

**UNDERGRADUATE CURRICULUM FRAMEWORK -2022
BASED ON
NATIONAL EDUCATION POLICY 2020**

Proposed Syllabus and Scheme of Examination

for

**GENERIC ELECTIVE (GE) COURSES OFFERED TO B.Sc. (Hons.) / B.A. (Hons.) /
B.Com (Hons.) (Other than B.Sc./B.A/B.Com (Hons.) Mathematics)**

Submitted to

Dhanamanjuri University

Manipur

under the

Choice Based Credit System

August 2022

**DESIGN OF QUESTION PAPER
MATHEMATICS**

Full Marks: 80 Marks

1. Weightage of Objectives:

Objectives	Knowledge	Understanding	Application	Skill	Total
Percentage of Marks	15	45	35	5	100
Marks	12	36	28	4	80

2. Weightage to Forms of questions:

Form of Questions	LA 6 marks	SA1 3 marks	VSA 1 mark	Objective 1 mark	Total
No. of Questions	6	10	10	4	30
Marks Allotted	36	30	10	4	80
Estimated Time(in minutes)	84	75	15	6	180

3. Weightage of Contents(Example for Analytical Geometry-GMA 101):

Unit	Name of Unit	No of lectures	Marks
I	Transformation of Co-ordinates and Pair of Straight lines	20	28
II	Systems of conics:	24	35
III	Polar equation of conics:	12	17

4. Scheme of Section : NIL

5. Scheme of option : Internal option may be given in Essay/ Long Answer type questions testing the same objective/ level of difficulties / same unit.

6. Difficulty level : Easy-25%, Average-40%, Difficulty-35%

7. N.B. : If skill questions are not available in some papers, the marks for skill question should be added to application questions.

V			GMA(select any one) GMA-309: Discrete Mathematics GMA- 310:Operations Research					
L+T/P			4,					
VI			GMA(select any one) GMA-311: Network analysis and Project Management GMA-312: Inventory and Marketing Management					
L+T/P			4					
VII								
L+T/P								
VIII								
L+T/P								
EXIT OPTION WITH BACHELOR'S DEGREE WITH HONOURS IN A DISCIPLINE ON COMPLETION OF COURSES EQUAL TO A MINIMUM OF 176 CREDITS								

Note -1: L: Lecture Class; T: Tutorial Class; P: Practical Class

Note-2: One-hour lecture per week equals 1 Credit; 2 Hours practical class per week equals 1 credit. 'Generic Elective (GE)' Course is an elective course may be chosen generally from an unrelated discipline/subject, with an intention to seek exposure to other disciplines.

Semester-I: Generic Elective (GE) Course -Mathematics

Any one of the following:

GMA-101: Analytical Geometry

GMA-102: Calculus

GMA-101: SEMESTER-I

[Analytical Geometry]

Total Marks: 100(External-80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: The goal of this paper is to acquaint students with certain ideas about conic sections, polar equation of Conics.

Course Learning Outcomes: After completion of this paper, the students will be able to:

- i) Transformation of Co-ordinates, pair of straight lines.
- ii) Classify different types of conic sections – the circle, the ellipse, the hyperbola and the parabola – in Cartesian and polar coordinates.

Course Contents:

Unit-I:

Transformation of Co-ordinates and Pair of Straight lines (Lectures: 20)/28marks

Transformation of axes: Change of Origin without changing the direction of axes, Rotation of axes: Change of Direction of axes of co-ordinates without changing the origin, Invariants, removal of the xy -term. Pair of straight lines: Homogeneous equation of second degree, Angle between pair of lines given by the homogeneous equation, Bisectors of angles between the pair of lines, Condition for the general equation of second degree to represent a pair of straight lines, Point of intersection, Equation of the pair of straight lines joining the origin to the point of intersection of lines and a curve.

Unit-II: Systems of conics: (Lectures: 24)/35marks

To find the equation of the tangent to the Circle, to find the equation of the chord of the circle, Chord of contact, pole and polar, to find the pole of straight line, to find the equation of the pair of tangents drawn from a given point to the circle, orthogonal circles, System of conics: Parabola, Ellipse and Hyperbola. Every general equation of second degree

in two variables always represents a conic section, Centre of a conic, Reduction of the general equation of second degree into central and non- central conics, Equation of tangent at a point on a conic, Condition that a line be a tangent to a conic, pair of tangents, Chord of contact, Co-normal points, pole and polar, Chord in terms of its middle point, Diameters and Conjugate diameters, Intersection of two conics, Conics through the points of intersection of two given conics, pair of tangents, Director circle,

Unit-III: Polar equation of conics:

(Lectures: 12)/17marks

Polar equation of conics: Polar equation of a conic with respect to focus as pole, Equation of chord, tangent and normal, Confocal conics: Equations and properties of confocal conics.

