List of New Courses Introduced

Department : *Mathematics*

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

Academic Year : 2019-20

List of New Courses Introduced

Sr. No.	Course Code	Name of the Course
01.	C3.1	Theory of Real Functions
02.	C3.2	Group Theory-I
03.	C3.3	PDE and System of ODE
04.	GE3.1	Ordinary Differential Equations and Vector Calculus
05.	GE3.2	Cryptography and Network Security
06.	GE3.3	Information Security
07.	SEC1.1	Logic and Sets
08.	SEC1.2	Computer Graphics
09.	C4.1	Numerical Methods
10.	C4.2	Riemann Integration and series of Functions
11.	C4.3	Ring Theory and Linear Algebra-I
12.	GE4.1	Partial Differential Equations, Laplace Transform and Fourier Series
13.	GE4.2	Applications of Algebra
14.	GE4.3	Combinatorial Mathematics
15.	SEC2.1	Graph Theory
16.	SEC2.2	Operating system: Linux
17.	MSC3.1	Functional Analysis

Head
Department of Mathematics
Guru Ghasidas Vishwavidyalaya

Minutes of Meetings (MoM) of Board of Studies (BoS)

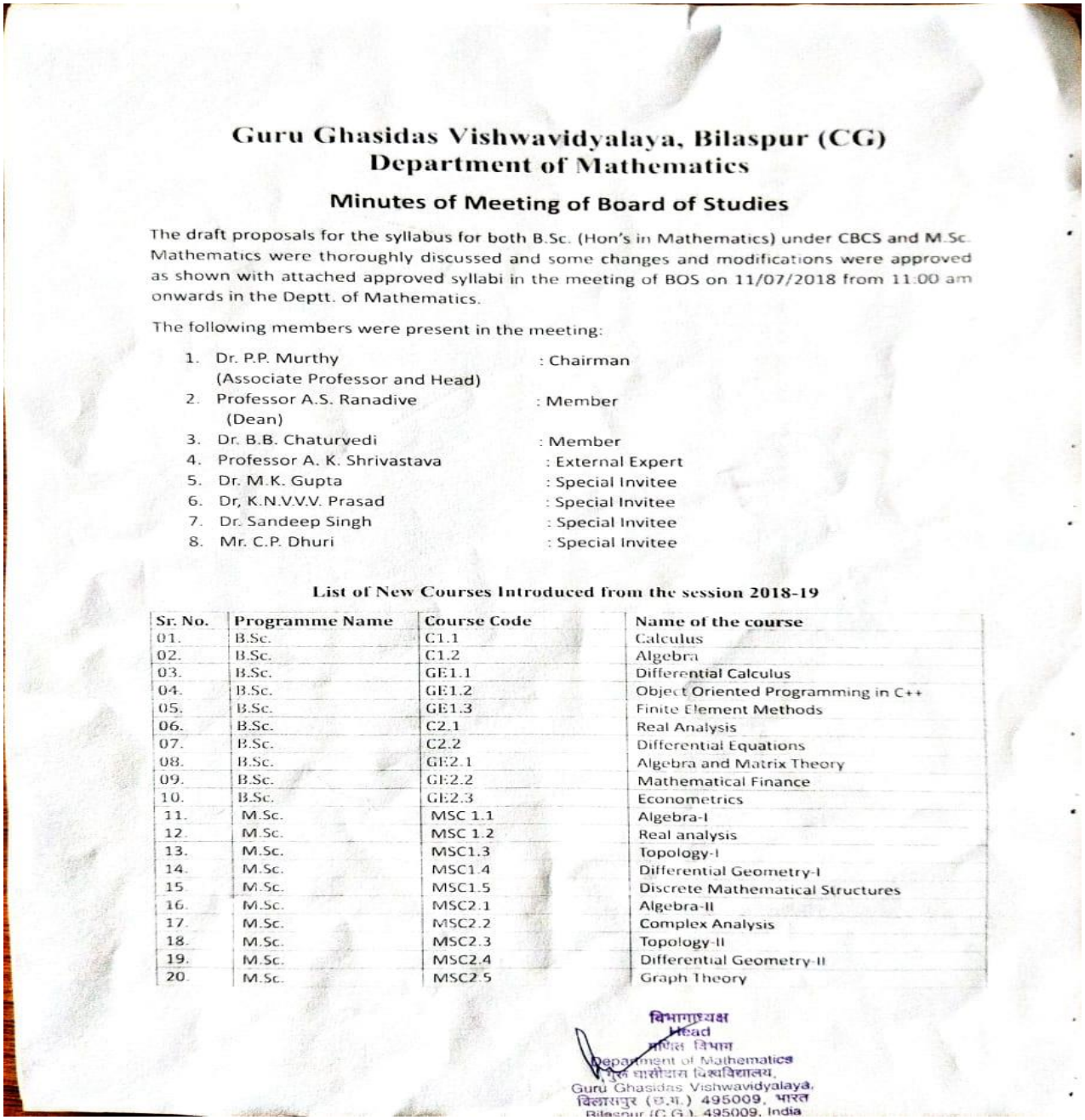
Academic Year : 2018-19

School : *School of Studies of Mathematical and Computational Science*

Department : *Mathematics*

Date and Time : *July 11, 2018 – 11:00 AM*

Venue : *Depaetment of Mathematics*



Guru Ghasidas Vishwavidyalaya, Bilaspur (CG)
Department of Mathematics

Minutes of Meeting of Board of Studies

