components of a vector, vector projection, vectors in the plane and in space.

**Vector valued functions:** introduction to vector valued functions and their limit and continuity.

**Vector differentiation:** Vector and scalar fields; vector operator, directional derivatives; gradient, divergence, curl.

**Vector integration:** Line, surface and volume integrals; theorems of Green, Gauss and Stokes with their applications.

#### Books Recommended:

1. *Spiegel, M.R.:* Vector Analysis
2. *Thomas and Finney:* Calculus and Analytic Geometry

### MIS225 Algorithm Design and Analysis

#### Theory: 3 Hours/Week, 3 Credits

#### **Analysis of Algorithm:**

Asymptotic analysis: Recurrences, Substitution method, Recurrence tree method, Master method

**Divide-and-Conquer:** Binary search, Powering a number, Fibonacci numbers, Matrix Multiplication, Strassen's Algorithm for Matrix Multiplication.

**Sorting:** Insertion sort, Merge sort, Quick sort, Randomized quick sort, Decision tree, Counting sort, Radix sort.

**Order Statistics:** Randomized divide and conquer, worst case linear time order statistics.

**Graph:** Representation, Traversing a graph, Topological sorting, Connected Components.

**Dynamic Programming:** Elements of DP (Optimal substructure, Overlapping subproblem), Longest Common Subsequence finding problem, Matrix Chain Multiplication.

**Greedy Method:** Greedy choice property, elements of greedy strategy, Activity selector problem, Minimum spanning tree (Prims algorithm, Kruskal algorithm), Huffman coding.

**Shortest Path Algorithms:** Dynamic and Greedy properties, Dijkstra's algorithm with its correctness and analysis, Bellman-ford algorithm, All pair shortest path: Warshall's algorithm, Johnson's algorithm

**Network flow:** Maximum flow, Max-flow-min-cut, Bipartite matching.

**Backtracking/Branch-and-Bound:** Permutation, Combination, 8-queen problem, 15-puzzle problem.

**Geometric algorithm:** Segment-segment intersection, Convex-hull, Closest pair problem.

**And NP Completeness, NP hard and NP complete problems.**

### **MIS226Algorithm Design and Analysis Lab**

**Theory: 3 Hours/Week, 2 Credits**

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Using different well known algorithms to solve the problem of Matrix-Chain Multiplication, Longest Common Subsequence, Huffman codes generation, Permutation, Combination, 8-queen problem, 15-puzzle, BFS, DFS, flood fill using DFS, Topological sorting, Strongly connected component, finding minimum spanning tree, finding shortest path (Dijkstra's algorithm and Bellman-Ford's algorithm), Flow networks and maximum bipartite matching, Finding the convex hull, Closest pair.

### **STA201Mathematical Statistics**

**Theory: 3 Hours/Week, 3 Credits**

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Discrete and continuous variables, population and sample, frequency distribution, Graphical representations of data; mean media mode, geometric mean, harmonic mean, variance, standard sample regression and correlation, regression coefficients, method of least squares, correlation co-efficient, rank correlation, correlation ratio, multiple correlation and regression. Sample space and Events, probabilities defined on events, conditional probabilities. Basic concepts of probability distribution and sampling distribution.

#### **Books Recommended:**

1. *Yule and Kendel: An Introduction to the Theory of Statistics*
2. *Weatherbum: A First Course in Mathematical Statistics*
3. *Mosteller R. Thomas: Probability with Statistical Application.*

### **MIS231Complex Analysis**

**Theory: 3 Hours/Week, 3 Credits**

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**Complex variables:** Geometry of the complex plane; elementary functions of a complex variable (including the general power and the logarithm). **Limit, continuity and differentiability** of functions of a complex variable; analytic functions and their properties; harmonic functions; meromorphic function and entire function. **Complex integrals:** Line integral over rectifiable curves; Cauchy's theorem for simple contours; Cauchy's integral formula; theorems of Liouville and Morera; fundamental theorem of algebra. **Zeros, singularities, poles and residues;** Taylor's and Laurent's series; expansion of functions; Cauchy's residue theorem; Rouché's theorem; the maximum modulus principle; evaluation of real integrals by contour integrations. **Conformal mappings,** bilinear transformations and their properties.

**Books Recommended:**

1. *Churchill and Brown: Complex variables and Applications*
2. *Stewart and Tall: Complex Analysis*
3. *Spiegel, M. R.: Complex Variable*
4. *Copson, E. I.: Theory of Function of Complex Variables*

**MIS233 Dynamics****Theory: 3 Hours/Week, 3 Credits**

**Rigid body motion:** motion under no forces, K.E. and angular momentum, inertia tensor, Euler's equations, invariable line and plane, momental ellipsoid, motion of rockets and artificial satellites.

