3. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

GE2.2 Econometrics

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Statistical Concepts Normal distribution; chi-square, t and F-distributions; estimation of parameters; properties of estimators; testing of hypotheses: defining statistical hypotheses; distribution of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples.

(2 questions)

UNIT II

Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting.

(3 questions)

UNIT III

Violations of Classical Assumptions: Consequences, Detection and Remedies Multicollinearity; heteroscedasticity; serial correlation.

(1 question)

Specification Analysis Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.

(1 question)

Books Recommended

1. Jay L. Devore, *Probability and Statistics for Engineers*, Cengage Learning, 2010.
2. John E. Freund, *Mathematical Statistics*, Prentice Hall, 1992.
3. Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and its Applications*, Prentice Hall, 2011.
4. Damodar N. Gujarati and D.C. Porter, *Essentials of Econometrics*, McGraw Hill, 4th Ed., International Edition, 2009.
5. Christopher Dougherty, *Introduction to Econometrics*, Oxford University Press, 3rd Ed., Indian Edition, 2007.

GE2.3 Differential equations (except mathematics hons.)

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

(2 questions)

UNIT II

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

(2 questions)

UNIT III

Reduction formulae, length of curves, volume and area of surface of revolution

(2 questions)

Vector differentiation, curl, divergence and gradient.

(1 question)

Books Recommended

1. G. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M. Weir, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag New York, Inc., 1989.

GE2 Mathematical Finance

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

(4 questions)

UNIT II

Assets: short selling, portfolio return, (brief introduction to expectation, variance, covariance, correlation), random returns, portfolio mean return and variance, diversification, portfolio problem, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index, Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

(3 questions)

Books Recommended

1. D. Luenberger, *Investment Science*, Oxford University Press, Delhi, 1998.
2. John C. Hull, *Options, Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian reprint

UNIT I

First ... exact differential equations. Integrating factors, rules to find an integrating factor. First ... higher degree equations solvable for x, y, p. Methods for solving higher-order differ... equations. Basic theory of linear differential equations, Wronskian, and its properties. Solvi... ...erential equation by reducing its order.

(2 questions)

UNIT II

Line... ...ogenous equations with constant coefficients, Linear non-homogenous equations, The ... of variation of parameters. The Cauchy-Euler equation. Simultaneous differential equ... ...al differential equations.

(3 questions)

UNIT III

Ord... ...egree of partial differential equations. Concept of linear and non-linear partial differe... equations. Formation of first order partial differential equations. Linear partial diff... equation of first order. Lagrange's method, Charpit's method.

(2 questions)

Boo... ...mmended

1. S... Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I... *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 19...

GI... ...ptography and Network Security

FULL ...0 **TIME: 3 hours**

...uestions will be set out of which candidates are required to answer ***four*** questions.

Qu... ...er **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Pub... ...Cryptography Principles & Applications, Algorithms: RSA, Message Authentication: One... ...Functions: Message Digest, MD5, SHA1. Public Key Infrastructure: Digital Sig... ...ital Certificates, Certificate Authorities.

(2 questions)

UN...

Net... ...tacks: Buffer Overflow, IP Spoofing, TCP Session Hijacking, Sequence Guessing, Ne... ...ning: ICMP, TCP sweeps. Basic Port Scans; Denial of Service Attacks: SYN Flo... ...p attacks, land, Smurf Attacks.IP security Architecture: Overview, Authentication hea... ...ulating Security Pay Load, combining Security Associations, Key Management. Vir... Network Technology: Tunneling using IPSEC.

(3 questions)

UN...

Re... ...ts, Secure Socket Layer, and Secure Electronic Transactions, Network Management Sec... ...view of SNMP Architecture- SNMPV1, SNMPV3.Firewall Characteristics & De... ...es, Types of Firewalls: Packet Filtering Router, Application Level Gateway or Pro... Filters, Bastion Host.

(2 questions)

Bo... ...mended

1. ... *Networks Security Essentials: Application & Standards*, Pearson Education, 20...

processes. Memory Management, library and system calls for memory. (2 questions)

Books Recommended

1. Arnold Robbins, *Linux Programming by Examples The Fundamentals*, 2nd Ed., Pearson Education, 2008.
2. Cox K. *Red Hat Linux Administrator's Guide*, PHI, 2009.
3. R. Stevens, *UNIX Network Programming*, 3rd Ed., PHI, 2008.
4. Sumitabha Das, *Unix Concepts and Applications*, 4th Ed., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, *Linux in a Nutshell*, 6th Ed., O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, *Beginning Linux Programming*, 3rd Ed., 2004

GE 1.1 Object Oriented Programming in C++

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

OOP Paradigm: Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++, Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers. Enumeration, Arrays and Pointer. (2 questions)

UNIT II

Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables with Functions.

