UNIVERSITY OF DELHI

DEPARTMENT OF MATHEMATICS

GENERIC ELECTIVE (GE) Courses For

B.A./B.Com. Programme

Learning Outcomes based Curriculum Framework (LOCF)

2019

GENERIC ELECTIVE (GE) COURSES
OFFERED TO
B.A./B.Com. Programme
(Students who are not having Mathematics as a Discipline Subject can opt for such courses)

Semester	Core Course (12)	Ability Enhancement Compulsory Course (AECC)(2)	Skill Enhancement Course (SEC) (4)	Discipline Specific Elective (DSE)(4)	Generic Elective (GE) (2) Credits: 6 each
I					
II					
III					
IV					
V					**GE-1 General Mathematics- 1**
VI					**GE-2 General Mathematics- 2**

Semester-V

GE-1: General Mathematics - I

Total Marks: 100 (Theory: 75, Internal Assessment: 25)
Workload: 5 Lectures, 1 Tutorial (per week) **Credits:** 6 (5+1)
Duration: 14 Weeks (70 Hrs.) **Examination**: 3 Hrs.

Course Objectives: The course aims at introducing number system, fundamental arithmetic operations, prime numbers and Pythagorean triplets to the students. The concept of matrices and determinants with their properties are also introduced.

Course Learning Outcomes: The course will enable the students to:

i) Learn about the contributions of the ancient Indian mathematicians in the field of algebra, geometry, trigonometry, calculus and astronomy.
ii) Know more about prime numbers, Fermat's last theorem, Latin and magic squares.
iii) Understand the various types of matrices, operations of matrices, and Cramer's rule to solve a system of linear equations.

Unit 1: Biographies of Ancient Indian Mathematicians
A brief introduction to the lives and information on the works of the following mathematicians**:** Aryabhata, Varahamihira, Brahmagupta, Bhaskara I & II, Mahavira, Madhava, and Paramesvara.

Unit 2: Number Systems
An overview of number systems, Algebraic and transcedental numbers with some historical background, Fundamental arithmetic operations, Rules of divisibility, Hierarchy of operations and Modular arithmetic, Euclidean algorithm, Prime numbers, The sieve of Eratosthenes, Fundamental theorem of arithmetic, Euclid's lemma, Fermat numbers, Mersenne numbers and Mersenne primes, prime testing method of Fermat, Statement and significance of the prime number theorem, Goldbach conjuctures, Twin primes, Uses of prime numbers, Perfect and amicable numbers, Pythagoreans triplets and its properties, Statement and historic background of Fermat's last theorem, Multiplication principle, Permutation and combinations, Latin squares and magic squares.

Unit 3: Matrices and Determinants
Matrices, Basic concepts and algebraic operations, Types of matrices, Transpose of a matrix, Symmetric and skew-symmetric matrices, Matrix multiplication and its properties, Powers of square matrices, Inverse square matrix and its properties, Determinant and its properties, Expansion by rows and columns, Cofactors, Matrix singularity, Adjoint matrix and calculation of inverse, Cramer's rule.

References:

1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Elsevier India.
2. Gulberg, Jan. (1997). *Mathematics from the Birth of Numbers*. W. W. Norton & Company.
3. Puttaswamy, T. K. (2012). *Mathematical Achievements of Pre-Modern Indian Mathematicians*. Elsevier Inc. USA.
4. Srinivasiengar, C. N. (1988). *The History of Ancient Indian Mathematics*. The World Press Private Ltd. Calcutta. Digitized Book (2009).

Additional Reading:

i. Divakaran, P. P. (2018). *The Mathematics of India*: *Concept*s, *Methods*, *Connections*. Springer Singapore. Indian Print by Hindustan Book Agency, New Delhi.

Teaching Plan (GE-1: General Mathematics-I):

Weeks 1 to 3: A brief introduction to the lives and information on the works of the following mathematicians: Aryabhata, Varahamihira, Brahmagupta, Bhaskara I & II, Mahavira, Madhava, and Paramesvara.

[3] Chapters 5, 6, 7, 9, 11 and 13 for brief statements and examples on the works of the above mathematicians.

[4] Sections 30, 31, 35, 41-44, 54 to 56, 59-61, 67 and 68 for brief introduction of the mathematicians.

Weeks 4 and 5: An overview of number systems, Algebraic and transcedental numbers with some historical background, Fundamental arithmetic operations, Rules of divisibility, Hierarchy of operations and modular arithmetic, Euclidean algorithm.