Recommended Books:

1. B Das, Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
2. S L Loney, Co-Ordinate Geometry of Two Dimensions, Macmillan and Co.

Reference Books:

1. J.G.Chakravorty, P.R. Ghosh, Analytical Geometry and vector Analysis.
2. Shanti Narayan and P K Mittal, Analytical Solid Geometry, S Chand & Co.

GMA-102: CALCULUS

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful to the real-world problems. .

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

- i) Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
- ii) Apply derivatives in Optimization, Social sciences, Physical sciences and Life sciences etc.
- iii) Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.

Course Contents:

Unit-I: Successive Differentiation (Lectures: 20)/28marks

Successive differentiation, Indeterminate forms and L. Hospital's Rule, Leibnitz theorem. Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax + b)^n\sin x$, $(ax + b)^n\cos x$, Rolle's theorem, Lagrange's and Cauchy's mean value theorems, Taylor's and Maclaurin's theorems with Lagrange's and Cauchy's forms of remainder, Expansion of standard functions: e^x , $\sin x$, $\cos x$, $\log(1+x)$, $(1+x)^n$, $\tan^{-1}x$

Unit -II: Derivatives and its applications (Lectures: 18)/26marks

. Function of Two and three variables, Limit and Continuity for functions of two and three variables, Partial differentiation, successive partial differentiations, Euler's theorem on Homogeneous functions of two and three variables, Maxima and Minima of functions of two variables.

Curvature, Radius of curvature for the Cartesian equation, parametric equation, implicit equation and polar equation, Asymptotes. The first-derivative test for relative extrema, Concavity and inflection points, Second derivative test for relative extrema, Curve sketching using first and second derivative tests, concavity and inflection points, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves

Unit -III: Volume and Area of Surfaces (Lectures: 18)/26marks

Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx dx$, $\int \cos nx dx$, $\int \tan nx dx$, $\int \sec nx dx$, $\int (\log x)^n dx$, $\int \sin^n x \cos^m x dx$. Evaluation of double integrals, Change of the order of integration, Change of variables in double integrals, Areas and lengths of curves in the plane, Volumes and Surface areas of solid of revolution.

Books Recommended:

1. Das and Mukherjee - Differential Calculus, U.N. Dhur and Sons Pvt. Ltd, Kolkata.
2. Shanti Narayan and PK Mittal - Differential Calculus, S.Chand and Company Ltd.
3. Das and Mukherjee-Integral Calculus, U.N. Dhur and Sons Pvt. Ltd, Kolkata.
4. Shanti Narayan and PK Mittal - Integral Calculus, S.Chand and Company Ltd.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pte.Ltd. Indian Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.
3. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Indian Reprint 2011.

4. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

Semester-II: Generic Elective (GE) Course -Mathematics

Any one of the following:

GMA-103: Linear Programming and its Applications

GMA-104: Vector analysis and Solid Geometry

GMA-103: Linear Programming and Applications

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear Programming with applications to Transportation, and Assignment.

Course Learning Outcomes: This course will enable the students to learn:

- i) Solve linear programming models of real life situations.
- ii) Simplex method for solution of LPP.

Course Contents:

Unit 1: Introduction to Linear Programming (Lectures: 18)/26marks

The Linear Programming Problem: Standard, Canonical and matrix forms, Graphical solution. Hyperplanes, Extreme points, Convex and polyhedral sets. Basic solutions; Basic Feasible Solutions; Reduction of any feasible solution to a basic feasible solution; Correspondence between basic feasible solutions and extreme points.

Unit 2: Methods of Solving Linear Programming Problem (Lectures: 20)/28marks

Simplex Method: Optimal solution, Termination criteria for optimal solution of the Linear Programming Problem, Unique and alternate optimal solutions, Unboundedness; Simplex Algorithm and its Tableau Format; Artificial variables, Two-phase method, Big-M method. Duality Theory of Linear Programming, Motivation and Formulation of Dual problem; Primal-Dual relationships; Fundamental Theorem of Duality; Complimentary Slackness.

Unit 3: Game Theory

(Lectures: 18)/26marks

Formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure.