(2 questions)

UNIT III

Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers – private, public and protected. Implementing Class Functions within Class declaration or outside the Class declaration, instantiation of objects, Scope resolution operator, Working with Friend Functions, Using static Class members. Understanding Compile Time Polymorphism function overloading Rules of Operator Overloading (Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators, Overloading Output/Input, Prefix/ Postfix Increment and decrement Operators, Overloading comparison operators, Assignment, subscript and function call Operator , concepts of namespaces.

(3 questions)

Books Recommended

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, *Mastering C++*, TMH, 1997.
2. S. B. Lippman and J. Lajoie, *C++ Primer*, 3rd Ed., Addison Wesley, 2000.

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi - partite graphs, isomorphism of graphs.

(2 questions)

UNIT II

Eulerian circuits, Eulerial graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems

(2 questions)

Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph,

(1 questions)

UNIT III

Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.

(2 questions)

Books Recommended

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

SEC 2.2 Operating System: Linux

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Linux – The Operating System: Linux history, Linux features, Linux distributions, Linux's relation to Unix, Overview of Linux architecture, Installation, Start up scripts, system process (an overview), Linux Security.

(2 questions)

UNIT II

The Ext2 and Ext3 File systems: General Characteristics of, The Ext3 File system, file permissions. User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.

(3 questions)

UNIT III

Resource Management in Linux: file and directory management, system calls for files Process Management, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for

3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall.
4. D. Parasons, *Object Oriented Programming with C++*, BPB Publication.
5. Bjarne Stroustrup , *The C++ Programming Language*, 3rd Ed., Addison Welsley.

GE1.2 Finite Element Methods

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares.

(1 questions)

Applications to solving simple problems of ordinary differential equations.
Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.

(2 questions)

UNIT II

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries

(1 questions)

Interpolation functions, numerical integration.

(2 questions)

UNIT III

Solution of time dimensional heat and wave equation and solution of two dimensional Laplace equation under different Geometric conditions.

(1 questions)

Books Recommended

1. J. N. Reddy, *Introduction to the Finite Element Methods*, Tata McGraw-Hill, 2003.
2. K.J. Bathe, *Finite Element Procedures*, Prentice-Hall, 2001.
3. D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite Element Analysis*, Wiley and Sons, 2002.
4. T.J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publication, 2000.
5. G. Buchanan, *Finite Element Analysis*, McGraw Hill, 1994.

GE1.3 CALCULUS (except mathematics hons.)

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Limit, continuity (ε and δ definition). Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.

2. R.C. Hibbeler and Ashok Gupta, *Engineering Mechanics: Statics and Dynamics*. 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

DSE 4.3 Differential Geometry

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I
Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

(2 questions)

UNIT II
Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula. Conjugate and Asymptotic lines.

(3 questions)

UNIT III
Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

(1 questions)

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem.

(1 questions)

Books Recommended

1. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, 2012.
2. B. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press 2003.
4. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.
5. S. Lang, *Fundamentals of Differential Geometry*, Springer, 1999.
6. B. Spain, *Tensor Calculus: A Concise Course*, Dover Publications, 2003.

SEC1.1 Logic and Sets

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Introduction to Mathematical modeling, its need, techniques and classifications. Linear growth and decay model and its uses in modeling dynamical and geometrical problems, mathematical modeling in population dynamics and Economics.

(3 questions)

UNIT II

Compartmental model, exponential decay model. Mathematical Modeling in Economics. Exponential growth of population.

(2 questions)

UNIT III

Modeling through linear programming; graphical solution, simplex method.

(1 question)

UNIT IV

Mathematical models on environmental pollution: air and water pollution.

(1 question)

List of Practical (using any software) for skill development

(i) Programming of the Simplex method for 2/3 variables.

Books Recommended

1. Mathematical Modeling, J.N.Kapur

2. Frank R. Giordano, Maurice D. Weir and William P. Fox, *A First Course in Mathematical Modeling*, Thomson Learning, London and New York, 2003.

3. **Mathematical Modeling in medicine and Biology, J.N.Kapur**

DSE4.2 Mechanics

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Analytical conditions of equilibrium of coplanar forces, virtual work, common catenary, forces in three dimension, Poinsot's central axis, wrenches. Null lines and planes, stable and unstable equilibrium

UNIT II (4 questions)

Velocities and acceleration along radial and transverse directions, along tangent and normal directions, simple harmonic motion, elastic string , Hook's law.

