# Syllabi of Courses which Address Crosscutting Issues

## (Mathematics)

# DEPARTMENT OF MATHEMATICS

## SACRED HEART COLLEGE FOR WOMEN, CHALAKUDY

1.3.1 Department integrates crosscutting issues relevant to professional ethics, gender, human values, environment and sustainability into the curriculum.

| SL NO. | NAME OF THE COURSE | COURSE CODE | NAME OF THE PROGRAMME | THE AREA DEALT WITH |
|---|---|---|---|---|
| 1. | Basic Logic and Number Theory | MTS1B01 | BSc Mathematics | Human Values |
| 2. | Linear Programming | MTS5B08 | BSc Mathematics | Professional Ethics |
| 3. | Graph Theory | MTS6B14(E01) | BSc Mathematics | Environment and Sustainability |
| 4. | Linear Mathematical Models | MTS5D03 | BSc Mathematics | Professional Ethics |
| 5. | Ability Enhancement Course | MTH1A01 | MSc Mathematics | Human Values |
| 6. | Operations Research | MTH2C10 | MSc Mathematics | Professional Ethics |
| **7.** | Professional Competency Course | MTH2A02 | MSc Mathematics | Professional Ethics |
| 8. | Cryptography | MTH3E02 | MSc Mathematics | Professional Ethics |
| **9.** | Graph Theory | MTH4E11 | MSc Mathematics | Professional Ethics |

# FIRST SEMESTER

## MTS1 B01 BASIC LOGIC & NUMBER THEORY

**4 hours/week** **4 Credits** **100 Marks Int:20+Ext:80]**

| *Aims, Objectives and Outcomes* | |
|---|---|

Logic, the study of principles of techniques and reasoning, is fundamental to every branch of learning. Besides, being the basis of all mathematical reasoning, it is required in the field of computer science for developing programming languages and also to check the correctness of the programmes. Electronic engineers apply logic in the design of computer chips. The first module discusses the fundamentals of logic, its symbols and rules. This enables one to think systematically, to express ideas in precise and concise mathematical terms and also to make valid arguments. How to use logic to arrive at the correct conclusion in the midst of confusing and contradictory statements is also illustrated.

The classical number theory is introduced and some of the very fundamental results are discussed in other modules. It is hoped that the method of writing a formal proof, using proof methods discussed in the first module, is best taught in a concrete setting, rather than as an abstract exercise in logic. Number theory, unlike other topics such as geometry and analysis, doesn't suffer from too much abstraction and the consequent difficulty in conceptual understanding. Hence, it is an ideal topic for a beginner to illustrate how mathematicians do their normal business. By the end of the course, the students will be able to enjoy and master several techniques of problem solving such as recursion, induction etc., the importance of pattern recognition in mathematics, the art of conjecturing and a few applications of number theory. Enthusiastic students will have acquired knowledge to read and enjoy on their own a few applications of number theory in the field of art, geometry and coding theory. Successful completion of the course enables students to

- Prove results involving divisibility, greatest common divisor, least common multiple and a few applications.
- Understand the theory and method of solutions of LDE.
- Solve linear congruent equations.
- Learn three classical theorems *viz*. Wilson's theorem, Fermat's little theorem and Euler's theorem and a few important consequences.

*Syllabus*

| | |
|---|---|
| Text (1) | Discrete Mathematics with Applications : Thomas Koshy, *Elsever Academic Press(2004) ISBN:0-12-421180-1* |
| Text:(2) | Elementary Number Theory with Applications (2/e) :Thomas Koshy, *Elsever Academic Press(2007) ISBN:978-0-12-372487-8* |

## Module- I Text (1) (15 hrs)

1.1: Propositions- definition, Boolean (logic) variables, Truth Value, Conjunction, Boolean expression, Disjunction (inclusive and exclusive), Negation, Implication, Converse, Inverse and Contra positive, Biconditional statement, Order of Precedence, Tautology Contradiction and Contingency [‘Switching Networks’ omitted]

1.2 : Logical equivalences- laws of logic [‘Equivalent Switching Networks’ ‘Fuzzy logic’ & ‘Fuzzy decisions’omitted]

1.3 : Quantifiers- universal & existential, predicate logic

1.4 : Arguments- valid and invalid arguments, inference rules

1.5: Proof Methods – vacuous proof, trivial proof, direct proof, indirect proof-contrapositive & contradiction, proof by cases, Existence proof- constructive & non constructive, counter example

## Module- II Text (2) (12 hrs)

1.3 : Mathematical induction- well ordering principle, simple applications, weak version of principle of mathematical induction, illustrations, strong version of induction (second principle of MI), illustration

1.4 : Recursion- recursive definition of a function, illustrations.