Books recommended: P.K Gupta and Man Mohan, Linear Programming and Theory of Games

Reference Books:

1. Bazaraa, Mokhtar S., Jarvis, John J., &Sherali, Hanif D. (2010). Linear Programming and Network Flows (4th ed.). John Wiley and Sons.
2. Hadley, G. (1997). Linear Programming.Narosa Publishing House. New Delhi.
3. Taha, Hamdy A. (2010). Operations Research: An Introduction (9th ed.). Pearson.
4. KantiSwarup, P.k. Gupta and Man Mohan(2020), Operations research, Sultan chand& Sons, New Delhi

GMA-104: Vector analysis and Solid Geometry

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: The goal of this paper is to acquaint students with certain ideas about three dimensional geometry and vectors in coordinate system.

Course Learning Outcomes: After completion of this paper, the students will be able to:

- i) Visualize three dimensional objects – spheres and cylinders.
- ii) Having Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola by using software say Mathematica/MATLAB.

Unit1: Vector Analysis:

(Lectures: 18)/26marks

Scalar product of three vectors and four vectors. Vector product of three vectors, and four vectors, Reciprocal vectors, Differentiation of Vectors, Gradient, Divergence and Curl of a vector, Vector integration, Ordinary integrals of vectors. Line integrals, Surface integrals and Volume integrals.

Unit 2: Sphere, Cone and Cylinder:

(Lectures: 23)/33marks

Sphere: To find the Equation of sphere, Condition for the general equation of second degree to represent a sphere, section of a sphere by a plane, Intersection of two spheres, Equation of a tangent plane, Condition for a plane to be a tangent plane to a sphere. To find the equation of the sphere described on the join of two points as diameter, Cone: Equation of a cone with a conic as guiding curve, To find the equation of a cone with its vertex as origin is homogeneous of second degree, Enveloping cone of a sphere, Quadratic cones with vertex at origin, Condition for the general equation of second degree to represent a cone, Reciprocal cone, Right circular cone.

Unit 2: Cylinder:

(Lectures: 15)/21marks

Cylinder: Equation of cylinder, Enveloping cylinder, Right circular cylinder. To find the equation of the right circular cylinder whose axis is the line. Central Conicoids, Ellipsoid, The hyperboloid of one sheet, the hyperboloid of two sheets, condition for tangent planes, Enveloping cone, Enveloping cylinder: Paraboloids, Elliptic paraboloid, Hyperbolic paraboloid, Equations and their properties.

Recommended Books:

- I) B Das, Analytical Geometry with Vector Analysis, Orient Book Company, Kolkata.
- II) Ghosh and Maity, Vector Analysis, New Central Book Agency.
- III) S L Loney, Co-Ordinate Geometry of Three Dimensions, Macmillan and Co.

Reference Books:

- I) Shanti Narayan and P K Mittal, Analytical Solid Geometry, S Chand & Co.
- II) R J T Bell, An Elementary Treatise on Co-Ordinate Geometry of Three Dimensions, Macmillan and Co.

Semester-III: Generic Elective (GE) Course -Mathematics

Any one of the following:

GMA-205: **Differential Equations**

GMA-206: **Fuzzy sets and its applications on Decision making problems**

GMA-205: Differential Equations

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: This course includes a variety of methods to solve ordinary and partial differential equations with basic applications to real life problems.

Course Learning Outcomes: The student will be able to:

- i) Solve the exact, linear and Bernoulli equations and find orthogonal trajectories.
- ii) Apply the method of variation of parameters to solve linear differential equations.
- iii) Formulate and solve various types of first and second order partial differential equations.

Unit 1:

Ordinary Differential Equations and Applications (Lectures:18)/26marks

Exact equations and integrating factors (Rules), Linear equations and equations reducible to linear form, Equations solvable for x, y, p and Clairaut's equation, Singular solutions

Unit 2:

Solving of Higher-Order Linear Differential Equations (Lectures:20)/28marks

Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order. Second order linear differential equations with constant coefficients, Homogeneous linear equations, Complementary functions and particular integrals, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Solutions of simultaneous equations of the form $\frac{dx}{p} = \frac{dy}{q} = \frac{dz}{r}$, total differential equations of the form: $Pdx + Qdy + Rdz = 0$, method of solutions and their geometrical interpretations, orthogonal trajectory

Unit 3:

First and Second Order Partial Differential Equations (Lectures: 18)/26marks

Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.