The draft proposals for the syllabus for both B.Sc. (Hon's in Mathematics) under CBCS and M.Sc. Mathematics were thoroughly discussed and some changes and modifications were approved as shown with attached approved syllabi in the meeting of BOS on 11/07/2018 from 11:00 am onwards in the Deptt. of Mathematics.

The following members were present in the meeting:

1. Dr. P.P. Murthy (Associate Professor and Head) : Chairman
2. Professor A.S. Ranadive (Dean) : Member
3. Dr. B.B. Chaturvedi : Member
4. Professor A. K. Shrivastava : External Expert
5. Dr. M.K. Gupta : Special Invitee
6. Dr, K.N.V.V.V. Prasad : Special Invitee
7. Dr. Sandeep Singh : Special Invitee
8. Mr. C.P. Dhuri : Special Invitee

List of New Courses Introduced from the session 2018-19

Sr. No.	Programme Name	Course Code	Name of the course
01.	B.Sc.	C1.1	Calculus
02.	B.Sc.	C1.2	Algebra
03.	B.Sc.	GE1.1	Differential Calculus
04.	B.Sc.	GE1.2	Object Oriented Programming in C++
05.	B.Sc.	GE1.3	Finite Element Methods
06.	B.Sc.	C2.1	Real Analysis
07.	B.Sc.	C2.2	Differential Equations
08.	B.Sc.	GE2.1	Algebra and Matrix Theory
09.	B.Sc.	GE2.2	Mathematical Finance
10.	B.Sc.	GE2.3	Econometrics
11.	M.Sc.	MSC 1.1	Algebra-I
12.	M.Sc.	MSC 1.2	Real analysis
13.	M.Sc.	MSC1.3	Topology-I
14.	M.Sc.	MSC1.4	Differential Geometry-I
15.	M.Sc.	MSC1.5	Discrete Mathematical Structures
16.	M.Sc.	MSC2.1	Algebra-II
17.	M.Sc.	MSC2.2	Complex Analysis
18.	M.Sc.	MSC2.3	Topology-II
19.	M.Sc.	MSC2.4	Differential Geometry-II
20.	M.Sc.	MSC2.5	Graph Theory

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Bilaspur (C.G.) 495009, India