**Lagrangian Meoanics:** Generalized coordinates, Holonomic dynamical systems, Derivation of Lagrange's equations, application of Lagrange's equations.

**Hamiltonian Mechanics:** Hamilton's variational principle, Euler-Lagrange's equation, Hamilton's canonical equations of motion, principle of least action, Hamilton-Jacobi's equation.

**Books Recommended:**

1. *Goldstein, H., Classical Mechanics*
2. *Whittaker, E.T., Dynamics*
3. *Rutherford, Classical Mechanics*
4. *Chorlton, F.: Text Book of Dynamics*

**MIS235 Theory of Computation****Theory: 2 Hours/Week, 2 Credits**

**Finite Automata:** Deterministic and nondeterministic finite automata and their equivalence. Equivalence with regular expressions, closure properties. The pumping lemma and applications. **Context-free Grammars:** Definitions, Parse trees. The pumping lemma for CFLs and applications. Normal forms. General parsing. Sketch of equivalence with pushdown automata.

**Turing Machines:** Designing simple TMs. Variations in the basic model (multi-tape, multi-head, nondeterminism). Church-Turing thesis and evidence to support it through the study of other models. **Undecidability:** The undecidability of the halting problem. Reductions to other problems. Reduction in general.

**ENV201 Fundamentals of Environment Chemistry and Energy****Theory: 3 Hours/Week, 3 Credits**

**1. Environmental Chemistry:** Concepts and Scope of Environmental chemistry, Nomenclature, Environmental segments, The natural cycles of the Environment.

**2. Chemistry of Atmosphere:** Composition of the atmosphere, Atmosphere structure, Evolution of the atmosphere, Earth's radiation balance, Particles, ions and radicals in the atmosphere, chemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry, Sulphur dioxide, Nitrogen oxide, Organic compounds, Green House Effect., Ozone hole, Human activities in meteorology.

**3. Energy:** History, different forms of energy, sources, conversion and storage. Renewable and non-renewable energy. **Hydro Energy:** Potential resources, Common features and Socio- economic issues of Hydro power installations. **Fossil Base Energy:** Fossil fuel types, Combustion kinetics and environmental impact, Clean combustion technologies. **Biomass Energy:** Definitions, Chemical and Physical properties, Thermal conversion to heat and electricity, Resources and production, Socio- economic and environment impacts. **Solar energy:** Potential & production, solar cells, Solar thermal energy power generation. **Wind Energy:** Potential and production.

**4. Environmental Ecology:** Concept, definition, branches and scope of ecology, autecology, synecology, habitat and ecological niche, habitat ecology – aquatic and terrestrial.

**5. Environmental protection, Global warming, Environmental changes, etc.**

**Books Recommended:**

1. Odum, E. P. Saunders Com, W. B. Fundamentals of Ecology, 3<sup>rd</sup> Edition
2. Edward, J. Kormondy. Concepts of Ecology- Prentice-Hall of India Pvt. Ltd., New Delhi
3. Clerke. Elements of Ecology, John Wiley & Son
4. Andrew R. W., Jackson & Julie M. Jackson, "Environmental Science – The Natural Environment and Human Impact", Addison Wesley Longman Limited
5. Santra, S. C. "Environmental Science", 2<sup>nd</sup> Edition, New Central Book Agency (P) Ltd, Kolkata, India
6. Fowler, John M., "Energy and the Environment", 2<sup>nd</sup> Edition, McGraw Hill, New York

**MIS311 Theory of Numbers****Theory: 3 Hours/Week, 3 Credits**

**Divisibility** and greatest common divisors; arithmetic in  $\mathbb{Z}$ ; prime numbers and perfect numbers; fundamental theorem of arithmetic and its consequences; division algorithm; **congruence**; least residue theorem; Fermat's theorem, Euler's theorem and Wilson's theorem; solutions of congruence; Lagrange's theorem of congruence; Chinese remainder theorem; arithmetic functions and their properties; multiplicative functions; Zeta function and its relation with arithmetic functions; **quadratic residues and non-residues**; law of quadratic reciprocity; **Legendre symbol**; some Diophantine equations and their solutions; representation of integers by sum of two squares or four sum squares; solution of the equation  $z^2 = x^2 + y^2$ ; **Selberg's proof** of the prime number theorems.

**Books Recommended:**

1. *Apostol*: Theory of Numbers
2. *Chowdhury, F. and Chowdhury, M.R.*: Essentials of Number Theory
3. *Hardy, G. H. and Wright, E. M.*: Theory of Numbers

**MIS313 Mathematical Methods****Theory: 3 Hours/Week, 3 Credits**

**Fourier series**, Fourier integral, Fourier transform and their applications. **Laplace transform** and its applications in differential equations. **Harmonic functions**: Laplace equation in different coordinates and its applications. Concepts of singularities and series solutions; Legendre polynomials, Hermite polynomials, Laguerre functions, Bessel function and their properties. **Boundary value problems** involving second order ordinary differential equations; eigenfunction, expansions and Green's functions. Ideas about Sturm-Liouville problems. **Linear integral equations**: Elementary ideas.