Central orbit, kepler's laws of motion.

(3 questions)

Books Recommended

1. I.H. Shames and G. Krishna Mohan Rao, *Engineering Mechanics: Statics and Dynamics*, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.

Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting, Host-Parasitoid systems (Nicholson-Bailey model),Numerical solution of the models and its graphical representation. Case Studies: Optimal Exploitation models, Models in Genetics, Stage Structure Models, Age Structure Models.

(2 questions)

Books Recommended

1. L.E. Keshet, *Mathematical Models in Biology*, SIAM, 1988.
2. J. D. Murray, *Mathematical Biology*, Springer, 1993.
3. Y.C. Fung, *Biomechanics*, Springer-Verlag, 1990.
4. F. Brauer, P.V.D. Driessche and J. Wu, *Mathematical Epidemiology*, Springer, 2008.
5. M. Kot, *Elements of Mathematical Ecology*, Cambridge University Press, 2001.

DSE3.3 Portfolio optimization

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Financial markets. Investment objectives. Measures of return and risk. Types of risks. Risk free assets. Mutual funds. Portfolio of assets. Expected risk and return of portfolio. Diversification.

(2 questions)

UNIT II

Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, risk-free assets and one fund theorem, efficient frontier. Portfolios with short sales. Capital market theory.

(3 questions)

UNIT III

Capital assets pricing model- the capital market line, beta of an asset, beta of a portfolio, security market line. Index tracking optimization models. Portfolio performance evaluation measures.

(2 questions)

Books Recommended

1. F. K. Reilly, Keith C. Brown, *Investment Analysis and Portfolio Management*, 10th Ed., South-Western Publishers, 2011.
2. H.M. Markowitz, *Mean-Variance Analysis in Portfolio Choice and Capital Markets*, Blackwell, New York, 1987.
3. M.J. Best, *Portfolio Optimization*, Chapman and Hall, CRC Press, 2010.
4. D.G. Luenberger, *Investment Science*, 2nd Ed., Oxford University Press, 2013.

DSE4.1 Mathematical Modeling

FULL MARKS: 80

TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations. (2 questions)

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. countability of a set. (3 questions)

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation,equivalence relations, Partial ordering relations, n-ary relations, lattices. (2 questions)

Books Recommended

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950

SEC1.2 Computer Graphics

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices. (3 questions)

UNIT II

Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing. (2 questions)

UNIT III

Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithm (2 questions)

Books Recommended

1. D. Hearn and M.P. Baker, *Computer Graphics*, 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, *Computer Graphics: Principals and Practices*, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, *Procedural Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 2001.
4. D.F. Rogers and A.J. Admas, *Mathematical Elements in Computer Graphics*, 2nd Ed., McGraw Hill Book Company, 1990.

SEC 2.1 Graph Theory

FULL MARKS: 80 TIME: 3 hours

DSE2.3 Probability and Statistics

FULL MARKS: 80

TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

(3 questions)

UNIT II

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

(2 questions)

UNIT III

Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance.

(2 questions)

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007

DSE3.1 Theory of Equations

FULL MARKS: 80

TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

[illegible] *A Beginners Guide*, Springer [illegible], Springer, 2010.
[illegible] Activities for Undergraduates, The Mathematical [illegible]
[illegible] *Inverse Problems*, 2nd Ed., [illegible]

DSE-2 5th Sem

[illegible] Boolean Algebra and Automata Theory

TIME: 3 hours

[illegible] to answer ***four*** questions.

[illegible] questions each of ***two*** marks covering [illegible]

[illegible]
[illegible] of ordered sets, maps between ordered sets, duality [illegible] algebraic structures, sublattices, products and [illegible] properties of modular and distributive lattices,

(3 questions)

[illegible]
[illegible] minimal forms of Boolean polynomials [illegible] Karnaugh diagrams, switching circuits and applications of switching [illegible]

(2 questions)

[illegible]
[illegible] Alphabets, strings, and languages. Finite Automata and Regular Languages: [illegible] non-deterministic finite automata, regular expressions, regular languages and [illegible] finite automata, pumping lemma and closure properties of regular [illegible]

(1 questions)

[illegible] Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, [illegible] grammars and languages, pushdown automaton (PDA) and the language accepted [illegible] PDA, Non- deterministic PDA, properties of context free languages; [illegible] pumping lemma, closure properties, decision properties.
[illegible] Turing machine as a model of computation, programming with a Turing [illegible] of Turing machine and their equivalence.