2.1: The division algorithm – statement and proof, div & mod operator, card dealing, The two queens puzzle (simple applications), pigeonhole principle and division algorithm, divisibility relation, illustration, divisibility properties, union intersection and complement-inclusion-exclusion principle & applications, even and odd integers.

2.5: Prime and Composite Numbers- definitions, infinitude of primes, [‘algorithm 2.4‘ omitted] The sieve of Eratosthenes, a number theoretic function, prime number theorem (statement only), distribution of primes (upto and including Example 2.25) . [rest of the section omitted]

| Module- III | Text (2) | (17 hrs) |
|---|---|---|

3.1 : Greatest Common Divisor- gcd, symbolic definition, relatively prime integers, Duncan's identity, Polya's theorem, infinitude of primes, properties of gcd, linear combination, gcd as linear combination, an alternate definition of gcd, gcd of n positive integers, a linear combination of n positive integers, pairwise relatively prime integers, alternate proof for infinitude of prime.

3.2: The Euclidean Algorithm- The Euclidean algorithm [algorithm 3.1 omitted], A jigsaw puzzle, Lame's theorem (statement only; proof omitted)

3.3: The Fundamental Theorem of Arithmetic- Euclid's lemma on division of product by a prime, fundamental theorem of arithmetic, Canonical Decomposition, number of trailing zeros, highest power of a prime dividing!, [only statement of Theorem3.14 required; proof omitted] Distribution of Primes Revisited, Dirichlet's Theorem (statement only)

3.4 : Least Common Multiple- definition, canonical decomposition to find lcm, relationship between gcd and lcm, relatively prime numbers and their lcm

3.5: Linear Diophantine Equations – LDE in two variables, conditions to have a solution, Aryabhatta's method, number of solutions, general solution, Mahavira's puzzle, hundred fowls puzzle, Monkey and Coconuts Puzzle, ['Euler's method for solving LDE's ' omitted] Fibonacci numbers and LDE, LDE in more number of variables and their solutions- Theorem 3.20

| Module- IV | Text (2) | (20 hrs) |
|---|---|---|

4.1:Congruences - congruence modulo m, properties of congruence, characterization of congruence, least residue, ['Friday-the-Thirteenth' omitted], congruence classes, A Complete Set of Residues Modulo m, properties of congruence, use of congruence to find the remainder on division, ['Modular Exponentiation' method omitted], Towers of Powers Modulo m, further properties of congruence and their application to find remainder ['Monkey and Cocunut Puzzle revisited'(example 4.17) omitted] congruences of two numbers with different moduli

4.2: Linear Congruence- solvability, uniqueness of solution, incongruent solutions, Modular Inverses, applications

5.1: Divisibility Tests-Divisibility Test for 10, Divisibility Test for 5, Divisibility Test for $2^i$, Divisibility Tests for 3 and 9, Divisibility Test for 11 [ rest of the section from Theorem 5.1 onwards omitted]

7.1: Wilson's Theorem- self invertible modulo prime, Wilson's theorem and its converse ['Factorial,Multifactorial and Primorial Primes' omitted]

7.2: Fermat's Little Theorem(FLT)- FLT and its applications, [Lagrange's alternate proof of Wilson's theorem omitted], inverse of a modulo p using FLT, application-solution of linear congruences [ ' Factors of $2^n + 1$ ' omitted], extension of FLT in various directions ['The Pollard p-1 factoring method' omitted]

