SARDAR PATEL UNIVERSITY
VALLABH VIDYANAGAR

SYLLABUS EFFECTIVE FROM: 2018-19
MSC (Mathematics)
Semester III

There will be six courses, each of 3 credit. The session work for each course will comprise of 3 formal lectures per week, each of 1 hour duration, and 1 seminar and a problem session of 1 hour and 45 minute duration in each course per week. There will be a 1 credit course for comprehensive viva and Mathematics presentation. Thus a student will be provided 30 hours actual teaching per week; and he/she will be required to earn 25 credits during the semester. Each course will have a weighting of 100 marks (70 marks for University examination + 30 marks for inter Assessment. Internal Assessment will comprise of 1 internal test of 20 marks, a seminar of 5 marks and 5 marks for quiz.) Each student will take 6 courses in consultation and with approval of the department. There will be 5 core courses and 1 elective course to be taken by a student.

Viva: There will be a viva-voce examination of 50 marks at the end of each semester covering all the courses offered during the semester.

List of courses

Core Courses

PS03CMTH21: Real Analysis II
PS03CMTH22: Mathematical Methods I
PS03CMTH23: Functional Analysis II
PS03CMTH24: Comprehensive Viva

Elective Courses

PS03EMTH31: Banach Algebras
PS03EMTH32: Computer Programming and Software
PS03EMTH33: Financial Mathematics I
PS03EMTH34: Graph Theory I
PS03EMTH35: Graph Theory II
PS03EMTH36: Group Theory
PS03EMTH37: Mathematical Probability Theory
PS03EMTH38: Number Theory and Cryptography

PS03EMTH39: Operations Research

PS03EMTH40: Problems and Exercises in Mathematics I

PS03EMTH41: Relativity I

PS03EMTH42: Topology II

PS03CMTH21: Real Analysis II

Unit I	Measure space, finite, σ-finite, complete measures, measurable functions, simple functions, integration, Fatou's Lemma, Monotone Convergence Theorem, Lebesgue's dominated Convergence Theorem, Bounded Convergence Theorem.
Unit II	Signed measure, Hahn decomposition, Jordan decomposition, Lebesgue decomposition, Radon-Nikodym theorem, Radon-Nikodym derivatives.
Unit III	$L^p(\mu)$, $1 \leq p \leq \infty$, Holder's inequality, Minkowski inequality, Completeness of $L^p(\mu)$, dual of $L^p(\mu)$, Riesz representation theorem.
Unit IV	Outer measure and measurability**,** measure on an algebra**,** outer measure induced by a measure (on an algebra), Caratheodory's extension theorem, Baire measure, Cumulative distribution.

Textbook

1 H.L.Royden, Real Analysis (Third Edition) Mc. Millan, 1998

Chapter 11: Sections 1, 2, 3, 5, 6, 7

Chapter 12: Sections 1, 2, 3.

Reference Books

1 G. de Berra, Introduction to Measure Theory, van-Nordstrand, 1974

2 P.R. Halmos, Measure Theory, van-Nordstrand, 1970.

3 Cohn D. L., Measure Theory(Second edition),Birkhauser Advanced Texts Basler Lehrbucher, 2013 Springer

PS03CMTH22: Mathematical Methods I

Unit I Fourier series, Euler's formulae, conditions for a Fourier expansion, functions having points of discontinuity, change of interval, odd and even functions, half range series, Parseval's formula, complex form of Fourier series, applications to boundary value problems, the Dirichlet interior problem for a circle, the Dirichlet exterior problem for a circle, the Neumann problem for a circle, the Dirichlet problem for a rectangle.

Unit II The Fourier integral formulas, definition of the Fourier transform and examples, basic properties of Fourier transforms, applications of Fourier transforms, solutions of partial differential equations, Fourier cosine and sine transforms with examples, properties of Fourier cosine and sine transforms, applications of Fourier cosine and sine transforms to partial differential equations, evaluation of definite integrals, exercise.