(1 questions)

Books Recommended

1. [illegible] and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. [illegible] and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, [illegible] Education (Singapore) P.Ltd., Indian Reprint 2003.
3. [illegible] Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. [illegible] and J. D. Ullman, *Introduction to Automata Theory, Languages*, [illegible] 2nd Ed., Addison-Wesley, 2001.
5. [illegible] C. Papadimitriou, *Elements of the Theory of Computation*, [illegible] 1997.
6. [illegible] *with Modern Applications*, Cambridge University Press,

(2 questions)

UNIT II

Symmetric functions. Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

(2 questions)

UNIT III

Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

(1 questions)

UNIT IV

Separation of the roots of equations, Strums theorem, Applications of Strum's theorem. Conditions for reality of the roots of an equation and biquadratic. Numerical Solution of equations.

(2 questions)

Books Recommended

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.
2. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

DSE3.2 Bio-Mathematics

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Mathematical Biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, Bacterial growth in a Chemostat, Harvesting a single natural population, Prey predator systems and Lotka Volterra equations, Populations in competitions, Epidemic Models (SI, SIR, SIRS, SIC).

(2 questions)

UNIT II

Activator-Inhibitor system, Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria, Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

(2 questions)

Spatial Models: One species model with diffusion, Two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population.

UNIT III

(1 questions)

Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice - Hall India, 2006.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

DSE1.2 Number Theory

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.

(3 questions)

UNIT II

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi - function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

UNIT III

(2 questions)

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation $x^4 + y^4 = z^2$, Fermat's Last theorem.

(2 questions)

Books Recommended

1. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw - Hill, Indian reprint, 2007.
2. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

DSE1.3 Analytical Geometry

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.

(2 questions)

UNIT III

Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

(2 questions)

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
5. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
5. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India, 1999.
6. Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra*, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
7. S.H. Friedberg, A.L. Insel and L.E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., 2004.

DSE 1 5th Sem

DSE1.1 Linear Programming

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Introduction to linear programming problem, convex sets and their properties, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two - phase method, Big - M method and their comparison.

UNIT II (2 questions)

Duality, formulation of the dual problem, primal - dual relationships, economic interpretation of the dual.

(1 question)

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

UNIT III

(2 questions)

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Books Recommended

(2 questions)

Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola.

(4 questions)

UNIT II

Spheres, cone, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

(3 questions)

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd. 2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

DSE2.1 Industrial Mathematics

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly.

UNIT I

Medical Imaging and Inverse Problems. The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, elementary differential equations, complex numbers and matrices.

(1 questions)

Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations. Geological anomalies in Earth's interior from measurements at its surface (Inverse problems for Natural disaster) and Tomography.

(2 questions)

UNIT II

X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction) Lines in the place.

(1 question)

Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom - Mathematical phantoms).
Back Projection: Definition, properties and examples.

UNIT III (1 question)

CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.

Books Recommended (2 questions)

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*. 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.
4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

C5.2 Group Theory II

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I
Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties

(2 questions)

UNIT II
Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

(2 questions)

UNIT III
Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.

(2 questions)

UNIT IV
Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.

(1 questions)

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

C6.1 Metric Spaces and Complex Analysis

FULL MARKS: 80 **TIME: 3 hours**

[illegible] dimension of subspaces, theorems.

(2 questions)

[illegible]

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

(2 questions)

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
6. Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
7. S. Kumaresan, *Linear Algebra- A Geometric Approach*, Prentice Hall of India,1999.
8. Kenneth Hoffman, Ray Alden Kunze, *Linear Algebra*, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
9. D.A.R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

CS 1 Multivariate Calculus

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, Extrema of functions of two variables, method of Lagrange multipliers,

UNIT II (2 question)

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

UNIT III (2 questions)

The gradient, maximal and normal property of the gradient, tangent planes Definition of vector field, divergence and curl Line integrals. Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path, Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem.

Books Recommended: (3 questions)

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable spaces.

(2 questions)

UNIT II

Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem.

(1 questions)

UNIT III

Limits. Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

(2 questions)

UNIT IV

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, bilinear transformation, cross ratio, conformal mapping.