List of New Courses Introduced from the session 2019-20

Sr. No.	Programme Name	Course Code	Name of the course
01.	B.Sc.	C3.1	Theory of Real Functions
02.	B.Sc.	C3.2	Group Theory-I
03.	B.Sc.	C3.3	PDE and System of ODE
04.	B.Sc.	GE3.1	Ordinary Differential Equations and Vector Calculus
05.	B.Sc.	GE3.2	Cryptography and Network Security
06.	B.Sc.	GE3.3	Information Security
07.	B.Sc.	SEC1.1	Logic and Sets
08.	B.Sc.	SEC1.2	Computer Graphics
09.	B.Sc.	C4.1	Numerical Methods
10.	B.Sc.	C4.2	Riemann Integration and series of Functions
11.	B.Sc.	C4.3	Ring Theory and Linear Algebra-I
12.	B.Sc.	GE4.1	Partial Differential Equations, Laplace Transform and Fourier Series
13.	B.Sc.	GE4.2	Applications of Algebra
14.	B.Sc.	GE4.3	Combinatorial Mathematics
15.	B.Sc.	SEC2.1	Graph Theory
16.	B.Sc.	SEC2.2	Operating system: Linux
17.	M.Sc.	MSC3.1	Functional Analysis
18.	M.Sc.	MSC3.2	Theory of Differential Equations-I
19.	M.Sc.	MSO3.1	Fuzzy Sets, Fuzzy Logic and Their Applications-I
20.	M.Sc.	MSO3.2	Integral Equations
21.	M.Sc.	MSO3.3	Operations Research-I
22.	M.Sc.	MSO3.4	Differential Geometry of Manifolds
23.	M.Sc.	MSO3.5	Difference equations-I
24.	M.Sc.	MSO3.6	Information Theory and Its Applications
25.	M.Sc.	MSO3.7	Object Oriented Programming with C++
26.	M.Sc.	MSO3.8	Number Theory and Cryptography
27.	M.Sc.	MSC4.1	Advanced Functional Analysis
28.	M.Sc.	MSC4.2	Theory of Differential Equations-II
29.	M.Sc.	MSO4.1	Fuzzy Sets, Fuzzy Logic and Their Applications-II
30.	M.Sc.	MSO4.2	Finsler Geometry
31.	M.Sc.	MSO4.3	Operations Research-II
32.	M.Sc.	MSO4.4	Complex Manifolds
33.	M.Sc.	MSO4.5	Difference equations-II
34.	M.Sc.	MSO4.6	Financial Mathematics and Its Applications

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Bilaspur (C.G.), 495009, India

List of New Courses Introduced from the session 2020-21

Sr. No.	Programme Name	Course Code	Name of the course
01.	B.Sc.	C5.1	Multivariate Calculus
02.	B.Sc.	C5.2	Group Theory-II
03.	B.Sc.	DSE1.1	Portfolio Optimization
04.	B.Sc.	DSE1.2	Number Theory
05.	B.Sc.	DSE1.3	Analytical Geometry
06.	B.Sc.	DSE2.1	Industrial Mathematics
07.	B.Sc.	DSE2.2	Boolean Algebra and Automata Theory
08.	B.Sc.	DSE2.3	Probability and Statistics
09.	B.Sc.	C6.1	Metric Space and Complex Analysis
10.	B.Sc.	C6.2	Ring Theory and Linear Algebra-II
11.	B.Sc.	DSE3.1	Theory of Equations
12.	B.Sc.	DSE3.2	Bio-Mathematics
13.	B.Sc.	DSE3.3	Linear Programming
14.	B.Sc.	DSE4.1	Mathematical Modeling
15.	B.Sc.	DSE4.2	Mechanics
16.	B.Sc.	DSE4.3	Differential Geometry

Head विभागाध्यक्ष
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Bilaspur (C.G.), 495009, India

18.	MSC3.2	Theory of Differential Equations-I
19.	MSO3.1	Fuzzy Sets, Fuzzy Logic and Their Applications-I
20.	MSO3.2	Integral Equations
21.	MSO3.3	Operations Research-I
22.	MSO3.4	Differential Geometry of Manifolds
23.	MSO3.5	Difference equations-I
24.	MSO3.6	Information Theory and Its Applications
25.	MSO3.7	Object Oriented Programming with C++
26.	MSO3.8	Number Theory and Cryptography
27.	MSC4.1	Advanced Functional Analysis
28.	MSC4.2	Theory of Differential Equations-II
29.	MSO4.1	Fuzzy Sets, Fuzzy Logic and Their Applications-II
30.	MSO4.2	Finsler Geometry
31.	MSO4.3	Operations Research-II
32.	MSO4.4	Complex Manifolds
33.	MSO4.5	Difference equations-II
34.	MSO4.6	Financial Mathematics and Its Applications

