List of Courses having focus on Employability

Department : *Mathematics*

Program Name : *B.Sc., MSc.*

Academic Year : 2021-22

List of Courses having focus on Employability

Sr. No.	Course Code	Name of the Course
01.	MSO 3.3 and 4.3	Operations Research I and II
02.	MSO 3.8	Number Theory and Cryptography
03.	MSO 3.7	Object Oriented Programming with C++
04.	GE 3.2	Cryptography and Network Security
05.	MSO 4.6	Financial Mathematics and its Applications
06.	DSE 2.3	Probability and Statistics
07.	DSE 3.3	Linear Programming

SCHEME OF EXAMINATION

All papers of B.Sc.(Honors'in Mathematics) **First, Second, Third** and **Fourth** Semesters are compulsory. In **Fifth** and **Sixth** Semesters **TWO PAPERS(02)** are **core papers** and each student has to choose three papers from the list of given **optional papers**. An examinee has to attempt total five (05) questions out of eight(08) i.e. one compulsory and four optional. Question No. 1 is compulsory and will consist of short answered type ten(10) questions spread all over the syllabus carrying 20 marks (2 marks of each question). Rest of all questions will carry 10 marks each.
In addition to this in the final semester (i.e. Fourth Semester of M.Sc. in Mathematics) a student can choose **two optional papers** and one **project dissertation (selection based on the criteria fixed by Department Head)** under the supervision/guidance of any of the faculty members in the relevant areas of Mathematics closely to the subjects taught at M.Sc. level. Supervisor and topic of the dissertation for student is being allotted at the level of Department in consultation with HOD by a team of faculty members. The dissertation evaluation of 100 marks is evaluated by a committee **consisting of HOD, supervisor and external subject expert**. Each paper (except project dissertation) is of 100 marks and its distribution is as under:

Internal Assessment: **40** (30 marks of internal examination + 05 marks of assignment + 05 maximum marks on attendance)

End Semester Examination: 60

B.Sc. (Hon's) in Mathematics				
Semester	**Course Type**	**Course Code**	**Course Name**	**Credit/ Hours**
I	Core	C1.1	Calculus (Theory)	04
		C 1.1	Practical (Lab)	02
		C 1.2	Algebra	06
	Generic Elective	GE 1.1	Differential Calculus	06
		GE 1.2	Object Oriented Programming in C++	06
		GE 1.3	Finite Element Methods	06
II	Core	C2.1	Real Analysis	06
		C 2.2	Differential Equations (Theory)	04
		C 2.2	Practical (Lab)	02
	Generic Elective	GE 2.1	Algebra and Matrix Theory	06
		GE 2.2	Mathematical Finance	06
		GE 2.3	Econometrics	06
	Core	C3.1	Theory of Real Functions	06
		C3.2	Group Theory I	06
		C3.3	PDE and System of ODE (Theory)	04
		C3.3	Practical (Lab)	02
		GE 3.1	Ordinary Differential Equations	06

III	Generic Elective		and Vector Calculus	
		GE 3.2	Cryptography and Network Security	06
		GE 3.3	Information Security	06
	SEC	SEC 1.1	Logic and Sets	06
		SEC 1.2	Computer Graphics	06
IV	Core	C4.1	Numerical Methods (Theory)	04
		C4.1	Practical (Lab)	02
		C4.2	Riemann Integration and series of Functions	06
		C4.3	Ring Theory and Linier Algebra I	06
	Generic Elective	GE4.1	Partial Differential Equations, Laplace Transform and Fourier Series	06
		GE 4.2	Applications of Algebra	06
		GE 4.3	Combinatorial Mathematics	06
	SEC	SEC 2.1	Graph Theory	06
		SEC 2.2	Operating System: Linux	06
V	Core	C 5.1	Multivariate Calculus	06
		C 5.2	Group Theory II	06
	DSE (Any One)	DSE 1.1	Portfolio Optimization	06
		DSE 1.2	Number Theory	06
		DSE 1.3	Analytical Geometry	06
	DSE (Any One)	DSE 2.1	Industrial Mathematics	06
		DSE 2.2	Boolean Algebra and Automata Theory	06
		DSE 2.3	Probability and Statistics	06
VI	Core	C 6.1	Metric Space and Complex Analysis	06
		C 6.2	Ring Theory and Linear Algebra II	06
	DSE (Any One)	DSE 3.1	Theory of Equations	06
		DSE 3.2	Bio-Mathematics	06
		DSE 3.3	Linear Programming	06
	DSE (Any One)	DSE 4.1	Mathematical Modeling	06
		DSE 4.2	Mechanics	06
		DSE 4.3	Differential Geometry	06