(2 questions)

Books Recommended

1. Satish Shirali and Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag, London, 2006.
2. S. Kumaresan, *Topology of Metric Spaces*, 2nd Ed., Narosa Publishing House, 2011.
3. G.F. Simmons, *Introduction to Topology and Modern Analysis*, McGraw-Hill, 2004.
4. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw – Hill International Edition, 2009.
5. Joseph Bak and Donald J. Newman, *Complex Analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

C6.2 Ring Theory and Linear Algebra II

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in $Z[x]$. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

UNIT II (3 questions)

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces

Use of Scientific Calculator is allowed.

UNIT I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation.
Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods. (1 questions)

UNIT II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. (1 question)

Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton's Gregory forward and backward difference interpolation. (2 questions)

UNIT III

Numerical differentiation, Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule.
Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule. (2 question)

Ordinary Differential Equations: Euler's method. Runge-Kutta methods of orders two and four. (1 question)

List of Practical (Using any software) for skill development

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. To find the absolute value of an integer.
3. Enter 100 integers into an array and sort them in an ascending order.
4. Bisection Method
5. Newton Raphson Method.
6. Secant Method.
7. Regulai Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedel Method.
11. Lagrange Interpolation or Newton Interpolation.
12. Simpson's rule.

Books Recommended

1. Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 6th Ed., New age International Publisher, India, 2007.
3. C.F. Gerald and P.O. Wheatley, *Applied Numerical Analysis*, Pearson Education, India, 2008.
4. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

C4.2 Riemann Integration and Series of Functions

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Lagrange's equation. Method of Separation of Variables for solving first order partial differential equations.

(2 questions)

UNIT II

Introduction of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms. (2 questions)

UNIT III

Nonlinear partial differential equation, standard forms I, II,III and IV, Charpit's method, Monge's method to solve equation of the form (i) $Rr + Ss + Tt = V$

and (ii) $Rr + Ss + Tt + U(rt - s^2) = V$

(2 questions)

UNIT IV

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form. (1 questions)

List of Practical (Using any software) for skill development

1. Finding the Characteristic for the 1st order PDE.
2. Plot the integral of a given order PDE with initial data.
3. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:
   (a) $u(x,0) = \phi(x),\ u_t(x,0) = \psi(x),\ x \in R,\ t > 0.$
   (b) $u(x,0) = \phi(x),\ u_t(x,0) = \psi(x), u(0,t) = 0\ x \in (0,\infty),\ t > 0$
4. Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions:
   (a) $u(x,0) = \phi(x),\ u\ (o,t) = a, u\ (l,t) = b,\ 0 < x < l, t > 0.$
   (b) $u(x,0) = \phi(x),\ x \in R,\ 0 < t < T.$

Books Recommended

1. Tyn Myint-U and Lokenath Debnath. *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.

C4.1 Numerical Methods

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability.

(1 question)

Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.

(2 questions)

UNIT II

Improper integrals and their convergence, Convergence of Beta and Gamma functions.

(1 question)

Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

(2 question)

UNIT III

Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

(1 questions)

Books Recommended:

1. K.A. Ross, *Elementary Analysis. The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.

C4.3 Ring Theory and Linear Algebra I

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

UNIT II (2 questions)

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

(1 question)

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors,

Power series solution of a differential equation about an ordinary point, solution about a regular Singular point, Bessel's equation and Legendre's equation, recurrence formulae, orthogonal properties, generating function.

(2 questions)

UNIT IV

Laplace transform and inverse transform, properties, application to initial value problem up to second order ODE.

NOV E TO EC

(1 questions)

List of Practical (Using any software) for skill development

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.

Books Recommended

1. Ordinary and partial differential equation, M.D. Raisinghania, S.Chand and Company limited, 2006.
2. Integral transform, A.R.Vashistha, krishna Publication.
3. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling*, Pearson Education India, 2005.
4. S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.
5. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004

C3.1 Theory of Real Functions

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

JUNE+JULY + AUG

UNIT I

Limits of functions ($\varepsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity, Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

(3 questions)

UNIT II

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities.

SEPT+OCT

(2 questions)

UNIT III

Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1+x)$, $1/ax+b$ and $(1+x)^n$.

NOV+DEC

(2 questions)

Books Recommended:

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Review of Algebraic and Order Properties of R, δ-neighborhood of a point in R. Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R. The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets. (2 questions)

UNIT II

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion. (2 questions)

UNIT III

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Raabe,s test, DeMorgan's and Bertrand's test, Alternating series, Leibniz test, Absolute and Conditional convergence, Kummer's test, logarithmic ratio test. (3 questions)

Books Recommended

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.
4. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994

C2.2 Differential Equations

FULL MARKS: 80 **TIME: 3 hours**

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly.