**Books Recommended:**

1. *Stephenson*: Mathematical Methods
2. *Ross, S. L.*: Introduction to Differential Equations
3. *Spiegel, M. R.*: Laplace Transform

**MIS315 Information Theory and Coding****Theory: 3 Hours/Week, 3 Credits**

Review of probability theory, Entropy, Mutual information, Data compression, Huffman coding, Asymptotic equipartition property, Universal source coding, Channel capacity, Differential entropy, Block codes and Convolutional codes.

**MIS317 Computational Complexity****Theory: 3 Hours/Week, 3 Credits**

Basic Concepts - Problem: Definition, encoding, instance, size, decision & optimization problems. Turing Machines - Deterministic and Nondeterministic polynomial Reducibility. Classification of Problems - P, NP, NP-complete, NP-hard. Examples

of similarly defined easy and difficult problems. Cook's Theorem, several important NP-complete problems, techniques of proving a problem, NP-complete restriction, component design, local replacement problems of intermediate complexity, problems beyond NP.

### MIS321 Abstract Algebra

Theory: 3 Hours/Week, 3 Credits

**Groupoids;** monoids and semigroups. **Groups;** subgroups; orders of elements in a group; cyclic group; multiplication of subgroups; cosets; Lagrange's theorem; normal subgroups; quotient (factor) groups; centre of a group; permutation groups; homomorphism, isomorphism and automorphism of groups with related theorems; Cayley's theorem; generalized isomorphism theorem; centralizer and normalizer of an element/subset in a group. **Rings;** different types of rings; subrings; ideals; prime, maximal, minimal and principal ideals with related theorems; idempotent and nilpotent ideals; sum and direct sum of ideals; factor (quotient) rings.

#### Books Recommended:

1. Herstein, I. N.: Topics in Algebra
2. Paley, H. and P. M. Weicheel: A First Course in Abstract Algebra
3. John B. Fraleigh: A First Course in Abstract Algebra

### MIS323 Hydrodynamics

Theory: 3 Hours/Week, 3 Credits

**Introductory motion:** Physical dimension; stream lines and path lines; hydrodynamic pressure; Bernoulli's theorem; adiabatic expansion. **Equation of motion:** Equation of continuity; equation of motion of inviscid liquid and Bernoulli's equation; steady motion and conservative forces; circulation and Kelvin's theorem; vorticity; irrotational motion and velocity potential; the energy equation; kinetic energy and Kelvin's minimum energy theorem. **Two dimensional motions:** Rate of change of vorticity; stream function and pressure equation; streaming motions; complex potential and complex velocity; stagnation points; circle theorem; motion past a cylinder; Joukowski transformation; Blasius theorem. **Two dimensional source and sink:** Doublets; combination of source and stream; source and sink of equal strength; source and sink in a stream; the method of image; source outside a cylinder. **Vortex motions:** Vortex lines; tubes and filaments; rectilinear vortex; circular vortex; and vortex doublets; kinetic energy of a system of vortices; vortex in or outside of a circular cylinder; vortex sheet; single infinite row of vortices and Karman's vortex street.

#### Books Recommended:

1. Milne-Thompson, L. M.: Theoretical Hydrodynamics
2. Lamb, H.: Hydrodynamics
3. Ramsey: Hydrodynamics

### MIS325 Numerical Analysis

Theory: 3 Hours/Week, 3 Credits

**Errors in numerical calculations:** Errors definitions, sources, examples; propagation error; a general error formula. **Root finding:** The bisection method; the iteration method; the method of false position; Newton-Raphson method. **Methods of interpolation theory:** Polynomial interpolation; error in polynomial interpolation; interpolation using Newton's forward and backward formulas and Newton's divided difference formula and central difference formula; Stirling's interpolating polynomial; Lagrange's interpolating polynomial; idea of extrapolation. **Numerical integration:** Trapezoidal method; Simpson's method; Weddle's method; Romberg's method; error analysis. **Interpolation:** Quadratic and cubic spline interpolation methods. **Solutions of systems of linear equations:** Gaussian elimination with and without pivoting; iteration method; solution of tri-diagonal system of equations. **Numerical solution of ordinary differential equation (IVP):** Euler's method (including modified form); Runge-Kutta method; predictor and corrector method. **Boundary value problem:** explicit and implicit finite

difference method for BVP involving ODE; explicit finite difference method for BVP involving PDE (elliptic, parabolic and hyperbolic).