Recommended books:

1. Piaggio – *An Elementary Treatise on Differential Equation and Their Applications*, C.B.S.Publishers& Distributors, New Delhi
2. M.D. Raisinghania- *Ordinary and Partial Differential Equations*, S.Chand, New Delhi

References:

1. R.K.Gosh and K.C. Maity-An introduction to Differential Equations NCBA (P) Ltd Kolkata
2. Coddington - *An Introduction to Ordinary Differential Equations and their Applications*, Prentice Hall of India., New Delhi
3. G.F.Simmons - *Differential Equations*, Tata McGraw Hill

GMA-206:**Fuzzy sets and its applications on Decision making problems**

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week), Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Objectives and Outcome: The objective of this course is to explore various important areas of fuzzy set theory and Mathematical programming algorithms to solve real life problems.

Contents:

Unit-1: (Lectures-16) /24marks

An overview of Crisp Sets, Basics of Fuzzy sets, Types of Fuzzy Sets, characteristics of Fuzzy Sets, Developing Membership Functions,

Unit-2: (Lectures-20)/28marks

Operations on Fuzzy sets, Extension principle for Fuzzy sets, Yager's Union and Intersection of two Fuzzy sets, Union and Intersection of two Fuzzy sets by Dubois and Prade, Union and Intersection of two Fuzzy sets by Hamacher, Fuzzy numbers and Fuzzy Arithmetic, Algebraic operations with Fuzzy numbers, Binary operations on two fuzzy numbers,

Unit-3: (Lectures-20)/28marks

Arithmetic operations on fuzzy numbers in the form of α – cuts, Fuzzy logic, Fuzzy Graphs, Possibility Theory, Fuzzy Control system models, Uncertainty based informations, , Defuzzification, Decision making in fuzzy Environment,

Books Recommended:

1. HJ Zimmermann, Fuzzy Set Theory and its Applications Springer Science, New York.

References:

1. RajjanShingal, Introduction to Fuzzy Logic: PHI Learning Private Limited, Delhi.
2. SK Pundir and R Pundir, Fuzzy Sets and their Applications, PragatiPrakashan.

Semester-4: Generic Elective (GE) Course -Mathematics

Any one of the following:

GMA-207: Algebra**GMA-208: Probability Theory and Statistics****GMA-207: Algebra**

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems.

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

- i) Employ De Moivre's theorem in a number of applications to solve numerical problems.
- ii) Apply Euclid's algorithm and backwards substitution to find greatest common divisor.
- iii) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
- iv) Find eigenvalues and corresponding eigenvectors for a square matrix.

Course Contents:

Unit 1: Theory of Equations

(Lectures:18)/26marks

Arithmetic mean, Geometric mean, Harmonic mean, Cauchy-Schwartz inequality, Holder's inequality, Minkowski's inequality. Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots; Equivalence relations, The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruence; Congruence relation between integers, Principles of mathematical induction and well ordering principle.

Unit 2: Convergence of series

(Lectures: 20)/28marks

Infinite series-Definitions, Geometric series, Theorems on series of positive terms, Comparison test of convergence, Convergence and Divergence of p-series, Cauchy's root test, D' Alembert's ratio test, Raabe's test, Logarithmic test, Leibnitz's test for alternating series, Conditional and Absolute convergence. Descartes rule of signs, Fundamental theorem of Algebra (Statement only). Transformation of equations,

Unit 3: Theory of Matrices and its Applications

(Lectures: 18)/26marks

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation $Ax = b$, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.

Books recommended:

1. Chandrika Prasad- Algebra and Theory of Equations, Pothisala Private Limited.
2. Shanti Narayan and P.K. Mittal- A text Book of Matrices, S. Chand and Co. New Delh
3. Bhattacharya, Jain and Nagpaul-First Course in Linear Algebra, Wiley Eastern, N. Delhi

References:

1. Andreescu, Titu & Andrica Dorin. (2014). Complex Numbers from A to...Z. (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (2009). First Course in The Theory of Equations. The Project Gutenberg EBook (<http://www.gutenberg.org/ebooks/29785>)

3. Goodaire, Edgar G., &Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.

GMA-208: Probability Theory and Statistics

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week), Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness.

Course Learning Outcomes: This course will enable the students to learn:

- i) Distributions to study the joint behaviour of two random variables.
- ii) To establish correlation and linear regression.
- iii) Central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell shaped curve.

Course Contents:

Unit 1:

Probability functions and Moment Generating Functions: (Lectures: 18)/26marks

Sample Space, Axiomatic definition of Probability, Random Variables- Discrete and Continuous, Cumulative distribution function, Probability mass/density functions, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit 2:

Discrete and Continuous Distributions (Univariate and Bivariate): (Lectures: 20)/28marks

Discrete distributions -Uniform, Geometric and poisson, Continuous distributions -Uniform, Exponential, Gamma, Beta and Normal; Bivariate distributions – Joint cumulative distribution, joint probability density functions, Marginal distributions, Expectation of two random variables, joint moment generating Function.