7.4 : Euler's Theorem- motivation, Euler's Phi Function $\varphi$, Euler's Theorem, applications, generalisation of Euler's theorem (koshy)

| **References:** | |
|---|---|
| 1 | Susanna S Epp: Discrete Mathematics with Applications(4/e) Brooks/ Cole Cengage Learning(2011) ISBN: 978-0-495-39132-6 |
| 2 | Kenneth H. Rosen: Discrete Mathematics and Its Applications(7/e) McGraw-Hill, NY (2007) ISBN: 978-0-07-338309-5 |
| 3 | David M. Burton : Elementary Number Theory(7/e) McGraw-Hill (2011) ISBN: 978-0-07-338314-9 |
| 4 | Gareth A. Jones and J. Mary Jones: Elementary Number Theory, Springer Undergraduate Mathematics Series(1998) ISBN: 978-3-540-76197-6 |
| 5 | Underwood Dudley :Elementary Number Theory(2/e), Dover Publications (2008) ISBN:978-0-486-46931-7 |
| 6 | James K Strayer: Elementary Number Theory, Waveland Press, inc. (1994), ISBN:978-1-57766-224-2 |
| 7 | Kenneth H. Rosen: Elementary Number Theory(6/e), Pearson Education (2018)ISBN: 9780134310053 |

## FIFTH SEMESTER

## MTS5 B08 LINEAR PROGRAMMING

**3 hours/week** **3 Credits** **75 Marks [Int:15+Ext:60]**

*Aims, Objectives and Outcomes*

Linear programming problems are having wide applications in mathematics, statistics, computer science, economics, and in many social and managerial sciences. For mathematicians it is a sort of mathematical modelling process, for statisticians and economists it is useful for planning many economic activities such as transport of raw materials and finished products from one place to another with minimum cost and for military heads it is useful for scheduling the training activities and deployment of army personnel. The emphasis of this course is on nurturing the linear programming skills of students *via*. the algorithmic solution of small-scale problems, both in the general sense and in the specific applications where these problems naturally occur. On successful completion of this course, the students will be able to

- solve linear programming problems geometrically
- understand the drawbacks of geometric methods
- solve LP problems more effectively using Simplex algorithm *via*. the use of condensed tableau of A.W. Tucker
- convert certain related problems, not *directly* solvable by simplex method, into a form that can be attacked by simplex method.
- understand duality theory, a theory that establishes relationships between linear programming problems of maximization and minimization
- understand game theory
- solve transportation and assignment problems by algorithms that take advantage of the simpler nature of these problems

*Syllabus*

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|---|---|
| Text | Linear Programming and Its Applications: James K. Strayer *Undergraduate Texts in Mathematics Springer (1989) ISBN: 978-1-4612-6982-3* |

**Module-I (16 hrs)**

Chapter1 Geometric Linear Programming: Profit Maximization and Cost Minimization, *typical motivating examples*, *mathematical formulation*, Canonical Forms for Linear Programming Problems, *objective functions, constraint set, feasible solution, optimal solution* , Polyhedral Convex Sets, *convex set, extreme point*, *theorems asserting existence of optimal solutions,* The Two Examples Revisited, *graphical solutions to the problems*, A Geometric Method for Linear Programming, *the difficulty in the method*, Concluding Remarks

Chapter2 The Simplex Algorithm:- Canonical Slack Forms for Linear Programming Problems; Tucker Tableaus, *slack variables, Tucker tableaus*, *independent variables* or *non basic variables, dependent variables* or *basic variables,* .An Example: Profit Maximization, *method of solving a typical canonical maximization problem*, The Pivot Transformation, *The Pivot Transformation for Maximum and Minimum Tableaus,* An Example: Cost Minimization, *method of solving a typical canonical minimization problem*, The Simplex Algorithm for Maximum Basic Feasible Tableaus, The Simplex Algorithm for Maximum Tableaus, Negative Transposition; The Simplex Algorithm for Minimum Tableaus, Cycling, Simplex Algorithm Anti cycling Rules, Concluding Remarks

**Module-II (14 hrs)**

Chapter3 Noncanonical Linear Programming Problems:- Unconstrained Variables, Equations of Constraint, Concluding Remarks