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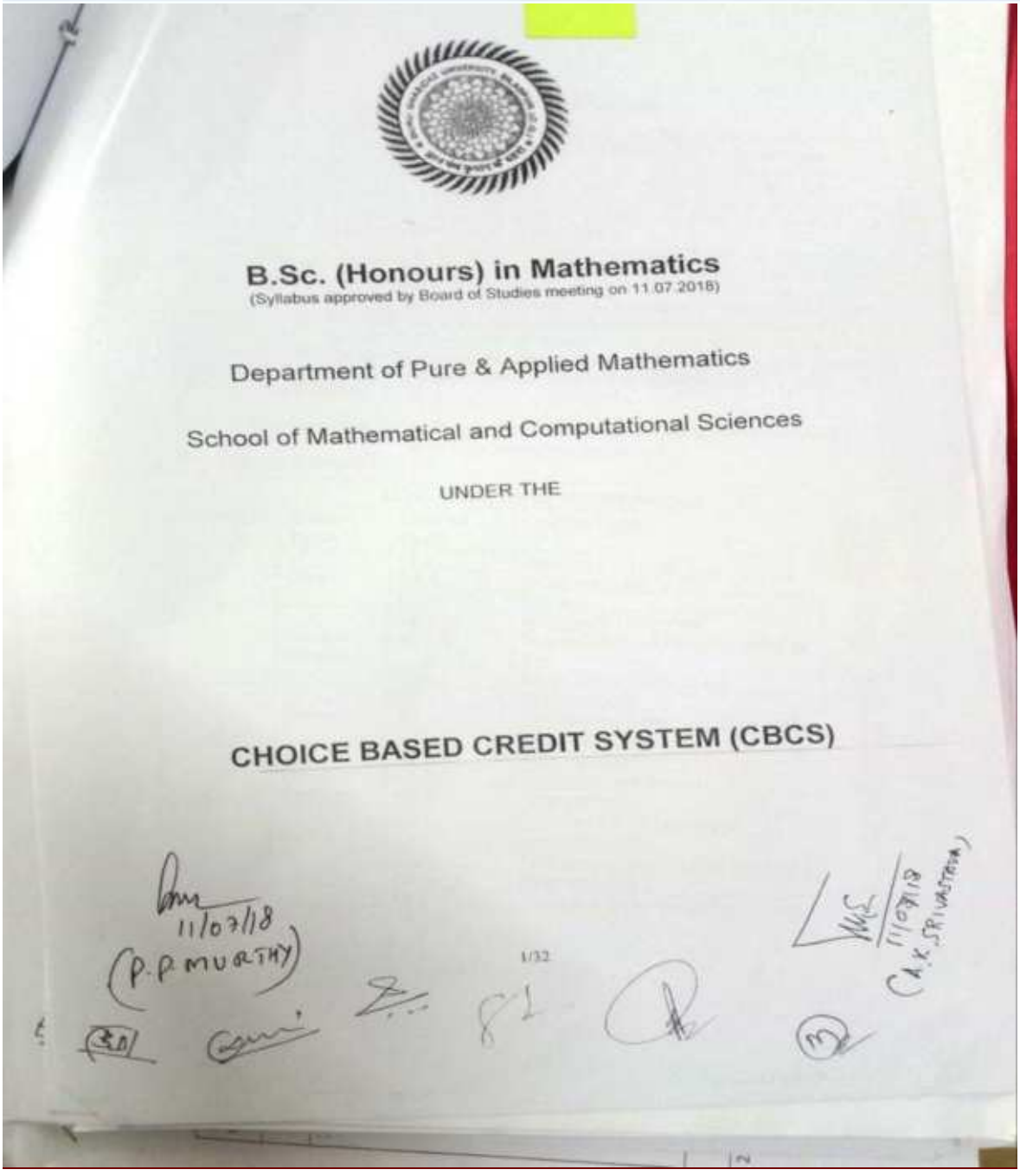

B.Sc. (Honours) in Mathematics

(Syllabus approved by Board of Studies meeting on 11.07.2018)

Department of Pure & Applied Mathematics

School of Mathematical and Computational Sciences

UNDER THE

CHOICE BASED CREDIT SYSTEM (CBCS)

11/07/18
(P.P MURTHY)

11/07/18
(A.K. SRIVASTAVA)

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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

M.Sc. in Mathematics

(Syllabus approved by Board of Studies meeting on 29.06.2017)

Department of Pure & Applied Mathematics

School of Mathematical and Computational Sciences

UNDER THE

CHOICE BASED CREDIT SYSTEM

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

4. Decay model (exponential case only).

5. Lake pollution model (with constant/seasonal flow and pollution concentration).

6. Case of single cold pill and a course of cold pills.

7. Limited growth of population (with and without harvesting).

8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).