Unit 3:

Correlation, Regression and Central Limit Theorem: (Lectures: 18)/26marks

The Correlation coefficient, Covariance, Linear regression of two variables, The method of Least square, Chebyshev's theorems, Strong law of large numbers, Central limit theorems and Weak law of large numbers

Books recommended:

1. D.Biswas, Probability and Statistics, New Central Book Agency(P) Ltd.
2. ParimalMukhopadhyay, Theory of Probability, New Central Book Agency (P), Ltd

References:

1. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). Introduction to Mathematical Statistics (7th ed.). Pearson Education, Inc.
2. Miller, Irwin & Miller, Marylees. (2014).John E. Freund's Mathematical Statistics with Applications (8th ed.). Pearson. Dorling Kindersley (India).
3. Ross, Sheldon M. (2014). Introduction to Probability Models (11th ed.). Elsevier Inc.
4. B.R Bhatt, Modern Probability theory, Wiley 1989.

Semester-5 Generic Elective (GE) Course -Mathematics

Any one of the following:

GMA-309: **Discrete Mathematics**

GMA-310: **Operations Research**

GMA-309: **Discrete Mathematics**

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives:

The course introduces formal logic notation, methods of proof, mathematical induction, set theory, permutations and combinations and counting principles.

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

- i) Understand the basic principles of logic, set theory.
- ii) Understand the ideas of mathematical induction and basic counting techniques.
- iii) Basic concepts of Fuzzy set.

Unit 1: Logical Mathematics

(18 Lectures)/26marks

Compound statements (and, or, implication, negation, contrapositive, quantifiers), Truth tables, Basic logical equivalences and its consequences, Logical arguments, Set theory, Operation on sets, Types of binary relations, Equivalence relations, Congruences and its properties, Partial and total ordering, Lattices, Properties of integers, Division algorithm, Divisibility and Euclidean algorithm, GCD, LCM, Relatively prime.

Unit 2: Applications of numbers

(18 Lectures)/26marks

Prime numbers, Statement of fundamental theorem of arithmetic, Fermat primes, Mathematical induction, Recursive relations and its solution (characteristics polynomial and generating function), Principles of counting (inclusion/exclusion, pigeon-hole), Permutation and combinations (with and without repetition).

Unit 3: Graph Theory

(Lectures: 20)/28marks

Introduction to graphs, Konigsberg Bridge problem, Instant insanity game; Definition, examples and basic properties of graphs, Subgraphs, Pseudographs, Complete graphs, Bipartite graphs, Isomorphism of graphs, Paths and circuits, Eulerian circuits, Hamiltonian cycles, Adjacency matrix, Weighted graph, Travelling salesman problem, Shortest path, Dijkstra's algorithm.

Books Recommended:

Rosen, Kenneth H. (2012) Discrete Mathematics and its Applications (7th ed.). McGraw-Hill Education (India) Pvt. Ltd.

References:

1. Davey, B A., & Priestley, H. A. (2002). Introduction to Lattices and Order (2nd ed.). Cambridge University Press. Cambridge. 7th Printing 2012.
2. Goodaire, Edgar G., & Parmenter, Michael M. (2003). Discrete Mathematics with Graph Theory (2nd ed.). Pearson Education (Singapore) Pte.Ltd. Indian Reprint.
3. Lidl, Rudolf & Pilz, Günter. (1998). Applied Abstract Algebra (2nd ed.). Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint 2004.
4. Rajjan Shinghal (2013), Introduction to Fuzzy logic, PHI learning private limited, Delhi

GMA-310: Operations Research

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.) Examination: 3 Hrs.

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear Programming with applications and Non-Linear programming.

Course Learning Outcomes: This course will enable the students to learn:

- i) Solve linear programming models of real life situations.
- ii) The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points.

Course Contents:

Unit-I: (Lectures: 18)/26marks

Operations research and its scope, features of Operations research, Operations research Methodology, Structure of Mathematical model. Linear programming, Convex sets and their properties, Simplex method, Duality in linear programming and Sensitivity analysis.

Unit-II: (Lectures: 18)/26marks

Simplex Method: Optimal solution, Integer programming, Gomory's all integer Cutting plane algorithm, Branch and Bound Technique, Applications of zero one integer programming, Dual Simplex method, Goal programming, Parametric linear programming.