Chapter 4 : Duality Theory :- Duality in Canonical Tableaus, The Dual Simplex Algorithm, *The Dual Simplex Algorithm for Minimum Tableaus, The Dual Simplex Algorithm for Maximum Tableaus,* Matrix Formulation of Canonical Tableaus ,The Duality Equation, Duality in Noncanonical Tableaus, Concluding Remarks

**Module-III (18 hrs)**

Chapter 5 Matrix Games:- An Example; Two-Person Zero-Sum Matrix Games, Domination in a Matrix Game, Linear Programming Formulation of Matrix Games, The Von Neumann Minimax Theorem, The Example Revisited, Two More Examples, Concluding Remarks

Chapter 6 Transportation and Assignment Problems :- The Balanced Transportation Problem, The Vogel Advanced-Start Method (VAM), The Transportation Algorithm, Another Example, Unbalanced Transportation Problems, The Assignment Problem, *The Hungarian Algorithm,* Concluding Remarks, *The Minimum-Entry Method*, *The Northwest-Corner Method*

**References:**


| | |
|---|---|
| 1 | RobertJ.Vanderbei:LinearProgramming:Foundations and Extensions (2/e) Springer Science+Business Media LLC(2001) ISBN: 978-1-4757-5664-7 |
| 2 | Frederick S Hiller, Gerald J Lieberman: Introduction to Operation Research(10/e) *McGraw-Hill Education, 2 Penn Plaza, New York(2015)ISBN: 978-0-07-352345-3* |
| 3 | Paul R. Thie, G. E. Keough : An Introduction to Linear Programming and Game Theory(3/e) *John Wiley and Sons,Ins.(2008)ISBN: 978-0-470-23286-6* |
| 4 | Louis Brickman: Mathematical Introduction to Linear Programming and Game Theory *UTM,Springer Verlag,NY(1989)ISBN:0-387-96931-4* |
| 5 | Jiri Matoušek, Bernd Gartner: Understanding and Using Linear Programming *Universitext, Springer-Verlag Berlin Heidelberg (2007)ISBN: 978-3-540-30697-9* |

## SIXTH SEMESTER (Elective)

## MTS6 B14 (E01) GRAPH THEORY

**3 hours/week** **2 Credits** **75 Marks [Int:15+Ext:60]**

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|---|---|
| Text | A First Look at Graph Theory: John Clark & Derek Allan Holton, *Allied Publishers, First Indian Reprint 1995* |

**Module-I (16 hrs)**

1.1 Definition of a graph
1.2 Graphs as models
1.3 More definitions
1.4 Vertex degrees
1.5 Sub graphs
1.6 Paths and Cycles
1.7 Matrix representation of a graph *[up to Theorem 1.6 ; proof of Theorem 1.5 is omitted]*

**Module-II (16 hrs)**

2.1 Definitions and Simple Properties
2.2 Bridges *[Proof of Theorem 2.6 and Theorem 2.9 are omitted]*
2.3 Spanning Trees
2.6 Cut Vertices and Connectivity *[Proof of Theorem 2.21omitted]*

**Module-III (16 hrs)**

3.1 Euler Tour *[up to Theorem 3.2, proof of Theorem 3.2 omitted]*
3.3:Hamiltonian Graphs *[Proof of Theorem 3.6 omitted]*
5.1:Plane and Planar graphs *[Proof of Theorem 5.1 omitted]*
5.2 Euler's Formula *[Proofs of Theorems 5.3 and Theorem 5.6 omitted]*

**References:**


| | |
|---|---|
| 1 | R.J. Wilson: Introduction to Graph Theory, 4th ed., *LPE, Pearson Education* |
| 2 | J.A. Bondy& U.S.R. Murty : Graph Theory with Applications |
| 3 | J. Clark & D.A. Holton: A First Look at Graph Theory, *Allied Publishers* |
| 4 | N. Deo : Graph Theory with Application to Engineering and Computer Science, *PHI.* |