**Books Recommended:**

1. *Hilderman, F. B.:* Introduction to Numerical Analysis
2. *Burden, R. L., and Faires, J. D.:* Numerical Analysis
3. *Gerald and Wheatley:* Applied Numerical Analysis
4. *Smith, G.D.:* Numerical solution of Partial Differential Equations
5. *Jain, M. K.:* Numerical Solution of Differential equations

**MIS326 Numerical Analysis Lab**  
**Theory: 3 Hours/Week, 2 Credits**

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Syllabus for programming will be designed by course teacher.

**MIS327 Data Communication**  
**Theory: 3 Hours/Week, 3 Credits**

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Fourier transforms; Modulation techniques: AM, FM, PM, OOK, FSK, PSK, QPSK, QAM; Pulse modulation- PCM, PPM, PAM, Delta modulation; Companding; Equalizers; Echo cancellation; Intersymbol interference; TDM, FDM; Error due to noise; Concept of channel coding and capacity;

**MIS331 General Topology**  
**Theory: 3 Hours/Week, 3 Credits**

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**Topology and topological space;** open sets and closed sets; closure of a set; interior, exterior and boundary; neighborhoods and neighborhoods systems; weak and strong topology; topology of the real line and plane; cofinite and cocountable topology; subspaces; relative topology; bases and subbases for a topology; continuity and topological equivalence; homeomorphic spaces. **Metric and normed spaces:** Metric topologies; properties of metric spaces; metrizable space; Hilbert space; convergence and continuity in metric space; normed spaces. **Countability:** First countable spaces; second countable spaces and related theorems. **Compactness:** Covers; compact sets; subset of a compact space; finite intersection property; Bolzano-Weierstrass theorem; locally compact spaces. **Connectedness:** Separated sets; connected sets; connected spaces; components; locally connected spaces and simply connected spaces. **Separation axioms:**  $T_1$ -spaces; Hausdorff spaces; regular spaces; normal spaces; completely normal spaces and completely regular spaces.

**Books Recommended:**

1. *Simmons, G.F.:* Introduction to Topology and Modern Analysis
2. *Gal, S.:* Point Set Topology
3. *Lipschutz, S.:* General Topology
4. *Kelley, J.L.:* General Topology
5. *Hocking and Young:* Topology

**MIS333 Mathematical Programming**  
**Theory: 3 Hours/Week, 3 Credits**

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**Linear programming:** Linear programs; convex set; graphical solution of systems of linear inequalities and linear program; solution of linear program by simplex method; algebraic basis and computational set up; duality problem-duality theorem; transportation set problems; assignment problem and simple applications; connection between linear programming and two-person zero-sum matrix game; simple inventory problems. **Non-linear programming:** Definiteness of matrix; general

optimization problem; concave and convex functions; optimization of convex functions; general nonlinear programming problem; tangent plane; regular point; equality constraint; Lagrangian for equality and inequality constraints; Kuhn-Tucker condition; standard extremization problem of convex and concave programming; saddle point.

**Books Recommended:**

1. Haldey, G.: Linear Programming
2. Gass, S.I.: Mathematical Programming
3. Luenberger: Linear and Nonlinear Programming

**MIS335 Database System**

**Theory: 3 Hours/Week, 3 Credits**

**Introduction:** Purpose of Database Systems, Data Abstraction, Data Models, Instances and Schemes, Data Independence, Data Definition Language, Data Manipulation Language, Database Manager, Database administrator, Database Users, Overall System Structure, Advantages and Disadvantage of a Database Systems. Data Mining and analysis, Database Architecture, History of Database Systems

**Relationship Entity-Model:** Entities and Entity Sets, Relationships and Relationship Sets, Attributes, Composite and Multivalued Attributes, Mapping Constraints, Keys, Entity-Relationship Diagram, Reducing of E-R Diagram to Tables, Generalization, Attribute Inheritance, Aggregation, Alternative E-R Notations, Design of an E-R Database Scheme.

**Relational Model:** Structure of Relational Database, Fundamental Relational Algebra Operations, The Tuple Relational Calculus, The Domain Relational Calculus, Modifying the Database.

**Relational Commercial Language:** SQL, Basic structure of SQL Queries, Query-by-Example, Quel., Nested Sub queries, Complex queries, Integrity Constraints, Authorization, Dynamic SQL, Recursive Queries.

**Relational Database Design:** Pitfalls in Relational Database Design, Functional Dependency Theory, Normalization using Functional Dependencies, Normalization using Multivalued Dependencies, Normalization using join Dependencies, Database Design Process.

**File And System Structure:** Overall System Structure, Physical Storage Media, File Organization, RAID, Organization of Records into Blocks, Sequential Files, Mapping Relational Data to Files, Data Dictionary Storage, Buffer Management.