Unit III Definition of the Laplace transform and examples, basic properties of Laplace transforms, the Convolution theorem and properties of convolution, differentiation and integration of Laplace transforms, the inverse Laplace transform and examples, partial fraction decomposition method, convolution theorem, exercises.
Applications of Laplace transforms: solutions of ordinary differential equations, partial differential equations, initial and boundary value problems, solutions of integral equations, evaluation of definite integrals, exercise.

Unit IV Definition of Z transform and examples, basic operational properties of Z transform, the inverse Z transform and examples, applications of Z transforms to finite difference equations, summation of infinite series.

Textbook

1 B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi (2004).
Sections: 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.9, 10.10.

2 Amarnath T., Elementary Course in Partial Differential Equations, Narosa Publ. House, New Delhi, 1997.
Sections: 2.4.6, 2.4.7, 2.4.8, 2.4.9.

3 Debnath, Lokenath; Bhatta, Dambaru, Integral transforms and their applications. Second edition. Chapman & Hall/CRC, Boca Raton, FL (2007).
Sections: 2.2, 2.3, 2.5, 2.12 (Examples 2.12.1, 2.12.2, 2.12.3, 2.12.4 only), 2.13, 2.14, 2.15, 2.16, 2.19; 3.2, 3.4, 3.5, 3.6 (except Theorem 3.6.1), 3.7(i), 3.7(ii), 3.9, 4.2 (Examples 4.2.1, 4.2.2, 4.2.6, 4.2.7, 4.2.12 only), 4.3 (Examples 4.3.1, 4.3.2, 4.3.6, 4.3.9, 4.3.10 only), 4.4, 4.6, 4.11; 12.3, 12.4, 12.5, 12.6, 12.7.

Reference Books

1 K. SankaraRao, Introduction to Partial Differential Equations, Prentice Hall India Learning Pvt. Ltd., Third Edition (2011).

2 M. D. Raisinghania, Advanced Differential Equations, S Chand Publishing (1995).

3 Georgi P. Tolstov, Fourier Series, (Translated from Russian by R. A. Silverman), Dover Publications Inc., New York (1976).

PS03EMTH23: Functional Analysis II

Unit I	Normed linear spaces (examples & basic properties), Holder-Minkowski inequalities, Bounded linear transformations, Space of bounded linear transformations.
Unit II	Hahn-Banach Extension Theorem, Strict convexity and uniqueness of Hahn-Banach extension, Banach spaces, Examples of Banach spaces.
Unit III	Uniform boundedness principle (consequences and examples), Closed graph Theorem, Projections, Open mapping Theorem, Bounded inverse theorem.
Unit IV	Spectrum of a bounded linear transformation and its parts, Examples, Spectrum of a finite rank operator, Duals and transposes, dual of ℓ^p.

Textbook

1 B. V. Limaye, Functional Analysis, New Age International (P) Ltd., 2001. Sections: 5, 6, 7(7.7 to 7.11), 8, 9(9.1 to 9.3), 10, 11(11.1 & 11.3), 12(12.1, 12.2, 12.7), 13.

Reference Books

1 V. K. Krishnan, Text book of Functional Analysis; A problem oriented approach, Prentice Hall of India, 2014.

2 Thamban Nair, Functional Analysis-a first course, Printice Hall of India, 2002.

3 S. Ponnusamy, Foundations of Functional Analysis, Narosa Pub. House, 2004.

PS03EMTH31: Banach Algebras

Unit I	Definition and Examples of Banach algebras, $C(X)$, $A(D)$, $BL(X), L^1(G)$ Regular and singular elements, topological divisors of zero, the spectrum, the Gel'fand Mazur's theorem.
Unit II	Spectral mapping theorem for polynomials, spectral radius formula, radical and semisimplicity, the Gel'fand mapping.
Unit III	Applications of the spectral radius formula, involutions in Banach algebras, the Stone Weierstrass theorem, the Gel'fand-Neumark theorem for commutative (abstract) C^*-algebras.
Unit IV	Ideals in $C(X)$ and Banach-Stone theorem, the commutative C^*-algebra of bounded linear operators on a Hilbert space, Computation of Gel'fand space of some Banach algebras.

