Math

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 relationship to Unix, Overview of Linux architecture, Installation, Start up scripts, system processes (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 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.

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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, publicand 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.

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.
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 one 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. R.D. Cook, D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite Element Analysis*, John Wiley and Sons, 2002.
4. Thomas J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*, Dover Publication, 2000.
5. George R. Buchanan, *Finite Element Analysis*, McGraw Hill, 1994.

GE 1.3 CACULUS (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 and 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 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.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.

47

GE2.1 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

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, 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. David G. Luenberger, *Investment Science*, Oxford University Press, Delhi, 1998.
2. John C. Hull, *Options, Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
3. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

GE2.2 Econometrics

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; distributions 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. D. 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.

49

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

UNIT I

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. 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.

(2 questions)

UNIT II

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.
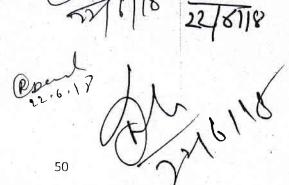
(3 questions)

UNIT III

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.

(2 questions)

Books Recommended

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

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GE3.1 Cryptography and Network Security

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

Public Key Cryptography Principles & Applications, Algorithms: RSA, Message Authentication: One way Hash Functions: Message Digest, MD5, SHA1. Public Key Infrastructure: Digital Signatures, Digital Certificates, Certificate Authorities.

(2 questions)

UNIT II

Network Attacks: Buffer Overflow, IP Spoofing, TCP Session Hijacking, Sequence Guessing, Network Scanning: ICMP, TCP sweeps, Basic Port Scans; Denial of Service Attacks: SYN Flood, Teardrop attacks, land, Smurf Attacks.IP security Architecture: Overview, Authentication header, Encapsulating Security Pay Load, combining Security Associations, Key Management. Virtual Private Network Technology: Tunneling using IPSEC.

(3 questions)

UNIT III

Requirements, Secure Socket Layer, and Secure Electronic Transactions, Network Management Security: Overview of SNMP Architecture- SNMPV1, SNMPV3.Firewall Characteristics & Design Principles, Types of Firewalls: Packet Filtering Router, Application Level Gateway or Proxy, Content Filters, Bastion Host.

(2 questions)

Books Recommended

1. W. Stallings, *Networks Security Essentials: Application & Standards,* Pearson Education, 2000.
2. TCP/IP Protocol Suite , Behrouz A. Forouzan, *Data Communication and Networking,* Tata McGraw Hill.
3. W. Stallings, *Cryptography and Network Security, Principles and Practice,* Pearson Education, 2000.

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GE 3.2 Information Security
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
Overview of Security: Protection versus security; aspects of security–data integrity, data availability, privacy; security problems, user authentication, Orange Book.

(1 questions)

Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy.

(2 questions)

UNIT II
Cryptography: Substitution, transposition ciphers, symmetric-key algorithms-Data EncryptionStandard, advanced encryption standards, public key encryption - RSA; Diffie-Hellman key exchange, ECC cryptography, Message Authentication- MAC, hash functions.

(2 questions)

UNIT III
Digital signatures: Symmetric key signatures, public key signatures, message digests, public key infrastructures.

(1 questions)

Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

(1 questions)

Books Recommended
1. W. Stallings, *Cryptography and Network Security Principles and Practices,* 4th Ed., Prentice-Hall of India, 2006.
2. C. Pfleeger and S.L. Pfleeger, *Security in Computing ,* 3rd Ed., Prentice-Hall of India, 2007.
3. D. Gollmann, *Computer Security,* John Wiley and Sons, NY, 2002.
4. J. Piwprzyk, T. Hardjono and J. Seberry, *Fundamentals of Computer Security,* Springer-Verlag Berlin, 2003.
5. J.M. Kizza, *Computer Network Security,* Springer, 2007.
6. M. Merkow and J. Breithaupt, *Information Security: Principles and Practices,* Pearson Education, 2006.

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GE 3.3 Real analysis (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

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., 2000.
3. E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
4. K.A. Ross, *Elementary Analysis- The Theory of Calculus Series-* Undergraduate Texts in Mathematics, Springer Verlag, 2003.

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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 set 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 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 algorithms.

(1 questions)

Books Recommended

1. I. N. Herstein and D. J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York, 1990.

54

GE4.2 Combinatorial 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

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. van Lint and R.M. Wilson, *A Course in Combinatorics*, 2nd Ed., Cambridge University Press, 2001.
2. V. Krishnamurthy, *Combinatorics, Theory and Application*, Affiliated East-West Press 1985.
3. P.J. Cameron, *Combinatorics, Topics, Techniques, Algorithms*, Cambridge University Press, 1995.
4. M. Jr. Hall, *Combinatorial Theory*, 2nd Ed., John Wiley & Sons, 1986.
5. S.S. Sane, *Combinatorial Techniques*, Hindustan Book Agency, 2013.
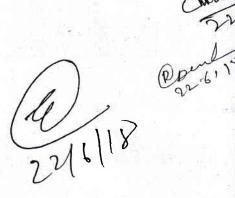6. R.A. Brualdi, *Introductory Combinatorics*, 5th Ed., Pearson Education Inc., 2009.

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2. S. R. Nagpaul and S. K. Jain, *Topics in Applied Abstract Algebra*, Thomson Brooks and Cole, Belmont, 2005.

3. Richard E. 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, 2007.

5. Fuzhen Zhang, *Matrix theory*, Springer-Verlag New York, Inc., New York, 1999.

GE 4.3 Algebra (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

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group U(n) of units under multiplication modulo n, complex roots of unity, introduction to cyclic group.

(2 questions)

UNIT II

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

(3 questions)

UNIT III

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p, Q, R, and C.

(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, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.