SCHEME OF EXAMINATION

All papers of M.Sc. First and Second Semesters are compulsory. In M.Sc. Third and Fourth Semester **Two papers** are **core papers** and each student has to choose three among the given list of **optional papers (Including Project)**. A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.
Supervisor and topic of the dissertation for student will be allotted at the level of Department. The dissertation evaluation of 100 maks evaluated by a committee consisting of HOD, supervisor and external subject expert. Each paper (except project dissertation) is of 100 marks and its distribution is as under:

Internal Assessment : 40

End Semester Examination : 60

M.Sc. in Mathematics

Semester	Course code	Core Course	Credit Hours
I	MSC 1.1	Algebra - I	04
	MSC 1.2	Real Analysis	04
	MSC 1.3	Topology-I	04
	MSC 1.4	Differential Geometry - I	04
	MSC 1.5	Discrete Mathematical Structures	04
II	MSC 2.1	Algebra - II	04
	MSC 2.2	Complex Analysis	04
	MSC 2.3	Topology-II	04
	MSC 2.4	Differential Geometry - II	04
	MSC 2.5	Graph Theory	04
III (Core Group)	MSC 3.1	Functional Analysis	04
	MSC 3.2	Theory of Differential Equations –I	04
	MSO 3.1	Fuzzy Sets, Fuzzy Logic and their Applications –I	04
	MSO 3.2	Integral Equations	04

III (Optional Group ANY THREE)	MSO 3.3	Operations Research- I	04
	MSO 3.4	Differential Geometry of Manifolds	04
	MSO 3.5	Difference Equations –I	04
	MSO 3.6	Information Theory and its Applications	04
	MSO 3.7	Object Oriented Programming with C++	04
	MSO 3.8	Number Theory and Cryptography	04
IV (Core Group)	MSC 4.1	Advanced Functional Analysis	04
	MSC 4.2	Theory of Differential Equations –II	04
IV (Optional Group ANY THREE)	MSO 4.1	Fuzzy Sets, Fuzzy Logic and their Applications–II	04
	MSO 4.2	Finsler Geometry	04
	MSO 4.3	Operations Research- II	04
	MSO 4.4	Complex Manifolds	04
	MSO 4.5	Difference Equation –II	04
	MSO 4.6	Financial Mathematics and its Applications	04
	MSO 4.7	Project	04

References:

1. Abdul-Majid Wazwaz, A first course in Integral Equations, World Scientific Publishing Co. Pvt. Ltd.
2. M. Rahman, Integral Equations and their Applications, WIT*PRESS*, Boston.
3. A.D. Polyanin and A.V. Manzhirov, Handbook of Integral Equations, CRC Press, Boca Raton/London/New York/Washington D.C.
4. Ram P. Kanwal, Linear Integral Equations, Theory and technique, Academic Press, New York/London.
5. A.B. Chandramouli, Integral Equations with Boundary Value Problems, Shiksha Sahitya Prakashan.

MSO 3.3: Operations Research-I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Operations research (O.R.): Origin and development, Nature and future, scientific methods, Modelling in O.R., advantages and limitations of models, general solution methods for O.R. models, methodology of O.R., O.R. and decision making, applications of O.R.

Inventory control: Types inventories, reasons for carrying inventories, the inventory decisions, objectives of scientific inventory control, costs associated with inventories, factors affecting inventory control, an inventory control problem, the concept of EOQ, Deterministic inventory problems with no shortages, Deterministic Inventory problem with shortages, problems of EOQ with price breaks, multi-item deterministic problems, dynamic order quantity, selective inventory control techniques .