**Indexing And Hashing:** Basic Concepts, Ordered Indices, B+ -Tree Index Files, B-Tree Index Files, Static and Dynamic Hash Function, Comparison of Indexing and Hashing, Index Definition in SQL, Multiple Key Access.

**Query Processing and Optimization:** Query Interpretation, Equivalence of Expressions, Estimation of Query-Processing Cost, Estimation of Costs of Access Using Indices, Join Strategies, Join Strategies for parallel Processing, Structure of the query Optimizer, Transformation of Relational Expression

**Concurrency Control:** Schedules, Testing for Serializability, Lock-Based Protocols, Timestamp-Based Protocols, Validation Techniques, Multiple Granularity, Multiversion Schemes, Insert and Delete Operations, Deadlock Handling

**Distributed Database:** Structure of Distributed Databases, Trade-off in Distributing the Database, Design of Distributed Database, Transparency and Autonomy, Distributed Query Processing, Recovery in Distributed Systems, Commit Protocols, Concurrency Control.

**Data Mining and Information Retrieval:** Data analysis and OLAP, Data Warehouse, Data Mining, Relevance Ranking Using Terms, Relevance Ranking Using Hyperlink, Synonyms, Homonyms, Ontology, Indexing of Document, Measuring Retrieval Efficiencies, Information Retrieval and Structured Data.

**Books Recommended**

1. Abraham Silberschatz, Henry K. Korth, S. Sudarshan Database System Concepts – (5<sup>th</sup> edition)
2. Benjamin/Cummings, Fundamentals of Database Systems -, 1994
3. Morgan Kaufmann, Database Principles, Programming, Performance - 1994
4. Prentice Hall, A First Course in Database Systems -, 1997
5. McGraw Hill, Database Management Systems, , 1996

**MIS336 Database System Lab**

**Theory: 3 Hours/Week, 2 Credits**

**Introduction:** What is database, MySQL , Oracle , SQL, Datatypes, SQL / PLSQL, Oracle Software Installation, User Type, Creating User , Granting.

**Basic Parts of Speech in SQL:** Creating Newspaper Table, Select Command (Where , order by), Creating View, Getting Text Information & Changing it, Concatenation, Cut & paste string (RPAD , LPAD , TRIM , LTRIM , RTRIM, LOWER , UPPER , INIT, LENGTH , SUBSTR , INSTR , SOUNDEX).

**Playing The Numbers:** Addition , Subtraction , Multiplication , Division, NVL , ABS , Floor , MOD , Power , SQRT , EXR , LN , LOG , ROUND, AVG , MAX , MIN , COUNT , SUM, Distinct, SUBQUERY FOR MAX,MIN.

**Grouping things together:** Group By , Having, Order By, Views Renaming Columns with Aliases.

**When one query depends upon another:** Union, Intersect , Minus, Not in , Not Exists.

**Changing Data :** INSERT,UPDATE,MERGE,DELETE, ROLLBACK , AUTOCOMMIT , COMMIT, SAVEPOINTS, MULTI TABLE INSERT, DELETE, UPDATE, MERGE.

**Creating And Altering tables & views:** Altering table, Dropping table, Creating view, Creating a table from a table.

**By What Authority:** Creating User, Granting User, Password Management.

**An Introduction to PL/SQL:** Implement few problems using PL/SQL (eg Prime Number, Factorial, Calculating Area of Circle, etc).

**An Introduction to Trigger and Procedure:** Implement few problems using Trigger and Procedures.

**An Introduction to Indexing:** Implement indexing using a large database and observe the difference of Indexed and Non-Indexed database.

### **MIS411 Functional Analysis**

**Theory: 3 Hours/Week, 3 Credits**

**General linear spaces:** Concepts of linear operator & spaces, linear functional in finite dimensional spaces & extension theorem, sublinear functional, annihilators, ranges & null manifolds. **Topological linear spaces:** Normed linear Spaces, Riesz lemma & Halmos theorem, Banach Space, quotient space, sequence space & Baire's theorem, conjugate space & Hahn-Banach theorem, inner product space. **Linear operator:** Closed & bounded linear operator, Banach - Steinhaus theorem, principle of uniform boundedness, weak topology & weak convergent. **Spectral analysis of linear operators & Hilbert space:** Spectrum & resolvent of an operator, reducibility-ascent & descent including compact operators, normal & symmetric operators, orthonormal systems. **Elementary distributions & its applications:** Test function space, supports of distributions & its applications.