Textbook

1 Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw-Hill Co., Tokyo, 1963.

Sections: 36 (Theorem A and Theorem B only), 64, 65, 66, 67, 68, 69, 68, 69, 70, 71, 72, 73, 74, 75, 76

Reference Books

1 E. Kaniuth, A Course in Commutative Banach Algebras, Springer, New York, 2009.

2 R. Larsen, Banach Algebras, Marcell-Dekker, 1973.

3 Banach Algebras and Automatic Continuity, London Mathematical Society, Monographs, 2001.

PS03EMTH32: Computer Programming and Software

Note: 50 Marks (35 marks for external examination and 15 marks for the internal examination) for theory and 50 Marks for practical on computers. External examination will be of two hours for theory and three hours for practical.

Unit I — The Basics: Literal constants, numbers, strings, variables, identifier naming, data types, objects, logical and physical lines, indentation. Operators, operator precedence, expressions. Control flow: the if statement, the while statement, the for loop, the break statement, the continue statement.

Unit II — Functions: Defining a function, local variables, default argument values, keyword arguments, the return statement, DocStrings. Modules: using the sys module, the from import statement, creating modules, the dir() function.

Unit III & IV — List of computer practical.

Practical No. **Purpose of the program**

1. To find the minimum/maximum of a given list of numbers.
2. To check whether a given number is odd or even. To check whether a given year is a leap year or not.
3. To find the real roots of a quadratic equation.
4. To compute $n!$, a^n, sum and average of a list of numbers. To prepare the result of a student.
5. Primality lists: To check whether a given number is prime or not, to list all the prime numbers within a given range, to factorize a number.
6. Manipulation of numbers: to check whether a given number is perfect or not, to check whether a given number is palindrome or not, to compute the sum of digits of a given number, to compute the sum of squares of the digits, to print a given number in reverse order of its digits.
7. To compute GCD and LCM of two numbers, to evaluate the functions $\sigma(n)$, $\tau(n)$, $\phi(n)$, $\mu(n)$ for a given positive integer n.
8. To generate Fibonacci sequence and Lucas sequences; to compute the sum of the series and hence evaluate e^x, sin(x), cos(x), tan(x), sinh(x), cosh(x) (terminate the program after n terms of the series or terminate the program at the desired level of accuracy).
9. Basics of Scilab 1: Sum of matrices, determinant of a matrix, product of matrices, inverse of a matrix, row reduced echelon form.
10. Basics of Scilab 2: Plotting Cartesian, polar and parametric curves, commands for plotting functions.

Textbook

1 Swaroop C. H., A byte of Python.

Chapters: 4, 5, 6, 7, 8.

Reference Books

1 James Payne, Beginning Python: Using Python 2.6 and Python 3, Wiley India, 2010.

2 AmitSaha, Doing Math with Python, No Starch Press (2015).

3 SCILAB- A Free software to MATLAB by Er. HemaRamachandran and Dr. Achuthsankar S. Nair., S. Chand and Company Ltd. (2008).

PS03EMTH33: Financial Mathematics I

Unit I Types of financial derivatives, Exchange Traded (ET) markets, Over The Counter (OTC) markets, Forward contracts, Futures contracts, Options, Types of traders: Hedgers, Speculators, Arbitrageurs, Uses of derivatives.

Unit II Background of futures contracts, Specifications of futures contracts, Convergence of futures price, Daily settlement and margins, Delivery of futures contracts, Distinctions and comparisons between forward and futures contracts, Types of interest rates: continuously compounding, treasury rate, LIBOR, Repo rate, n-year zero rate, Forward rate.

Unit III Short selling, Forward price for an investment asset, Valuing forward contracts, Comparisons of forward and futures prices, Futures and forward contracts on currencies, Futures contracts on commodities.

Unit IV Types of options, Option positions, Underlying assets, Factors affecting option prices, Upper and lower bounds for option prices, Put-call parity, Early exercise, Effect of dividends.