[2] Chapter 3 (Sections 3.0, 3.1, and 3.4), and Chapter 4 (Section 4.2 up to Page 128).

Weeks 6 and 7: Prime numbers, The sieve of Eratosthenes, Fundamental theorem of arithmetic, Euclid's lemma, Fermat numbers, Mersenne numbers and Mersenne primes, Prime testing method of Fermat, Statement and significance of the prime number theorem, Goldbach conjuctures, Twin primes, Uses of prime numbers.

[2] Chapter 3 (Section 3.2).

Weeks 8 and 9: Perfect and amicable numbers, Pythagoreans triplets and its properties, Statement and historic background of Fermat's last theorem.

[2] Chapter 3 (Section 3.3), and Chapter 9 (Section 9.9, Pages 332 to 334).

Weeks 10 and 11: Multiplication principle, Permutation and combinations, Latin squares and magic squares.

[2] Chapter 5 (Sections 5.1 to 5.4, and 5.6 up to Page 212).

Weeks 12: Matrices, Basic concepts and algebraic operations, Types of matrices, Transpose of a matrix, symmetric and skew-symmetric matrices, Matrix multiplication and its properties, Powers of square matrices.

[1] Chapter 1 (Sections 1.4, and 1.5).

Week 13 and 14: Inverse of a square matrix and its properties, Determinant and its properties, Expansion by rows and columns, Cofactors, Matrix singularity, Adjoint matrix and calculation of inverse, Cramer's rule.

[1] Chapter 2 (Section 2.4 up to Example 3, Page 138), and Chapter 3 (Sections 3.1 to 3.3).

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Learn about the contributions of the ancient Indian mathematicians in the field of algebra, geometry, trigonometry, calculus and astronomy.	(i) Each topic to be explained with illustrations. (ii) Students be encouraged to discover the relevant concepts. (iii) Students to be given homework/assignments. (iv) Students to be encouraged to look for applications in real life.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • End-term examinations.
2.	Know more about prime numbers, Fermat's last theorem, Latin and magic squares.		
3.	Understand the various types of matrices, operations of matrices, and Cramer's rule to solve a system of linear equations.		

Keywords: Ancient Indian mathematicians, Euclidean algorithm, Prime numbers, Goldbach conjucture, Permutation and combinations, Latin squares and magic squares, Matrix operations, Cramer's rule.

Semester-VI

GE-2: General Mathematics – II

Total Marks: 100 (Theory: 75, Internal Assessment: 25)
Workload: 5 Lectures, 1 Tutorial (per week) **Credits:** 6 (5+1)
Duration: 14 Weeks (70 Hrs.) **Examination**: 3 Hrs.

Course Objectives: The course aims at introducing graph theory, perspective geometry and its uses in art, fractals in nature, Fibonacci sequences and their uses. Method to solve the linear system of equations using row operations of matrices is also introduced.

Course Learning Outcomes: The course will enable the students to:

i) Learn about the contributions of remarkable mathematicians in the field of algebra, analysis, number theory, calculus, analytic geometry, differential equations and mechanics.
ii) Understand basics of graph theory, functions and their graphs, perspective geometry and its uses in art, fractals and Fibonacci sequences with applications.
iii) Learn about types of symmetry and patterns by looking at monuments/buildings/ornamental art.
iv) Solve systems of linear equations using Gauss elimination and Gauss–Jordon methods, and rank of matrices.

Unit 1: Biographies of Remarkable Mathematicians
A brief introduction to the lives and information on the works of the following mathematicians: Euler, Lagrange, Gauss, Cauchy, Abel, Galois, Riemann, Hardy, Noether, Ramanujan, von Neumann, Wiles, and Bhargava.

Unit 2: Functions, Perspective Geometry, Symmetry and Fractals
Basics of graph theory, Königsberg bridge problem, Four-color map problem, Möbius strip, Klein bottle.

Introduction of functions, Graphs of functions, Increasing and decreasing functions, Even and odd functions, Location of points of extrema, Inflection, Periodic functions – all via graphs.

Perspective and Projection, Perspective geometry**:** Lines and points in 2D and 3D, Fundamental trigonometric functions, Use of perspective in drawing, Historic background, Common tools adopted by artists for such representations, Analysis of some paintings to spot uses of perspective and projection techniques.

Types of symmetry, Concrete examples of symmetry groups, Study of symmetry and patterns by looking at monuments/buildings/ornamental art, Fibonacci sequences in nature, Golden ratio, Golden triangle.