**FIFTH SEMESTER (OPEN COURSE)**
**(For students not having Mathematics as Core Course)**

## MTS5 D03 LINEAR MATHEMATICAL MODELS

| 3 hours/week | 3 credits | 75marks [Int:15+Ext:60] |
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|---|---|
| Text | Finite Mathematics and Calculus with Applications (9/e) *Margaret L. Lial, Raymond N. Greenwell & Nathan P. Ritchey* Pearson Education, Inc(2012) ISBN: 0-321-74908-1 |

Module I 18 hrs

Chapter-1 Linear Functions

1.1: Slopes and Equations of Lines

1.2: Linear Functions and Applications

1.3: The Least Squares Line

Chapter-2 Systems of Linear Equations and Matrices

2.1: Solution of Linear Systems by the Echelon Method

2.2: Solution of Linear Systems by the Gauss-Jordan Method

2.3: Addition and Subtraction of Matrices

2.4: Multiplication of Matrices

2.5: Matrix Inverses

2.6: Input-Output Models

Module II 12 hrs

Chapter-3 Linear Programming: The Graphical Method

3.1: Graphing Linear Inequalities

3.2: Solving Linear Programming Problems Graphically

3.3 : Applications of Linear Programming

Module III 18 hrs

Chapter-4 Linear Programming: The Simplex Method

4.1: Slack Variables and the Pivot

4.2: Maximization Problems

4.3: Minimization Problems; Duality

4.4 :Nonstandard Problems

| References: | |
|---|---|
| 1 | Soo T Tan: Finite Mathematics For the Managerial, Life, and social sciences(11/e) *Cengage Learning(2015) ISBN: 1-285-46465-6* |
| 2 | Ronald J. Harshbarger, James J. Reynolds: Mathematical Applications for the Management, Life, and Social Sciences (9/e) *Brooks/Cole Cengage Learning(2009) ISBN: 978-0-547-14509-9* |
| 3 | Stefan Waner, Steven R. Costenoble: Finite Mathematics and Applied Calculus(5/e) *Brooks/Cole Cengage Learning(2011) ISBN: 978-1-4390-4925-9* |
| 4 | Seymour Lipschutz, John J. Schiller, R. Alu Srinivasan: Beginning Finite Mathematics *Schaum's Outline Series, McGraw-Hill(2005)* |
| 5 | Howard L. Rolf: Finite Mathematics *Enhanced Edition*(7/e) *Brooks/Cole, Cengage Learning(2011) ISBN:978-0-538-49732-9* |
| 6 | Michael Sullivan: Finite Mathematics An Applied Approach(11/e*) John Wiley & Sons, Inc(2011)ISBN: 978-0470-45827-3* |

## List of Elective Courses in Third Semester

1. MTH3E01 Coding theory
2. MTH3E02 Cryptography
3. MTH3E03 Measure & Integration
4. MTH3E04 Probability Theory

## List of Elective Courses in Fourth Semester

1. MTH4E05 Advanced Complex Analysis
2. MTH4E06 Algebraic Number Theory
3. MTH4E07 Algebraic Topology
4. MTH4E08 Commutative Algebra
5. MTH4E09 Differential Geometry
6. MTH4E10 Fluid Dynamics
7. MTH4E11 Graph Theory
8. MTH4E12 Representation Theory
9. MTH4E13 Wavelet Theory

## ABILITY ENHANCEMENT COURSE(AEC)

Successful fulfilment of any one of the following shall be considered as the completion of AEC. (i) Internship, (ii) Class room seminar presentation, (iii) Publications, (iv) Case study analysis, (v) Paper presentation, (vi) Book reviews. A student can select any one of these as AEC.

**Internship:** Internship of duration 5 days under the guidance of a faculty in an institution/department other than the parent department. A certificate of the same should be obtained and submitted to the parent department.

**Class room seminar:** One seminar of duration one hour based on topics in mathematics beyond the prescribed syllabus.

**Publications:** One paper published in conference proceedings/ Journals. A copy of the same should be submitted to the parent department.

**Case study analysis:** Report of the case study should be submitted to the parent department.

**Paper presentation:** Presentation of a paper in a regional/ national/ international seminar/conference. A copy of the certificate of presentation should be submitted to the parent department.