#### **Books Recommended**

1. *A.E. Taylor:* Introduction to Functional Analysis
2. *I.J. Maddox:* Elements of Functional Analysis
3. *H.G. Heuser:* Functional Analysis
4. *W. Rudin:* Functional Analysis
5. *C.L. Devito:* Functional Analysis & Linear Operator Theory

### **MIS413 Partial Differential Equations**

**Theory: 3 Hours/Week, 3 Credits**

Formation of partial differential equation (PDE) and first order linear PDEs, first order quasilinear and non-linear PDEs, second order homogeneous and non-homogeneous PDEs, second order non-linear PDEs, classification of general second order PDEs and canonical forms, Solutions of Laplace's equations in Cartesian, cylindrical and spherical coordinates, diffusion equation and wave equation.

#### **Books Recommended:**

1. *Ayres, F.:* Differential Equations
2. *Ross, L.:* Introduction to Differential Equations
3. *Sneddon, I.N.,* Elements of Partial Differential equations.
4. *Dennemeyer, R.,* Introduction to Partial Differential equations.

### **MIS415 Operations Research**

**Theory: 3 Hours/Week, 3 Credits**

Two-person game, zero-sum game in extensive form, the normal form, mixed strategies, minimax theorem, domination, solution techniques, LP formula, assignment and transportation problems, the revised simplex method, sensitivity analysis, parametric LP.

**n-person game:** Characteristic function, imputions, domination, the core, shapley value, Nucleous and other solution.

**Markov chain:** Markov chain having two states, transition function, computations with transition function, classifications of states.

#### **Books Recommended**

1. Ross, S.M. Introduction to Probability Models.
2. Ross, S.M. Introduction to Stochastic Dynamic Programming.
3. White, D.J., Operational Research

#### **MIS417 Computer Networks**

**Theory: 3 Hours/Week, 3 Credits**

**Introduction:** Introduction to Computer Networks, Network Goals, Applications of Networks, Network Structure, Network Architectures, The OSI Reference Model, Data Transmission in the OSI Model, OSI Terminology, The ARPANET.

**Local Area Network :** LAN Technology - Architecture, Topology.

**Wired LANs:** Ethernet and Fast-Ethernet, Token Ring, FDDI.

**Wireless LANs:** IEEE 802.11, Bluetooth. Backbone Networks, Virtual LANs.

**Wide Area Network:** SONET, Virtual Circuit Networks - Frame Relay, ATM and ATM LANs.

**Network Layer:** Logical Addressing,

**Internet Protocol:** Internetworking, Routing Protocol, IPv4 and IPv6.

**Address Mapping, Error Reporting and Multicasting:** ICMP, IGMP, ICMv6. Delivery, Forwarding and Routing.

**Transport Layer:** Process-to-Process delivery, Transport Services, Protocol mechanisms, TCP, UDP, SCTP, Congestion and QoS.

**Application Layer:** Domain Name System, Abstract Syntax Notation One (ASN.1), Network Management - SNMPv2, Electronic mail - SMTP and MIME, Uniform Resource Locator (URL) and Universal Resource Identifier (URI), Hypertext Transfer Protocol (HTTP).

**Wireless and Mobile Networking:** Wireless Networking: Issues and Trends, Wireless Physical Layer Concepts , Wireless Cellular Networks, Mobile IP - IPv4, IPv6, TCP over Wireless, Ad Hoc Networks: Issues and Routing, Wireless Sensor Networks, Wireless Mesh and Multi-Hop Relay Networks, Wireless Network Security, Energy Management in Ad Hoc Wireless Networks.

**Network Security:** Security requirements and attacks, Privacy with conventional encryption, Message Authentication and Hash functions, Public-key encryption and digital signatures, Ipv4 and Ipv6 security.

#### **Books Recommended:**

1. Data Communications and Networking – Behrouz A. Forouzan (4<sup>th</sup> edition)
2. Data and Computer Communications - W Stallings, Macmillan, 1994 (4th edition)
3. Computer networks - A. S. Tanenbaum, Addison-Wesley, 1996 (3rd edition)
4. Data Communication and Computer Network - Stawling

#### **MIS418 Computer Networks Lab**

**Theory: 3 Hours/Week, 2 Credits**

*Subnetting and designing a network using Packet Tracer.*

*Analysis of the TCP/IP behavior.*

*Packet analysis.*

*Server configuration: DHCP, SMTP, FTP, Web*

*Switch and Router Configuration.*

*Socket Programming*

### **MIS421 Theory of Rings and Fields** **Theory: 3 Hours/Week, 3 Credits**

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Embedding of Rings, local rings, Artinian & Noetherian rings, Zorn's Lemma. Principal ideal domain (PID), unique factorization domain (UFD), Euclidean domains, polynomial rings over UFD, Divisibility in integral domain, Factorization theory for polynomial domains. Homomorphism of rings, isomorphism theorems of rings, quotient rings, rings of fractions & embedding theorems. Sum & direct sum of ideals, maximal & prime ideals, nilpotent ideals. **Integral domain and field** with related theorems; characteristic of a field.