Inventory problems with uncertain demand, systems of inventory control, one period problem, one period problem without set-up cost, one period problem with set-up cost, dynamic programming and inventory control.

Queuing theory: Queuing system, elements of a Queuing system, operating characteristics of a Queuing system, deterministic Queuing system, probability distributions in Queuing system, classification of Queuing models, definition of transient and steady states, Poisson Queuing systems, non-Poisson Queuing systems, cost models in Queuing , other Queuing models.

Replacement Problem

Text Books:

1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison –Wesley, Reading Mass.
3. H. A. Taha, Operation Research- An Introduction, Macmillan Publishing Co. Inc., New York.
4. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.

Projective connection parameters, Projectively flat spaces, Szabó Theorem.

Lie derivatives and their applications: Infinitesimal transformations, Lie derivative of scalars, vectors and tensors, Lie derivative of connection parameters of Cartan and Berwald, Motion, Affine motion and Projective motion.

Books Recommended:

1. H. Rund, The Differential Geometry of Finsler Spaces, Springer-Verlag, Berlin, 1959.
2. M. Matsumoto, Foundations of Finsler Geometry and Special Finsler Spaces, Kaisheisha Press, Otsu, 1986.
3. P.L. Antonelli (ed.), Handbook of Finsler Geometry, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2003.

MSO 4.3: Operations Research-II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Sequencing problem: introduction, problems of sequencing, the basic terms of use in sequencing, processing n –jobs through two machines, processing n-jobs through k-machines, processing two jobs through k-machines,

Dynamic programming problem: introduction, the recursive equation approach, charactersitcs of dynamic programming, dynamic programming algorithm, solution of DPP, some applications, solution of LPP by dynamic programming.

Integer Programming: Introduction, Pure and mixed integer problems, Gomory's All I.P.P method, construction of Gomory's constants, fractional cut method All I.P.P. , fraction cut method -mixed integer linear programming problem, Branch and bound method, applications of integer programming.

Non-Linear Programming: Introduction, formulating a Non-linear programming problem(NLPP), general NLPP, constraint optimization with equality constraints, constraint optimization with inequality constraints,saddle point problems, saddle point and NLPP.

Text Book:

1. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi.
2. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
3. G. Hadley, Nonlinear and Dynamic Programming, Addison –Wesley, Reading Mass.
4. H. A. Taha, Operation Research- An Introduction, Macmillan Publishing Co. Inc., New York.
5. Prem Kumar Gpta and D. S. Hira, Operations Research- An Introduction, S. Chand & Company Ltd. New Delhi.

Reference Book:

1. S. D. Sharma, Operation Research, S. Chand Publication, New Delhi.

MSO 3.8: Number Theory and Cryptography

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Elementary Number Theory : Divisibility and Euclidean Algorithm, Congruence, Applications to factoring, Time Estimates for doing arithmetic.

Cryptography : Some simple crypto systems, Enciphering matrices.

Finite Fields and quadratic Residues, Quadratic residues and Reciprocity.

Public Key Cryptography: The idea of public key cryptography, RSA, Discrete log, Knapsack.

Primality and Factoring: Pseudo primes, The rho method, Fermat factorization and factor bases, The Continued fraction method, The quadratic sieve method.

Recommended Text

1. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, NewYork, 2002, Second Edition.

Reference Books

1. Niven and Zuckermann, An Introduction to Theory of Numbers (Edn. 3), WileyEastern Ltd., New Delhi, 1976.
2. David M.Burton, Elementary Number Theory, Wm C.Brown Publishers, Dubuque,Iowa, 1989.
3. K.Ireland and M.Rosen, A Classical Introduction to Modern Number Theory, Springer Verlag, 1972.
4. J. Buchmann, Introduction to Cryptography, Second Edition (2005), Springer.