UNIT I

First order exact differential equations, integrating factors, rules to find an integrating factor. First order and higher degree equations solvable for x, y, p. Clairaut's form, singular solutions, general solution. Second order linear differential equation with constant coefficient. (2 questions)

UNIT II

General solution of second order linear homogeneous and non-homogeneous equations, linear homogeneous and non-homogeneous equations of higher order with constant coefficients, The Cauchy-Euler equation. Second order linear differential equations with variable coefficients. (2 questions)

UNIT III

5. Sketching ellipsoid, hyperboloid, elliptic cone, paraboloid using Cartesian coordinate.
6. Matrix operations.

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*. 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

C1.2 Algebra

TIME: 3 hours

FULL MARKS: 80

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

Syllabus:

UNIT I

Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications, logarithmic of complex numbers. JUNE

(2 questions)

UNIT II

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic. July + Aug

(2 questions)

UNIT III

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence. Sept

(1 questions)

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix. Oct Nov + Dec

(2 questions)

Books Recommended

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
3. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

C2.1 Real Analysis

FULL MARKS: 80

TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

2. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.

C3.2 Group Theory I

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

(1 questions)

Subgroups and examples and theorems on subgroups, normal subgroup, centralizer, normalizer, center of a group.

(2 questions)

UNIT II

Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group. properties of cosets, Lagrange's theorem and consequences including. Fermat's Little theorem.

(2 questions)

UNIT III

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

(2 questions)

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

C3.3 PDE and Systems of ODE

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-

B.Sc. Mathematics (Honours)

C1.1 Calculus
FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly.

UNIT I
Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule. (2 questions)

UNIT II
Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sin^n x \cos^m x\,dx$, $\int \sin^m x \cos nx\,dx$, $\int (\log x)^n dx$, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, volume and area of surface of revolution. (2 questions)

UNIT III
Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics. (1 questions)

UNIT IV
Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration. (2 questions)

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*. 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis. *Calculus*. 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

List of Practical (Using any software) for skill development.

1. Plotting of graphs of the functions e^{ax+b}, $\log(ax+b)$, $\frac{1}{ax+b}$, $\sin(ax+b)$, $\cos(ax+b)$, $|ax+b|$ and to illustrate the effect of a and b on the graph.
2. Sketching parametric graph.
3. Obtaining surface of revolution of a curve.
4. Tracing of conic in Cartesian/polar coordinate.

B.Sc. Mathematics (Honours)

C1.1 Calculus
FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly.

UNIT I
Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule. (2 questions)

UNIT II
Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sin^n x \cos^m x\,dx$, $\int \sin^m x \cos nx\,dx$, $\int (\log x)^n dx$, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, volume and area of surface of revolution. (2 questions)

UNIT III
Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics. (1 questions)

UNIT IV
Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

(2 questions)

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

List of Practical (Using any software) for skill development.

1. Plotting of graphs of the functions e^{ax+b}, $\log(ax+b)$, $\frac{1}{ax+b}$, $\sin(ax+b)$, $\cos(ax+b)$, $|ax+b|$ and to illustrate the effect of a and b on the graph.
2. Sketching parametric graph.
3. Obtaining surface of revolution of a curve.
4. Tracing of conic in Cartesian/polar coordinate.

UNIVERSITY DEPARTMENT OF MATHEMA[illegible]S
VINOBA BHAVE UNIVERSITY HAZARIP[illegible]G

Revised Syllabus

for

B.Sc. (Hons.) Mathematics

under

Choice Based Credit System

2015

Scheme for Choice Based Credit System in B.Sc. (Hons.) Mathematics

Semester	Core Course (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
[illegible]	C1 Calculus(P)	AECC1			GE1
[illegible] Paper	C2 Algebra				
[illegible]	C3 Real Analysis	AECC2			GE2
[illegible]	C4 Differential Equations(P)				
3.	C5 Theory of Real Functions		SEC1		GE3
	C6 Group Theory I				
	C7 PDE and Systems of ODE (P)				
4.	C8 Numerical Methods (P)		SEC2		GE4
	C9 Riemann Integration and Series of Functions				
	C10 Ring Theory and Linear Algebra I				
5.	C11 Multivariate Calculus			DSE-1	
	C12 Group Theory II			DSE-2	

6.	C13 Metric Spaces and Complex Analysis			DSE-3	
	C14 Ring Theory and Linear Algebra II			DSE-4	

(P) means course with practical
Discipline Specific Electives (DSE)
Choices for DSE 1 (choose one)
1. Linear Programming
2. Number Theory
3. Analytical Geometry