**Book Reviews:** Review of a book. Report of the review should be submitted to the parent department.

## PROFESSIONAL COMPETENCY COURSE (PCC)

A student can select any one of the following as Professional Competency course:

1. Technical writing with LaTeX.
2. Scientific Programming with Scilab.
3. Scientific Programming with Python.

## PROJECT

The Project Report (Dissertation) should be self contained. It should contain table of contents, introduction, at least three chapters, bibliography and index. The main content may be of length not less than 30 pages in the A4 format with one and half line spacing. The project report should be prepared preferably in LaTeX. There must be a project presentation by the student followed by a viva voce. The components and weightage of External and Internal valuation of the Project are as follows:

| Components | External(weigtage) | Internal (weightage) |
|---|---|---|
| Relevance of the topic & staement of problem | 4 | 1 |
| Methodology & analysis | 4 | 1 |
| Quality of Report & Presentation | 4 | 1 |
| Viva Voce | 8 | 2 |
| Total weigtage | 20 | 5 |

The external project evaluation shall be done by a Board consisting two External Examiners. The Grade Sheet is to be consolidated and must be signed by the External Examiners.

## MTH4V01 VIVA VOCE EXAMINATIONS

The Comprehensive Viva Voce is to be conducted by a Board consisting of two External Examiners. The viva voce must be based on the core papers of the entire programme. There should be questions from at least one course of each of the semesters I, II, and

**SEMESTER 2**

## MTH2C10: OPERATIONS RESEARCH
**No. of Credits: 4**
**No. of hours of Lectures/week: 5**

**TEXT :** K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS(3rd. Edn.), New Age International(P) Ltd., 1996.

(Pre requisites : A basic course in calculus and Linear Algebra)

**Module 1**

Convex Functions; Linear Programming [Chapter 2 : Sections 11 to 12 ; Chapter 3 : Sections 1 to 15, 17 from the text]

**Module 2**

Linear Programming (contd.); Transportation Problem [Chapter 3 : Sections 18 to 20, 22; Chapter 4 Sections 1 to 11, 13 from the text]

**Module 3**

Integer Programming; Sensitivity Analysis [Chapter 6 : Sections 1 to 9; Chapter 7 Sections 1 to 10 from the text] Flow and Potential in Networks; Theory of Games [Chapter 5 : Sections 1 to 4, 6 7; Chapter 12 : all Sections]

## References


[1] **R.L. Ackoff and M.W. Sasioni**: Fundamentals of Operations Research; Wiley Eastern Ltd. New Delhi; 1991

[2] **C.S. Beightler, D.T. Philiphs and D.J. Wilde**: Foundations of optimization(2nd Edn.); Prentice Hall of India, Delhi; 1979

[3] **G. Hadley**: Linear Programming; Addison-Wesley Pub Co Reading, Mass; 1975

[4] **G. Hadley**: Non-linear and Dynamic Programming; Wiley Eastern Pub Co. Reading, Mass; 1964

[5] **H.S. Kasana and K.D. Kumar**: Introductory Operations Research-Theory and Applications; Springer-Verlag; 2003

[6] **R. Panneerselvam**: Operations Research; PHI, New Delhi(Fifth printing); 2004

[7] **A. Ravindran, D.T. Philips and J.J. Solberg**: Operations Research-Principles and Practices(2nd Edn.); John Wiley & Sons; 2000

[8] **G. Strang**: Linear Algebra and Its Applications(4th Edn.); Cengage Learning; 2006

[9] **Hamdy A. Taha**: Operations Research- An Introduction(4th Edn.); Macmillan Pub Co. Delhi; 1989

SEMESTER 3(Elective)

## MTH3E02: CRYPTOGRAPHY
## No. of Credits: 3
## No. of hours of Lectures/week : 5

**TEXT :** Douglas R. Stinson, Cryptography Theory and Practice, Chapman & Hall, 2nd Edition.

### Module 1

Classical Cryptography: Some Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Ciphers. Cryptanalysis of the Affine, Substitution, Vigenere, Hill and LFSR Stream Cipher.