#### **Books Recommended:**

1. *John R. Durbin: Modern Algebra an introduction*
2. *I.N. Herstein: Topics in Algebra*
3. *Dean, R.A.: Elements of Abstract Algebra*
4. *Hiran Paley and Paul M. Wrichsel: A First Course in Abstract Algebra*
5. *D.G. Northcott: Ideal Theory*

### **MIS423 Advance Hydrodynamics** **Theory: 3 Hours/Week, 3 Credits**

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**Three dimensional motions:** Three dimensional axi-symmetric motions and Stoke's stream function; three dimensional sources in a uniform stream; Butler's sphere theorem; sphere in a stream and moving cylinders. **Hydrodynamic waves:** Mode of energy transmission; mathematical representation of wave motion and conditions at the free surface; surface waves; speed of propagation and wave length; progressive and standing waves; kinetic energy of waves; group velocity and wave at interface.

#### **Books Recommended:**

1. *Milne-Thompson, L. M.: Theoretical Hydrodynamics*
2. *Lamb, H.: Hydrodynamics*
3. *Ramsey: Hydrodynamics*

### **MIS425 Software Engineering** **Theory: 3 Hours/Week, 3 Credits**

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**Introduction:** Overview of Software Industry, Introduction to Software Engineering, Software Development Process and Various Life Cycle Models. **Requirement Analysis:** Communication Techniques, Analysis Principles, Software Prototyping, Requirement Specification. **Group Dynamics:** Working in Teams, Characteristics of Successful Team, Understanding Group Dynamics, Team Roles and Temperament, Democratic Team and Chief Programmer Team Approach. **Introduction to Extreme Programming, Analysis Modeling:** Steps of system analysis, Feasibility study, Economic and technical analysis, System specification, the elements of analysis model, Data modeling, Functional modeling and information flow, Behavioral modeling, Mechanics of structured analysis, Data Dictionary. **Software Design:** Design principles, Design Concepts, effective modular design, design heuristics, Data Design, Architectural Design process, Transformation mapping, Transaction mapping, interface design, human-computer interface design, procedural design. **Software Testing:** Testing fundamentals, test case design, white-box testing, black-box testing, testing GUIs, Unit testing, Integration testing, validation testing, system testing, debugging. **Maintenance:** Major maintenance activities, estimating maintenance cost and productivity. **Technical Metrics for Software:** Software quality, Framework for technical metrics, metrics for analysis and design models, source code, testing and maintenance. **Software Architecture:** Pipe and Filter, Object Oriented, Event Based, Layered System, Data-centered repository, Process Control Architectures, **Objet Oriented Software Engineering:** O-O concepts, O-O analysis, Domain analysis, O-O analysis process, Object relational model. O-O design: system design process, object design process, O-O programming. **O-O Testing:** Testing strategies, test case design. **Service Oriented Software Engineering:** Introduction to SOA, SOAP, Analysis, design, validation, verification, implementation and maintenance of service oriented software; ESB, Messaging Architecture, Software Tools for SOA. **Software Project Management:** Cost estimation, risk analysis, project scheduling. **Introduction to CASE Tools:** What is CASE, taxonomy of CASE tools, iCASE environment, CASE repository, Example CASE tools. **Intellectual Properties:** Trade Marks, Copy Rights, Trade Secrets, Patents, **Introduction to UML.**

### MIS426 Software Engineering Lab Theory: 3 Hours/Week, 2 Credits

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Software Engineering lab works is solely designed to attain hands on experience of architectural design, documentation and testing of software so that students can develop the software following the documents only.

**Step1 (Requirement Engineering):** Choose a company/institute/client for which software will be developed (make sure that they will provide required information whenever necessary). Follow the steps for eliciting requirements and generate use-case diagram. Also analyze the sufficiency of the requirement engineering outcome for steps to follow.

**Step 2 (Analysis model to Architectural and Component level design):** Generate Activity diagram, Data flow diagram (DFD), Class diagram, State diagram, Sequence diagram and follow other relevant steps for creating complete architectural and component level design of the target software.

**Step 3 (User Interface design, Design evaluation, Testing strategies and Testing Tactics):** Perform the user interface design with the help of swimlane diagram. Carry out the design evaluation steps. Generate all test cases for complete checking of the software using black box, white box testing concept.