9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).

10. Battle model (basic battle model, jungle warfare, long range weapons).

11. Plotting of recursive sequences.

12. Study the convergence of sequences through plotting.

13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.

14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

15. Cauchy's root test by plotting n^{th} roots.

16. Ratio test by plotting the ratio of n^{th} and $(n+1)^{th}$ term.

Books Recommended

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, ADifferential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group,London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problemsComputing and Modeling,* Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

4. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.

C3.1 Theory of Real Functions

Limits of functions(ϵ, δ) – *technique*, 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, preservation

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of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

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.

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 $(1 +x)^m$.

Books Recommended

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

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

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

Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

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.

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.

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.

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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

Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-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. Method of Separation of Variables for solving first order partial differential equations.

Derivation 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.

The Cauchy problem, the Cauchy-Kowaleewskaya theorem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions, Non-Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem

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, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method.

List of Practicals (using any software)

(i) Solution of Cauchy problem for first order PDE.

(ii) Finding the characteristics for the first order PDE.

(iii) Plot the integral surfaces of a given first order PDE with initial data.

(iv) 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) $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u(o,t) = 0, x \in (0,\infty), t > 0$

(c) $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u_x(0,t) = 0, x \in (0,\infty), t > 0$

(d) $u(x,0) = \phi(x), u_t(x,0) = \psi(x), u\ (0,t) = 0, u(l,t) = 0, 0 < x < l, t > 0$

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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.

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SEC1.1 Logic and Sets

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

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.

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, Partial ordering relations, n-ary relations.

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

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices. Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing. Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

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 andPractices*, 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.

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(v) Solution of wave equation $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

(a) $u(x,0) = \phi(x), u(0,t) = a, u(l,t) = b, 0 < x < l, t > 0$

(b) $u(x,0) = \phi(x), x \in R, 0 < t < T$

(c) $u(x,0) = \phi(x), u(0,t) = a, x \in (0,\infty), t \geq 0$

Books Recommended

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists andEngineers,* 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

Use of Scientific Calculator is allowed.

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.

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

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

Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

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

List of Practicals (using any software)

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------→ 1/ N.
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Bisection Method.
(v) Newton Raphson Method.
(vi) Secant Method.
(vii) Regulai Falsi Method.
(viii) LU decomposition Method.

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(ix) Gauss-Jacobi Method.
(x) SOR Method or Gauss-Siedel Method.
(xi) Lagrange Interpolation or Newton Interpolation.
(xii) Simpson's rule.

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating datatypes, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

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 EngineeringComputation*, 6th Ed., New age International Publisher, India, 2007.

4. C.F. Gerald and P.O. Wheatley, Applied *Numerical Analysis*, Pearson Education, India, 2008.

5. Uri M. Ascher and Chen Greif, *A First Course in Numerical Methods*, 7th Ed., PHI Learning Private Limited, 2013.

6. 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

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

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.

Improper integrals; Convergence of Beta and Gamma functions.

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.

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.

Books Recommended

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

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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

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.

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

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

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.

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.

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GE 4.1 Partial Differential Equations, Laplace Transform and Fourier Series

Linear partial differential equations of first order. Non-linear PDE of first order: Charpit's method.

Linear partial differential equation of second and higher order of homogeneous and non homogeneous forms with constant coefficients. Second order PDE with variable coefficients. Monge's method. Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Laplace Transform, Laplace Transforms of derivatives and integrals, shifting theorems, Dirac's delta function, differentiation and integration of transforms, convolution theorem. Inverse Laplace Transform, Application of Laplace transform in solution of ordinary differential equations. Fourier series expansion, Even and odd functions, Change of Interval, Half-range expansions and some Illustrative examples.

Recommended Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Son Inc., New York, 1999.
2. Ian N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill Book Company, 1988.
3. S.B. Rao and H.R. Anuradha, Differential Equations, University Press, 1996.
4. W.T.H. Piaggio, Elementary Treatise on Differential Equations and their applications, CBS Publishers N.Delhi, 1985.