MSC 4.1: Advanced Functional Analysis

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Inner product spaces. Hilbert spaces. Orthonormal sets. Bessels inequality. Structure of Hilbert spaces. Projection theorem. Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces. Self adjoint operator, positive projection, normal and unitary operators.

Convex Sets and Projections, Orthogonality and Orthonormal Bases, Continuous Linear Functionals, Riesz Representation Theorem, Weak Convergence, Nonlinear Functionals and Generalized Curves, The Hahn-Banach Theorem.

Support functional of a Convex Set, Minkowski Functinoals, The Support Mapping Theorem, Separation Theorem, Applications to Convex Programming, Geeralization to

Stability of nonlinear systems, Chaotic behaviour.

Asymptotic methods- Introduction. Asymptotic Analysis of sums. Linear equations. Nonlinear equations.

Text Book:

W. G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

References:

C. Ahlbrandt and A. C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations. Kluwer, Boston, 1996.

MSO 3.6: Information Theory and its Applications

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Basic concepts of information theory: Memory less finite schemes. Elements of encoding.

Discrete schemes without memory: Basic concepts of discrete Probability.

Continuous channel without memory. Entropy of a single events. Functional Equations. Shannon's measure of informations. The fundamental equation of informations. Applications of informations theory in various fields.

Books Recommended:

1. F.M. Reza, An introduction to information theory, Dover Publications Inc. New York
2. J. Aczel and Z. Doroczy, On Measures of information and their characterizations, Academic Press, New Yark.
3. Robert B. Ash, Information Theory, Interscience Publisher, New York
4. John R. Pierce, An Introduction to Information Theory, Dower Publications Inc. New York
5. John Avery , Information theory and evolution, World Scientific , New Jersey

MSO 3.7: Object Oriented Programming with C++

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Principles of Object Oriented Programming: A look at procedure-oriented programming, Object oriented programming Paradigm, Basic Concepts of Object Oriented Programming, Benefits of OOP, Object oriented languages, Applications of OOP, Concept of C++, Applications of C++ , Structure of C++ program, creating the

source files, Compiling and linking a simple C++ program.

Tokens Expressions and Control Structure: Tokens, Keywords, Identifiers and constants, basic data types, User defined data types, Storage classes, Derived data types, Symbolic constants, Type compatibility, Declaration of variables, Dynamic initialization of variables, Reference variables.

Operators and Expressions: Operators in C++, Scope resolution, Operator, Member differencing Operators, Memory Management Operators, Manipulators, Type cast operators, Expressions and their types, Special assignment expressions, Implicit conversion operator, overloading, Operator precedence, Control structure.

Functions in C++: The main functions, Function Prototypes, Call by reference, Returned by reference, Inline function, Default argument, Constant argument, Recursion, Function overloading, Friend and Virtual function, Math library functions.

Classes and Objects: C structures revisited, Specifying a class, Defining member function in a C++ program with class, Nesting of member functions, private member function, Arrays within class, Memory allocation for objects, Static data members and static member functions, Arrays of objects as a function arguments, friendly function, returning objects, Constant member functions, Pointers to members, local classes.

Constructors and Destructors: Constructors, parameterized constructors, multiple constructors in a class, Constructors with default arguments, Dynamic initialization of objects, Copy Constructor, Dynamic Constructor, Destructors.

Inheritance: Defining derived classes, single inheritance, Multi level inheritance, multiple inheritance, Hierarchical inheritance, Hybrid Inheritance.

Pointers and Virtual Functions: Pointers, Pointers to objects this Pointers, Pointers to derived classes, Virtual functions, Pure virtual function, Virtual constructors and destructors.

Working with Files: Classes for files stream operations, Opening and closing a file ,Detecting a file, File Modes, File pointers and their manipulation, sequential input and output operations, Random Access, Error handling during file operations.

Text Books:

1. E. Balagurusmy, Object oriented programming with C++, Tata Mac-Graw Hill.

Reference Books:

1. D. Ravichandan, Programming with C++
2. M. P. BhaveS. A. Patekar, Object Oriented Programming With C++ Pearson Education
3. Robert Lafore Object Oriented Programming in turbo C++ Pearson.