**Step 4 Software testing and debugging**

**Step 5 (Managing Software Projects):** Analyze the estimation and project schedule.

### MIS431 Theory of Groups Theory: 3 Hours/Week, 3 Credits

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**The class equation** of a group;  $p$ -group and related theorems; Cauchy's theorem; commutator subgroup; characteristic subgroup; maximal subgroup. **Group action** on a set; double cosets; Sylow's theorems with applications; groups of order  $pq$ ; classification of groups of small orders (up to 15). **Normal/ subnormal series**; composition series; Jordan-Hölder theorem; Zassenhaus's Butterfly Lemma. Solvable groups and nilpotent groups with related theorems. Direct products of groups with application. **Group extension**; splitting extension of groups; non-abelian group of order  $p^3$ . **Representaion of groups**; generalization of Cayley's theorem; permutational and matrix representation of finite groups; Maschke's theorem; Schur's lemma; Galois Theory.

#### Books Recommended:

1. Hall, M.: The Theory of Groups
2. B. Bhattacharya, S.K. Jain and S.R. Paul: Basic Abstract Algebra
3. B. Baumslag and B. Chandler: Theory and Problems of Group Theory
4. Martin Burrow: Representation Theory of Finite Groups

### MIS433 Fuzzy Mathematics Theory: 3 Hours/Week, 3 Credits

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**Crisp Sets and Fuzzy sets:** An overview of crisp sets, fuzzy sets, Equality of two fuzzy sets, **Operations:** complement of a fuzzy set, Union and Intersection of fuzzy sets, Products of fuzzy sets. **Fuzzy Arithmetic:** Fuzzy numbers, linguistic variables, arithmetic operations on intervals and fuzzy numbers, lattice of fuzzy numbers, fuzzy equations. Fuzzy relations: crisp and fuzzy relations, binary relation on single set, equivalence and order relations, relational equations, fuzzy morphisms. **Fuzzy logic:** fuzzy proposition, quantifier, interference.

#### Books Recommended

1. Klir, G.J., Fuzzy Sets and Fuzzy Logic
2. A Jones: Fuzzy Sets Theory & Applications D. Riedel pub. Co. (1986), A Kaufmann and H. J. Zimmermann (editors)

### MIS435 Theory of Lattices and Boolean Algebras Theory: 3 Hours/Week, 3 Credits

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**Ordered sets:** Ordered sets; diagrams; constructing and deconstructing ordered sets; down-sets and up-sets; order preserving map.

**Lattices and complete lattices:** Lattices as ordered sets; lattices as an algebra; sublattices and convex sublattice of a lattice; product lattice; ideals and filters; prime ideals and maximal ideals; Zorn's Lemma; complete lattice; chain conditions and completeness; join irreducible elements. **Modular, distributive and Boolean lattices:** Modular and distributive lattices and its characterizations; ideals;

prime ideals and maximal ideals for modular and distributive lattices; Stone's separation theorem; Boolean lattice and Boolean algebra.

**Congruences and lattice homomorphism:** Introducing congruence; congruences and diagrams; the congruences lattice; factor lattice; lattice homomorphism and related theorems. **Representation:** Finite Boolean algebras and power set algebras; finite distributive lattice and finite ordered sets in partnership; Stone's representation theorem for Boolean algebras; Priestley's representation theorem for distributive lattices; distributive lattices and Priestley spaces in partnership.

#### **Books Recommended:**

1. Balbs, R. and Dwinger, P.: Distributive lattices, *University of Missouri Press*, 1974
2. Birkhoff, G.: Lattice Theory, 3<sup>rd</sup> edition, *Coll. Publ., XXV, American Mathematical Society*, 1967.
3. Davey, B.A. and Priestley, H.A.: Introduction to Lattices and Order, 2<sup>nd</sup> edition, *Cambridge University Press*, 2002.
4. Grätzer, G.: General Lattice Theory, 2<sup>nd</sup> edition, *Birkhäuser Verlag*, 1998.

### **MIS437 Mathematical Modeling in Biology**

**Theory: 3 Hours/Week, 3 Credits**

**Existence and uniqueness theory:** The Lipschitz's condition; existence and uniqueness theorem. **Graphical theory** (Representation of solution of non-linear differential equation by graphs): Line element and direction field; the method of isocline. **Qualitative theory:** Critical points and paths of non-linear system; limit cycles and periodic solution. **Stability theory** (Mathematical models and stability in Ecology): Single-species growth: (i) Malthusian growth, (ii) logistic growth, (iii) the general autonomous model, (iv) nonautonomous growth, (v) discrete growth. **Two-species population models:** (i) predator prey models, (ii) competition models, (iii) models of mutualism, (iv) the Kolmogorov model. **Some three-species population models:** Stability versus complexity in multi-species models. **Models with few-species:** Limit cycles and time delays.

#### **Books Recommended:**

1. S.L. ROSS: Differential equations
2. J.C. Frauenthal: Introduction to population modeling
3. H. F. Freedman: Deterministic mathematical models in population Ecology
4. R. M. May: Stability and complexity in Model Ecosystems.