GE 4.2 Applications of Algebra

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.

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

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs.

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.

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×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.

Books Recommended

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

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 withMaple*, 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 Combinatorial Mathematics

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.

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

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

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

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.

SEC 2.1 Graph Theory

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

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

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, 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.

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.

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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MSC 2.5: Graph Theory

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.

Definition of undirected graphs, Four colour theorem, paths, circuits, cycles and subgraphs. Induced subgraphs degree of a vertex, connectivity. Planar graphs and their properties, tree, Euler's formula for connected planer graphs, complete and complete biparted graphs. Kuratowaski's theorem (Statement only) and its use.

Spanning trees, cut sets, fundamental cut sets and cycles. Minimal spanning trees. Matrix representation of graphs. Euler's Theorem on the existence of Eulirian path and circuits. Directed graphs, in degree and out degree of the vertex, weighted undirected graphs, Shortest path problems.

Finite state machine and their transition table diagrams, equivalence of finite state machine, reduced machines

Text Books:

1. J. P. Trembly and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. J. L. Gersting, Mathematical structures for Computer Science, III- Edition, Computer Sci. Press New York.
3. C. L. Liu, Elements of Discrete Mathematics, Mc-Graw Hill Book Company.
4. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India.

Reference Book:

1. S. Lepschutz, Finite Mathematics, Mc-Graw Hill Book Company.

MSC 3.1: 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.

Normed linear spaces, properties of normed spaces, subspaces, Banach spaces, compactness and finite dimensional spaces, linear operators, bounded and continuous linear operators, linear functional, linear operators and functional on finite dimensional spaces, normed spaces of operators, dual spaces.

Hahn-Banach theorem, complex normed linear spaces, applications to bounded linear functionals on C[a,b], adjoint operators, reflexive spaces, Category theorem, Uniform boundedness theorem and some of its consequences, strong and weak convergence, convergence of a sequence of operators and functionals, Open mapping theorem and closed graph theorem.

Banach fixed point theorem and its applications to linear equations, differential equations and integral equations.

Text Books:

1. Ervin Kreyszig, Functional Analysis, Willy Eastern Publications.
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

MSC 3.2: Theory of Differential Equations –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.

Linear differential equations of order two or more: Higher order linear differential equations, a modelling problem, Linear independence, equations with constant coefficients, equations with variable coefficients, Wronskian, method of variation of parameters, method of Laplace transform.

Power Series Solution: Second order linear equations with ordinary points, Legendre equations and Legendre Polynomials, Second order equations with regular singular points, Bessel's equations and Bessel's functions.

Systems of Linear Differential Equations : Systems of First order equations, some examples, Existence and uniqueness theorem, Fundamental matrix, Non-homogeneous linear systems, Linear systems with constant coefficients, Linear systems with periodic coefficients.

Existence and Uniqueness of Solutions: Successive approximations, Picard's iteration method with some examples, Continuation of solution of IVP and dependence on initial conditions, Existence and uniqueness of solutions of systems, Fixed point method.

Text book:

1. S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of Ordinary Differential Equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

Recommended Books:

1. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. W.T. Reid, Ordinary Differential Equations, John Wiley & Son's, NY (1971)
3. Phillip Hartman, Ordinary Differential Equations, John Wilwy& Son's, NY(1971)
4. E.A. Coddington and N. Levinson, Theorem of Ordinary Differential Equations, Mac, Graw Hill, Ny(1955)

MSO 3.1: Fuzzy Sets, Fuzzy Logic and their Applications –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.

Fuzzy Sets: Basic definitions, α-cuts, convex fuzzy sets, Basic operations on fuzzy sets, Types of fuzzy sets, Properties of α-cuts, Representation of fuzzy sets, First and second decomposition theorems, Extension principle for fuzzy sets, fuzzy complements, The characterization theorems for fuzzy complements, T-norms and T-conorms, Algebraic product and sum, bounded difference and sum, Statements of characterization theorem for T-norm and T-conorm, combination of operations.

Fuzzy Arithmetic: Fuzzy numbers, Arithmetic operations on fuzzy numbers, Lattices of fuzzy numbers, fuzzy equations.