Shapes and solids, Basic tilings, The regular polyhedron, Importance of Platonic solids and mystical significance to the ancient Greeks; Fractals in nature, Snowflake curves, Sierpinski triangle.

Unit 3: Solving Systems of Linear Equations using Matrices

Solving systems of linear equations, Gaussian elimination method and row operations, Consistent and inconsistent system, Gauss–Jordon row reduction and reduced row echelon form, Homogenous system, Equivalent systems and row equivalence of matrices, Rank of a matrix, Relation between homogenous system and rank.

References:

1. Andrilli, S., & Hecker, D. (2016). *Elementary Linear Algebr*a (5th ed.). Elsevier India.
2. Gallian, Joseph. A. (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.
3. Gulberg, Jan. (1997). *Mathematics from the Birth of Numbers*. W. W. Norton & Company.
4. James, Ioan. (2002). *Remarkable Mathematicians*: *From Euler to von Neumann*. The Mathematical Association of America. Cambridge University Press.

Teaching Plan (GE-2: General Mathematics-II):

Weeks 1 to 3: A brief introduction to the lives and information on the works of the following Mathematicians: Euler, Lagrange, Gauss, Cauchy, Abel, Galois, Riemann, Hardy, Noether, Ramanujan, von Neumann, Wiles, and Bhargava.

[2] Pages 41, 126, 161, 207, 280, 346, and 579–580.

[4] Chapter 1 (Pages 1–7), Chapter 5 (Pages 182 – 189), Chapter 8 (Pages 299–306), Chapter 9 (Pages 357–362), and Chapter 10 (Pages 412–416).

Week 4: Basics of Graph theory, Königsberg bridge problem, Four-color map problem, Möbius strip and Klein bottle.

[3] Chapter 5 (Section 5.5), and Chapter 11 (Section 11.5).

Weeks 5 and 6: Introduction of functions, Graphs of functions, Increasing and decreasing functions, Even and odd functions, Location of points of extrema, Inflection, Periodic functions – all via graphs.

[3] Chapter 10 (Sections 10.0, and 10.1 up to Page 344).

Weeks 7 and 8: Perspective and Projection, Perspective geometry: lines and points in 2D and 3D, Fundamental trigonometric functions, Use of perspective in drawing, Historic background, Common tools adopted by artists for such representations, Analysis of some paintings to spot uses of perspective and projection techniques.

[3] Chapter 11 (Section 11.2), Chapter 13 (Section 13.1), and Chapter 15 (Section 15.1)

Weeks 9 and 10: Types of symmetry, Concrete examples of symmetry groups, Study of symmetry and patterns by looking at monuments/buildings/ornamental art, Fibonacci sequences in nature, Golden ratio, Golden triangle.

[2] Chapter 1.

[3] Chapter 8 (Section 8.5), and Chapter 12 (Pages 418 and 419).

Weeks 11 and 12: Shapes and solids, Basic tilings, The regular polyhedron, Importance of Platonic solids and mystical significance to the ancient Greeks; Fractals in nature, Snowflake curves, Sierpinski triangle.

[3] Chapter 12 (Sections 12.0, and 12.1 up to Page 399), and Chapter 17 (Sections 17.0 to 17.4).

Weeks 13 and 14: Solving system of linear equations, Gauss elimination method and row operations, Consistent and inconsistent system, Gauss–Jordon row reduction and reduced row echelon form, Homogenous system, Equivalent system, Row equivalence, Rank of a matrix, Relation between homogenous system and rank.

[1] Chapter 2 (Sections 2.1 to 2.3).

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
1.	Learn about the contributions of remarkable mathematicians in the field of algebra, analysis, number theory, calculus, analytic geometry, differential equations and mechanics.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students to be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • End-term examinations.
2.	Understand basics of graph theory, functions and their graphs, perspective geometry and its uses in art, fractals and Fibonacci sequences with applications. Learn about types of symmetry and patterns by looking at monuments/buildings/ornamental art.		
3.	Solve systems of linear equations using Gauss elimination and Gauss–Jordon methods, and rank of matrices.		

Keywords: Remarkable Mathematicians, Ramanujan, Bhargava, Graph Theory, Functions, Perspective geometry, Golden ratio, Fractals, Gaussian elimination method, Rank of a matrix.

Acknowledgments

The following members were actively involved in drafting the LOCF syllabus of Mathematics of Generic Elective Courses for B.A./B.Com. Programme, University of Delhi.

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