Choices for DSE 2 (choose one)
1. Industrial Mathematics
2. Boolean Algebra and Automata Theory
3. Probability and Statistics

Choices for DSE 3 (choose one)
1. Theory of Equations
2. Bio-Mathematics
3. Portfolio Optimization

Choices for DSE 4 (choose one)
1. Mathematical Modeling
2. Mechanics
3. Differential Geometry

Skill Enhancement Course (SEC)
Choices for SEC 1 (choose one)
1. Logic and Sets
2. Computer Graphics

Choices for SEC 2 (choose one)
1. Graph Theory
2. Operating System: Linux

Generic Electives (GE)
Choices for GE 1 (choose one)
1. Object Oriented Programming in C++ (P)
2. Finite Element Methods
3. Calculus (except mathematics hons.)

Choices for GE 2 (choose one)
1. Mathematical Finance
2. Econometrics
3. Diffential Equations(except mathematics hons.)

Choices for GE 3 (choose one)
1. Cryptography and Network Security
2. Information Security
3. Real analysis(except mathematics hons.)

Choices for GE 4 (choose one)
1. Applications of Algebra
2. Combinatorial Mathematics
3. Algebra (except mathematics hons.)

Details of courses under B.Sc. (Hons.) Mathematics

Course *Credits
Theory + Practical Theory + Tutorial

I. Core Course
(14 Papers) 14×4 = 56 14×5 = 70
Core Course Practical / Tutorial* 14×2 = 28 14×1 = 14
(14 Papers)

II. Elective Course (8 Papers)
A.1. Discipline Specific Elective 4×4 = 16 4×5 = 20
(4 Papers)
A.2. Discipline Specific Elective Practical/ Tutorial* 4×2 = 8 4×1 = 4
(4 Papers)
B.1. Generic Elective/ Interdisciplinary 4×4 = 16 4×5 = 20
(4 Papers)
B.2. Generic Elective Practical/ Tutorial* 4×2 = 8 4×1 = 4
(4 Papers)

· Optional Dissertation or project work in place of one Discipline Specific Elective Paper (6 credits) in 6th Semester

III. Ability Enhancement Courses

1.**Ability Enhancement Compulsory Courses (AECC)**
(2 Papers of 2 credit each) 2×2 = 4 2×2 = 4
Environmental Science English/MIL Communication

2. **Skill Enhancement Courses (SEC)**
(Minimum 2) 2×2 = 4 2×2 = 4
(2 Papers of 2 credit each)

Total credit 140 140

Institute should evolve a system/ policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

*** wherever there is a practical there will be no tutorial and vice-versa**

quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

(2 questions)

UNIT IV

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an $m \times n$ matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithm.

(1 questions)

Books Recommended

1. L. Smith and D. J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York, 1990.
2. S. Singh and S. K. Jain, *Topics in Applied Abstract Algebra*, Thomson Brooks and Cole, Belmont, 2005.
3. Rick Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, *Linear Algebra and its Applications*. 3rd Ed., Pearson Education Asia, Indian Reprint, 2005.
5. Peter Lancaster, *Matrix theory*, Springer-Verlag New York, Inc., New York, 1999.

GE4.2 Combinatorial Mathematics

FULL MARKS: 80 TIME: 3 hours

Questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers. Principle of Inclusion and Exclusion, Derangements, Inversion formulae

(1 questions)

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.

(1 questions)

UNIT II

Recurrence relations: Recurrence relation models, Solution of recurrence relations, Solutions by generating functions.

(2 questions)

Integer partitions, Systems of distinct representatives, Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group, Polya's theorems and their immediate applications.

(1 questions)

UNIT III

Latin squares, Hadamard matrices, Combinatorial designs: t designs, BIBDs, Symmetric designs.

(2 questions)

Books Recommended

1. J.H. [illegible] and R.M. Wilson, *A Course in Combinatorics*, 2nd Ed., Cambridge University Press.
2. V. [illegible]murthy, *Combinatorics, Theory and Application*, Affiliated East-West Press 1985.
3. P. [illegible], *Combinatorics, Topics, Techniques, Algorithms*, Cambridge University Press, 19[illegible]
4. M. [illegible], *Combinatorial Theory*, 2nd Ed., John Wiley & Sons, 1986.
5. S. [illegible] *ombinatorial Techniques*, Hindustan Book Agency, 2013.
6. D. [illegible], *Introductory Combinatorics*, 5th Ed., Pearson Education Inc., 2009.