Fuzzy Relations: Fuzzy relation on a set, Fuzzy binary relation and fuzzy equivalence relations, Fuzzy morphism, Standard composition of fuzzy relation, sup-i composition, Inf-ω_i composition of fuzzy relations.

Text Book:

1. G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic. Theory and Applications, Prentice-Hall of India Pvt. Ltd., New Delhi 2002.

Reference Book:

1. H. I. Zimmerman, Fuzzy Set Theory and its Applications, Allied publishers Ltd., New Delhi, 1991.

MSO 3.2: Integral Equations

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 concept of Integral Equations, Classification of integral equations, Libnitz's rule of differentiation under the sign of integration, transformation of differential equation into integral equation and vice-versa.

Volterra Integral Equations: Resolvent Kernel, Method of successive approximation.

Fredholm Integral Equations: Method of successive approximation, Orthogonal Kernels, Iterated kernels, Fredholm determinants, Degenerated kernels, Eigen value and Eigen function of homogeneous integral equations.

Boundary Value Problem, Green's function.

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.

5. P. K. Gupta and D. S. Hira, Operations Research- An Introduction, S. Chand & Company Ltd. New Delhi.

6. J.K. Sharma

Reference Book:

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

MSO 3.4: Differential Geometry of Manifolds

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.

Differentiable manifolds: Smooth maps, charts, atlas, differentiable structure, Definition and examples of differentiable manifolds, Tangent spaces, Vector fields on differentiable manifolds, Vector fields and Lie bracket.

Integral curves and Flows: Definition and One parameter group of transformations.

Exterior Algebra, Exterior derivative: Definition, examples and related problems.

Linear Connection: Affine connections, Torsion tensor of affine connection, Curvature tensor of affine connection and related problems.

Riemannian Manifolds: Definition, Riemannian connection, Riemannian metric, Sectional curvature tensor, Schur's theorem, Projective curvature tensor, conformal curvature tensor, Semi- symmetric metric connection and related theorems.

Books:

2. R. S. Mishra: A course in Tensor with applications to Riemannian Geometry, Pothishala (Pvt.) Ltd, Allahabad, 1965.

3. Y. Matsushita: Differentiable manifolds, Marcei Dekkar, 1972.

4. B. B. Sinha: an Introduction to modern differential geometry, Kalyani Prakashan, New Delhi, 1982

MSO 3.5: Difference Equation- 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.

Difference Calculus- The Difference Operator, Summation, Generating functions and approximate summation.

Linear Difference Equations- First order equations. General result for linear equations. Equation with Constant coefficients. Applications. Equations with variable coefficients. Nonlinear equations that can be linearized. The z-transform.

Stability Theory- Initial value problems for linear systems. Stability of linear systems.

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.

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

Infinite Dimensional Inequality, The Fundamental Result of Game Theory: Minimax Theorem, Application: Theorem of Farkas.

Text Book:

1. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.
2. Alampallam V. Balakrishnan, Applied Functional Analysis (Applications of Mathematics), Springer, 2nd edition (May 4, 1981), ISBN-10: 0387905278.

MSC 4.2: Theory of Differential Equations –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.

Boundary value problems: Sturm-Liouville Problem, Green's function, Application of Boundary Value Problem, Picard's theorem.

Oscillations of second order equations: Fundamental results, Sturm's Comparison theorem, Elementary linear oscillations, Comparison theorem of Hille , Wintner, oscillations of $x'' + a(t)x = 0$.

Stability of linear and nonlinear systems: Elementary critical points, system of equations with constant coefficients, Linear equation with constant coefficients, Lyapunov stability, stability of quasi linear systems, second order linear differential equations,

Equations with deviating arguments: equations with constant delay, Equations with piecewise constant delay, a few other types of delay equations.

Text Book: S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of ordinary Differential equations, Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

Recommended Books:

1. George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. W.T.Reid, Ordinary Differential Equations, John Wiley &Son's, NY (1971)
3. Phillip Hartman, Ordinary Differential Equations, John Willy &Son,s, NY(1971)
4. E.A. Coddington& N. Levinson, Theorem of Ordinary Differential Equations, Mac, Graw Hill, Ny(1955)

MSO 4.1: Fuzzy Sets, Fuzzy Logic and their Applications –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.