Unit-III: (Lectures: 20)/28marks

Non-linear Programming, Convex function, Concave function, Pseudo convex function, Quasiconvex function, Quasiconcave function, Lagrangian method, Kuhn Tucker theory, Quadratic programming- Beale's method, Wolfe's method.

Books recommended:

1. KantiSwarup, P.k. Gupta and Man Mohan(2020), Operations research, Sultan chand& Sons, New Delhi

References:

2. Hillier, Frederick S. & Lieberman, Gerald J. (2015). Introduction to Operations Research (10th ed.). McGraw-Hill Education (India) Pvt. Ltd.
3. Thie, Paul R., &Keough, G. E. (2014). An Introduction to Linear Programming and Game Theory. (3rd ed.). Wiley India Pvt. Ltd.
4. Hadley, G. (1997). Linear Programming.Narosa Publishing House. New Delhi.
5. Taha, Hamdy A. (2010). Operations Research: An Introduction (9th ed.). Pearson.

Semester-6: Generic Elective (GE) Course -Mathematics

Any one of the following:

GMA-311: Network analysis and Project Management

GMA-312: Inventory and Marketing Management

GMA-311: Network analysis and Project Management

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: The main objective of this course is to teach students how to model physical problems.

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

The basic concepts of graph theory, Network flows, Transportation problems and assignment problems.

Unit1: (Lectures: 20)/28marks

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, Test for optimality, MODI method, algorithm for solving transportation problem, Assignment problem and its mathematical formulation, Hungarian method for solving Assignment problem.

Unit-II: (Lectures-18)/26marks

Basics of project management, feasibility and technical analysis: materials and equipment, project costing & financing, financial aspects, cost benefit analysis, success criteria and success factors, risk management Mathematical models: project selection, project planning, cost-time trade-off, resource handling. Project management through PERT/CPM, Network Scheduling by PERT/CPM, Updating of PERT Charts. Project Crashing,

Unit-III: (Lectures-18)/26marks

Network Analysis , Network notations and definitions, nodes, links and flows, Paths, Cycles, Trees, Construction of minimal spanning tree and its applications, Shortest path, Shortest route problems, and travelling salesman problem..Flows in networks, Maximal flow.

Books Recommended:

1. P.K Gupta and Man Mohan, Linear Programming and Theory of Games
2. KantiSwarup, P.k. Gupta and Man Mohan(2020), Operations research, Sultan chand& Sons, New Delhi

Reference Books:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory 2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
2. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate
4. G. Hadley, Nonlinear and Dynamic Programming, Addison-Wesley, 1964.

GMA-312: Inventory and Marketing Management

Total Marks: 100(External -80, Internal-20)

Workload: 4 Lectures (per week) ,Credits: 4 Duration: 14 Weeks (56 Hrs.)

Examination: 3 Hrs.

Course Objectives: This course aims at introducing the concepts of Inventory systems and marketing management.

Course Learning outcomes: After the course, the student will be able to understand the concepts of:

- i) Different Inventory models
- ii) Applications of the models in real life situations.

Course Contents:

Unit 1: Inventory systems

(Lectures: 18)/26marks

Concepts and problems in Inventory Systems, Objectives of Scientific Inventory Control, classification of Inventory Systems, different costs in Inventory Systems and method of their estimation. The concept of EOQ

Unit 2: Deterministic Inventory models

(Lectures: 20)/28marks

Deterministic Inventory models with and without lead time. Deterministic Inventory models with and without shortages.

Unit 3:

Concepts of marketing management and related models (Lectures: 18)/26marks

Concept of marketing and its role in organization. Marketing decisions, scientific marketing analysis. Uses and limitations of mathematical models in marketing , classification of market structure in competitive conditions.

Books Recommended 1. G. Hadley, T.M. Whitin, Analysis of Inventory Systems, D.B. Taraporevala and Sons, Published by arrangement with Prentice Hall Inc., 1979.

2.KantiSwarup, P.k. Gupta and Man Mohan(2020), Operations research, Sultan chand& Sons, New Delhi

Reference Books:1. Zipkin, Foundations of Inventory Management, McGraw Hall Inc., 2000. 2. Donald Waters, Inventory Control, John Wiley, 2003.

3. Philip Kotler, Marketing Management, 13th Ed., Prentice Hall of India, 2008.

5. Tony Curtis, Marketing for Engineers, Scientists and Technologists, John Wiley & Sons Inc., 2008.