GE 4.3 Algebra (except mathematics hons.)

FU[illegible] TIME: 3 hours

[illegible]uestions will be set out of which candidates are required to answer ***four*** questions.

Qu[illegible]mber 1 is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

U[illegible]

De[illegible] examples of groups, examples of abelian and non-abelian groups, the group Z_n of int[illegible] ddition modulo n and the group U(n) of units under multiplication modulo n. Cy[illegible]om number systems, complex roots of unity, circle group, the general linear gr[illegible]

(2 questions)

U[illegible]

Su[illegible]ic subgroups, the concept of a subgroup generated by a subset and the co[illegible]group of group, examples of subgroups including the center of a group. Cosets, In[illegible]p, Lagrange's theorem, order of an element, Normal subgroups: their definition, ex[illegible]haracterizations, Quotient groups.

U[illegible] (3 questions)

De[illegible] examples of rings, examples of commutative and non-commutative rings; rings fr[illegible]tems, Z_n the ring of integers modulo n, ring of real quaternions, rings of m[illegible]nial rings, and rings of continuous functions. Subrings and ideals, Integral do[illegible]ds, examples of fields: Z_p, Q, R, and C.

Bo[illegible]ended (2 questions)

1. [illegible]
2. [illegible]gh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
3. [illegible]*ract Algebra*, 2nd Ed., Pearson, 2011.
4. [illegible]an, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
[illegible]rews, *Number Theory*, Hindustan Publishing Corporation, 1984.

2.TCP/IP Protocol Suite , Behrouz A. Forouzan, *Data Communication and Networking*, Tata
Mc[illegible]
3. W[illegible]gs, *Cryptography and Network Security, Principles and Practice*, Pearson
Edu[illegible]2000

GE[illegible] rmation Security

FUL[illegible] TIME: 3 hours

[illegible]questions will be set out of which candidates are required to answer ***four*** questions.

Qu[illegible]ber **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UN[illegible]
Ov[illegible]ecurity: Protection versus security; aspects of security–data integrity, data ava[illegible]ivacy; security problems, user authentication, Orange Book.
(1 questions)

Sec[illegible]ts: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flo[illegible]reats- intruders; communication threats- tapping and piracy.
(2 questions)

UN[illegible]
Cry[illegible]: Substitution, transposition ciphers, symmetric-key algorithms-Data Enc[illegible]ndard, advanced encryption standards, public key encryption - RSA; Diffie-Hel[illegible]xchange, ECC cryptography, Message Authentication- MAC, hash functions.
(2 questions)

UN[illegible]
Dig[illegible]res: Symmetric key signatures, public key signatures, message digests, public key inf[illegible]
(1 questions)

Sec[illegible]nisms: Intrusion detection, auditing and logging, tripwire, system-call mo[illegible]
(1 questions)

Bo[illegible]mended

1. W[illegible], *Cryptography and Network Security Principles and Practices*, 4th Ed., Prentice-Hal[illegible]006.
2. [illegible] and S.L. Pfleeger, *Security in Computing* , 3rd Ed., Prentice-Hall of India, 2007.
3. [illegible]n, *Computer Security*, John Wiley and Sons, NY, 2002.
4. [illegible], T. Hardjono and J. Seberry, *Fundamentals of Computer Security*, Springer-Ve[illegible]2003.
5. [illegible] *Computer Network Security*, Springer, 2007.
6. [illegible]nd J. Breithaupt, *Information Security: Principles and Practices*, Pearson Ed[illegible]6.

GE[illegible]analysis (except mathematics hons.)

FU[illegible] TIME: 3 hours

[illegible]questions will be set out of which candidates are required to answer ***four*** questions.

Question number **1** is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UN[illegible]

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.

(2 questions)

UNIT II

Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).

(2 questions)

UNIT III

Infinite series, Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of convergence without proof). Definition and examples of absolute and conditional convergence.

(3 questions)

Books Recommended

1. T. M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
2. R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 200
3. K. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. E.A. Maxwell, *Elementary Analysis- The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

GE4.1 Applications of Algebra

FULL MARKS: 80 TIME: 3 hours

Eight questions will be set out of which candidates are required to answer ***four*** questions.

Question number 1 is compulsory consists of ***ten*** short answer type questions each of ***two*** marks covering entire syllabus uniformly

UNIT I

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference families, construction of BIBD from finite fields.

(2 questions)

UNIT II

Coding Theory: introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance.

(1 questions)

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns.

(1 questions)

UNIT III

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices, positive semi-definite matrices, square root of apositive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and