Fuzzy Relation Equations: General discussion, problem partitioning, Solution method, Fuzzy relation equation based upon sup-i composition and inf ω_i composition, approximate solutions.

Possibility Theory: Fuzzy Measures, Evidence theory, Possibility theory, Fuzzy sets and possibility theory, possibility theory versus probability theory.

Fuzzy Logic: An overview of classical logic, Multivalued logic, Fuzzy propositions, Fuzzy quantifiers, Linguistic Hedges, Inference from conditional, conditional and qualified propositions, quantified propositions.

Approximate Reasoning: An overview of fuzzy expert systems, fuzzy implications and their selection, Multi conditional approximate reasoning, Role of fuzzy relation equations.

Fuzzy Systems: An introduction to fuzzy controllers, fuzzy rule base, fuzzy inference engine, Defuzzification and the various defuzzification methods (the centre of area method, centre of maxima method, mean of maxima method)

Fuzzy Decision Making: General discussion, Individual decision making, multi-person decision making, multi-criterion decision making, multi-stage decision making, fuzzy ranking methods, fuzzy linear programming.

Text Book:

G. J. Klir and B. Yuan, Fuzzy sets and fuzzy logic. Theory and Applications, Prentice- hall of India pvt. Ltd., New Delhi 2002.

Reference Book:

H. I. Zimmerman, Fuzzy set theory and its application, Allied publishers Ltd., New Delhi, 1991.

MSO 4.2: Finsler Geometry

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 a Finsler space: Line elements, Finsler space, Minkowskian space, Tangent space, Metric Tensor, Dual tangent space, Hamiltonian function, Angle between two vectors, Generalized Christoffel symbols, Geodesics.

Covariant Differentiation: δ-derivative, Partial δ-derivative, Fundamental postulates of E. Cartan, Different deductions, Cartan's two processes of covariant differentiation, Berwald connection parameters, Berwald's covariant differentiation.

Theory of Curvature: Commutation formulae resulting from Cartan's covariant differentiation, Cartan curvature tensor, Commutation formulae resulting from Berwald's covariant differentiation, Berwald curvature tensor, Generalizations of Bianchi identities, Space of scalar curvature, Space of constant curvature, Generalization of Schur's theorem, Recurrent spaces, Symmetric spaces.

Projective Change: Projective change, Projective invariants, Projective change of Berwald's connection parameters, Projective deviation tensor, Generalized Weyl's projective curvature tensor.

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 4.4: Complex Manifolds

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.

Complex Manifold and Almost complex manifold: Definition and examples, Nijenhuis tensor, Eigen Values of an almost complex structure, Existence theorem and integrability condition, contravariant and covariant almost analytic vector fields.

Almost Hermite manifold: Nijenhuis tensor, Almost analytic vector fields, Curvature in almost Hermite manifold, Holomorphic Sectional Curvature, Linear connection in an almost Hermite manifold

Kaehler Manifolds: Holomorphic Sectional Curvature, Bochner Curvature tensor, Affine connection in almost Kaehler manifold.

Nearly Kaehler Manifolds: Definition, Projective correspondence between two Nearly Kaehler manifolds, Curvature identities.

Para Kaehler Manifolds: Definition, Curvature Identities and conformal flatness of parakaehler manifold.

Books:

1. R. S. Mishra: A course in Tensor with applications to Riemannian geometry, Pothishala (Pvt.) Ltd, Allahabad.
2. B. B. Sinha: an Introduction to modern differential geometry, Kalyani Prakashan, New Delhi, 1982.
3. K. Yano: Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

MSO 4.5: Difference Equations- 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.

The self-adjoint second order linear equation, Sturmian theory, Green's functions, Disconjugacy, The Riccati Equations, Oscillation.

The Srurm-Liouville problem-Introduction, Finite Fourier Analysis, A non-homogeneous problem.

Discrete Calculus of variations, Necessary conditions, Sufficient Conditions and Disconjugacy.

Boundary Value Problems for Nonlinear equations, The Lipschitz case, Existence of solutions, Boundary value Problems for Differential equations.

Partial Differential Equations, Discretization of Partial Differential Equations, Solutions of Partial Differential 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 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.