5. Christopher Dougherty, *Introduction to Econometrics*, Oxford University Press, 3rd Ed., Indian edition, 2007.

GE 3.1 Ordinary Differential Equations and Vector Calculus

Ordinary differential equations of first order and first degree. Method of Variable separable. Homogeneous and Reducible to homogeneous form equations, linear equations, Bernoulli equation, Exact differential Equation. Integrating factor.

First order higher degree equations solvable for x, y, p. Singular solution and envelopes, Clairaut's equations. Orthogonal trajectory.

Linear differential equations with constant coefficients, homogeneous linear differential equations, linear differential equations of second order with variable coefficients. Cauchy equation, Normal form, Changing the independent variable.

Series solutions of differential equations.

Vector Calculus: Directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, Divergence and curl. Gauss' divergence, Green's and Stoke's theorems and its applications.

Text Books:

1. Gorakh Prasad, Integral Calculus, Pothishala Private Ltd. Allahabad.
2. B. Rai, D. P.Choudhary, Ordinary Differential Equations, Narosa Publ. 2004.
3. R. S. Senger, Ordinary Differential Equations with Integration, Prayal Publ. 2000.

Reference Books:

1. S. BalachandraRao and H. R. Anuradha, Differential Equations with Applications and Programmes, University Press, Hyderabad, 1996.
2. D. A. Murray, Introductory Course in Differential Equations, Orient Longman (India), 1967.

E. A. Codington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1961

GE 3.2 Cryptography and Network Security

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.

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.

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.

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.

GE 3.3 Information Security

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

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

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.

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

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

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.

Text Book:

W. G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications. Academic Press Inc., Harcourt Brace Joranovich Publishers, 1991.

References:

C. Ahlbrandt and A. C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations. Kluwer, Boston, 1996.

MSO 4.6: Financial Mathematics and its Applications

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Financial Derivatives – An introduction: Types of financial derivatives –Forwards and futures: Options and its kinds and SWATS. Securities markets, Technical Analysis and fundamental analysis.

The arbitrage theorems and introduction to portfolio selection and capital market theory; Static and continuous-time models.

Pricing by arbitrage- A single period option pricing model; Multi period pricing models- Cox-Ross-Rubinstein Model.

Martingales and martingales representation, the Black –Scholes option pricing model-using no arbitrage approach, limiting case of binomial option pricing and risk –neutral probabilities.

The American option pricing –extended trading strategies; analysis of American of put and call option.

Books Recommended

1. John C Hall, Options , features and other derivatives, Prentice- Hall of India Private Limited.
2. Sheldon M Ross, An introduction to Mathematical Finance, Cambridge University Press.
3. Sahil N. Nettci and Ali Hirsa, An introduction to Mathematics of financial derivatives, Academic Press Inc.
4. Robert J Elliot and P. ekkehard Kopp, Mathematics of financial markets, Springer-verlag New Yark Inc.
5. Kevin, Security analysis and portfolio management, PHI learning Private limited

MSO 4.7: PROJECT

Note: Under the guidance of faculty member(s) on a topic to be approved by the Department.

5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, *Elements of the Theory of Computation*, 2nd Ed., Prentice-Hall, NJ, 1997.

6. J.A. Anderson, *Automata Theory with Modern Applications*, Cambridge University Press, 2006.

DSE2.3 Probability and Statistics

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.

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.

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, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to MathematicalStatistics*, 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 ofStatistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

DSE3.1 Theory of Equations

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.

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.

11/7/18

DSE3.3 Linear Programming

Introduction to linear programming problem, 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.

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

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.

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

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and NetworkFlows*, 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.

DSE4.1 Mathematical Modeling

Power series solution of a differential equation about an ordinary point, solution about a regular singular point, Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.

Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence, Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis

List of Practicals (using any software)

i. Plotting of Legendre polynomial for n = 1 to 5 in the interval [0,1]. Verifying graphically that all the roots of Pn (x) lie in the interval [0,1].

11/7/18