### Module 2

Shannons Theory:- Elementary Probability Theory, Perfect Secrecy, Entropy, Huffman Encodings, Properties of Entropy, Spurious Keys and Unicity Distance, Product Cryptosystem.

### Module 3

Block Ciphers: Substitution Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis , Data Encryption Standard (DES), Advanced Encryption Standard (AES). Cryptographic Hash Functions: Hash Functions and Data integrity, Security of Hash Functions, iterated hash functions- MD5, SHA 1, Message Authentication Codes, Unconditionally Secure MAC s. [ Chapter 1 : Section 1.1( 1.1.1 to 1.1.7 ), Section 1.2 ( 1.2.1 to 1.2.5 ) ; Chapter 2 : Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 ; Chapter 3 : Sections 3.1, 3.2, 3.3( 3.3.1 to 3.3.3 ), Sect.3.4, Sect. 3.5( 3.5.1,3.5.2), Sect.3.6(3.6.1, 3.6.2); Chapter 4 : Sections 4.1, 4.2( 4.2.1 to 4.2.3), Section 4.3 (4.3.1, 4.3.2), Section 4.4(4.4.1, 4.4.2), Section 4.5 (4.5.1, 4.5.2) ]

## References


[1] **Jeffrey Hoffstein:** Jill Pipher, Joseph H. Silverman, An Introduction to Mathematical Cryptography, Springer International Edition.

[2] **H. Deffs & H. Knebl:** Introduction to Cryptography, Springer Verlag, 2002.

[3] **Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone:** Handbook of Applied Cryptography, CRC Press, 1996.

[4] **William Stallings:** Cryptography and Network Security Principles and Practice, Third Edition, Prentice-hall India, 2003.

SEMESTER 4 (Elective)

## MTH4C11: GRAPH THEORY

**No. of Credits: 3**

No. of hours of Lectures/week : 5

**TEXT :** J.A. Bondy and U.S.R.Murty : Graph Theory with applications. Macmillan

### Module 1

Basic concepts of Graph. Trees, Cut edges and Bonds, Cut vertices, Cayleys Formula, The Connector Problem, Connectivity, Blocks, Construction of Reliable Communication Networks, Euler Tours, Hamilton Cycles, The Chineese Postman Problem, The Travelling Salesman Problem.

### Module 2

Matchings, Matchings and Coverings in Bipartite Graphs, Perfect Matchings, The Personnel Assignment Problem, Edge Chromatic Number, Vizings Theorem, The Timetabling Problem, Independent Sets, Ramseys Theorem

### Module 3

Vertex Colouring-Chromatic Number, Brooks Theorem, Chromatic Polynomial, Girth and Chromatic Number, A Storage Problem, Plane and Planar Graphs, Dual Graphs, Eulers Formula, Bridges, Kuratowskis Theorem, The Five-Colour Theorem, Directed Graphs, Directed Paths, Directed Cycles.

[ Chapter 2 Sections 2.1(Definitions & Statements only), 2.2, 2.3, 2.4, 2.5; Chapter 3 Sections 3.1, 3.2, 3.3; Chapter 4 Sections 4.1(Definitions & Statements only), 4.2, 4.3, 4.4; Chapter 5 Sections 5.1, 5.2, 5.3, 5.4; Chapter 6 Sections 6.1,6.2,6.3; Chapter 7 Sections 7.1,7.2; Chapter 8 Sections 8.1, 8.2, 8.4, 8.5, 8.6; Chapter 9 Sections (9.1,9.2,9.3 Definitions & Statements only), 9.4, 9.5, 9.6; Chapter 10 Sections 10.1, 10.2, 10.3.

## References


[1] **F. Harary :** Graph Theory, Narosa publishers, Reprint 2013.

[2] **Geir Agnarsson, Raymond Greenlaw:** Graph Theory Modelling, Applications and Algorithms, Pearson Printice Hall, 2007.

[3] **John Clark and Derek Allan Holton :** A First look at Graph Theory, World Scientific (Singapore) in 1991 and Allied Publishers (India) in 1995

[4] **R. Balakrishnan & K. Ranganathan :** A Text Book of Graph Theory, Springer Verlag, 2nd edition 2012.