Textbook

1 J. C. Hull and S. Basu, Options, Futures and Other Derivatives, 7th edition, Pearson Prentice Hall, 2011.

Chapter 1: Sec 1.1 - 1.9

Chapter 2: Sec 2.1 - 2.4, 2.6

Chapter 4: Sec 4.1 - 4.3, 4.6

Chapter 5: Sec 5.2, 5.4, 5.7, 5.8, 5.10, 5.11

Chapter 8: Sec 8.1 - 8.3

Chapter 9: Sec 9.1 - 9.7

2 S. L. Gupta, Financial Derivatives: Theory, Concepts and Problems, Prentice Hall of India, 2005.

Chapter 1: Sec 1.4, 1.7

Chapter 3: Sec 3.5

Reference Books

1 P. Wilmott, S. Howison and J. Dewynne, The mathematics of financial derivatives, Cambridge Uni. Press, 1995.

2 S. M. Ross, An elementary introduction to mathematical finance, Cambridge Uni. Press, 3rd edition, 2011.

3 S. N. Neftci, An introduction to the mathematics of financial derivatives, Academic Press, 2nd edition, 2000.

PS03EMTH34: Graph Theory I

Unit I	Review of basic facts about graphs: connected graph, distance and diameter, tree, Euler graph, fundamental circuits, matrix representation of graphs, isomorphic graphs. Directed Graphs: Definitions and examples, vertex degrees, some special types of digraphs, directed path and connectedness, Euler digraphs.
Unit II	Trees with directed edges, spanning out-tree, spanning in-tree and their relation with Euler digraph, Incidence matrix , Circuit matrix and Adjacency matrix of digraphs, Fundamental circuits and fundamental circuit matrix in digraphs.
Unit III	Chromatic number, chromatic partitioning, Uniquely colorable graphs, Chromatic polynomial, Four-color Problem. Hamiltonian cycles: necessary conditions, sufficient conditions.
Unit IV	Matching and Covers: maximum matching, Hall's matching condition, min-max theorems, independent sets, vertex cover, edge cover.

Textbook

1. NarsinghDeo, Graph Theory with applications to Engg. and Computer Science, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
   Chapter 9: Sections 9.1 to 9.9 (omit 9.3, Kirchhoff matrix from 9.9), Chapter 8: Sections 8.1 to 8.3(omit dominating sets, 8.6)
2. Douglas B. West, Introduction to Graph Theory, Pearson Education, Inc. 2002.
   Chapter 3: Section 3.1(up to 3.1.24), Chapter 7: Section 7.2(up to 7.2.8) & 7.2.19

Reference Books

1. John Clark and Holton D.A., A first look at graph theory, Allied Publishing Ltd., 1991.
2. Robin J. Wilson, Introduction to graph theory, Pearson Education Asia Pvt. Ltd., 2000.

PS03EMTH35: Graph Theory II

Unit I	Eigen values of graphs: Definition & basic properties, examples, eigen values of bipartite graphs, eigen values and graph parameters – Diameter, $\Delta(G)$ and $\delta(G)$, chromatic number, regularity & connectedness.
Unit II	Network: Flows and cuts, maximal flow, Min-max theorem. Ramsey theory: The Pigeonhole principle & its applications, Ramsey number-definition, graph theoretic representation for r = 2, Ramsey's theorem (Equivalent statements), lower and upper bound for Ramsey number.
Unit III	Enumeration of Trees: Cayley's formula, degree sequence of graphs. Spanning Trees in graphs: Contraction by edge, matrix-tree theorem. Decomposition and graceful labeling.
Unit IV	Minimum spanning trees: Kruskal's algorithm, Prim's algorithm. Shortest Path Problems: Breadth First Search algorithm, Back-tracking algorithm, Dijkstra's algorithm for weighted graphs.

Textbook

1. Douglas B. West: Introduction to Graph Theory, Pearson Education Pvt. Ltd., India, 2001.
   Sections: 2.2 – 2.2.1 to 2.2.19, 8.3 – 8.3.1 to 8.3.6, 8.3.9 to 8.3.11, 8.6 – 8.6.1 to 8.6.9 [omit 8.6.4 to 8.6.6], 8.6.16 to 8.6.27 [omit 8.6.20 to 8.6.22]
2. John Clark and D. A. Holton: A First look at Graph Theory, Allied Publishing Ltd., 1991.
   Sections 2.4 & 2.5, Section 8.1

Reference Books

1. NarsinghDeo: Graph Theory with applications to Engg. And Computer Science, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
2. Russell Merris, Graph Theory, Wiley-Interscience, John Wiley & Sons, Inc., 2001.

PS03EMTH36: Group Theory

Unit I Definition of a group, some examples of groups, some preliminary lemmas, subgroups, two equivalence relations $a \equiv b mod H$ if $ab^{-1} \in H$ and $a \sim mod H$if $a^{-1}b \in H$, Lagrange's theorem, Euler's theorem, Fermat's theorem, counting principle, the condition for HK to be a subgroup and determination of $o(HK)$, normal subgroups, and quotient groups, characterizations of normal subgroups, homomorphism, isomorphism, first isomorphism theorem, simple group, Cauchy's theorem for abelian groups.

Unit II Automorphism, inner automorphism, Cayley's theorem and its applications, permutation groups, permutation as a product of disjoint cycles and transpositions, even and odd permutations, alternating group, another counting principle, conjugate classes, class equation and its applications, Cauchy's theorem (general case), number of conjugate classes in S_n.

Unit III Sylow's theorem, first proof, definition of p-Sylow subgroup, second proof of Sylow's theorem, existence of p-Sylow subgroup in S_{p^k}, double cosets and its order, existence of p-Sylow subgroup in subgroups, second part of Sylow's theorem, number of p-Sylow subgroups in a group, third part of Sylow's theorem, examples based on Sylow's theorems.

Unit IV Direct products, external direct product and internal direct product, properties of internal direct product, finite abelian groups as direct product of cyclic groups, invariants of an abelian group of order p^n for prime p, the subgroup $G(s)$ of an abelian group G, for an integer $so(G(p^m))$ for a prime p, uniqueness of invariants, number of non-isomorphic abelian groups of order ${p_1}^{\alpha_1} \cdots {p_r}^{\alpha_r}$, where $p_i$are distinct primes and $\alpha_i > 0$.

Textbook

1 Herstein, I. N., Topics in Algebra, (Second Edition), Wiley Eastern Ltd., New Delhi, 1975.
Chapter 2: § 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 (except Application 2 and its Corollary, Lemma 2.7.5 and Theorem 2.7.2), 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14

Reference Books

1 Fraleigh J. B., A First Course in Abstract Algebra (Third Edition), Narosa, 1983.
2 Gallian J. A., Contemporary Abstract Algebra (Fourth Edition), Narosa, 2008.

PS03EMTH37: Mathematical Probability Theory

Unit I	Random variables, Vector random variables, Limits of random variables, General probability space, Induced probability space, Distribution function of random variable, Jordan Decomposition theorem.
Unit II	Distribution function of vector random variables, Distribution function of dense subset of R, Expectation, Properties of expectation, Expectation of complex random variables, C_r- Inequality, Holder's Inequality, Minkowski Inequality, Jensen's Inequality, Chebyshev's Inequality.
Unit III	Convergence in probability, Weak law of large numbers, Convergence almost surely, Strong law of large numbers, Convergence in distribution, Convergence in r^{t} mean, Monotone convergence theorem, Fatou's theorem, Dominated convergence theorem.
Unit IV	Characteristic function, Properties of characteristic function, Inversion formula, Helly's theorems, Helly-Bray theorem, Levy's theorem (continuity theorem), Kolmogorov's Inequality, Central limit theorem (Lindeberg-Levy's theorem).

Textbook

1 B. R. Bhat, Modern Probability Theory: An Introductory Textbook, New Age International Publishers, 4th edition, 2014.

Unit 2: Sec 2.2(a)(b), 2.3(b)(c)

Unit 3: Sec 3.4(a), 3.5(a)

Unit 4: Sec 4.1(a), 4.2(a)(b), 4.3(a), 4.4(a)

Unit 5: Sec 5.1(a)(b)(c), 5.2(a)(b)(c), 5.3(c)(d)

Unit 6: Sec 6.1(a)(b)(c)(d), 6.2(a), 6.3(a)(b), 6.4(a)(b), 6.5(a)(b)(c)

Unit 7: Sec 7.1(a)(b)(c), 7.2(a)(b), 7.3(a) (Theorem 7.2 only), 7.3(b)

2 A. K. Basu, Measure Theory and Probability, Prentice Hall of India, 2nd edition, 2015.

Chapter 6: Sec 6.1 (Lemma 6.1 only)

Chapter 8: Sec 8.1, 8.3 (Theorem 8.3 & Theorem 8.4 only)

Chapter 9: Sec 9.6 (Theorems 9.12, 9.13, 9.14, 9.15 only)

Chapter 10: Sec 10.1

Reference Books

1 P. Wilmott, S. Howison and J. Dewynne, The mathematics of financial derivatives, Cambridge Uni. Press, 1995.

2 S. M. Ross, An elementary introduction to mathematical finance, Cambridge Uni. Press, 3rd edition, 2011.

3 S. N. Neftci, An introduction to the mathematics of financial derivatives, Academic Press, 2nd edition, 2000.

PS03EMTH38: Number Theory and Cryptography

Unit I Number Theory and Discrete Logarithm Problem: Simple substitution ciphers (except cryptanalysis), divisibility and GCD, modular arithmetic, prime numbers, unique factorization and finite fields, primitive roots in finite fields. The discrete logarithm problem.

Unit II DLP based cryptosystems: The Diffie-Hellman key exchange, the ElGamal public key cryptosystem, difficulty of discrete log problem (DLP), a collision algorithm for the DLP, the Chinese remainder theorem, the Pohlig-Hellman algorithm.

Unit III The RSA Algorithm: Euler's formula and roots modulo pq, the RSA public key cryptosystem, implementation and security issues, primality testing, Pollard's p-1 factorization algorithm.

Unit IV Elliptic curve cryptography: Elliptic curves, elliptic curve over finite fields, the elliptic curve discrete logarithm problem, elliptic curve cryptography.

Textbook

1 Hoffstein J., Pipher J., Silverman J. H., An Introduction to Mathematical Cryptography, Undergraduate Texts in Mathematics, Springer, New York, (2008).

Sections: 1.1 (except 1.1.1), 1.2, 1.3, 1.4, 1.5, 1.7, 2.2; 2.3, 2.4, 2.6, 2.7, 2.8, 2.9; 3.1, 3.2, 3.3, 3.4, 3.5; 5.1, 5.2, 5.3, 5.4.

Reference Books

1 Douglas R. Stinson, Cryptograph: Theory and Practice, Second Edition, Chapman and Hall/CRC, (2005).

2 N. Koblitz, A Course in Number Theory and Cryptography, Springer (1994).

3 J. A. Buchmann, Introduction to Cryptography, Second Edition, Undergraduate Texts in Mathematics, Springer-Verlag, New York, (2004).

PS03EMTH39: Operations Research

Unit I	Modelling with Linear Programming: two-variable LP model, graphical LP solution, LP model in equation form, the simplex method, artificial starting solution, M-method, Two-Phase method, graphical sensitivity analysis.
Unit II	Special Cases in the Simplex Method: degeneracy, alternative optima, unbounded solution, infeasible solution, definition of dual problem, primal-dual relationships, economic interpretation of duality, dual simplex algorithm.
Unit III	Transportation Model and its Variants, definition of the transportation model, non-traditional transportation models, the transportation algorithm, determination of starting solution, iterative computations of the transportation algorithm, simplex method explanation of the method of multipliers, the Assignment model, the Hungarian method, Simplex explanation of the Hungarian method.
Unit IV	Classical Optimization Theory: unconstrained problems, necessary and sufficient conditions, constrained problems, equality constraints, inequality constraints – Karush-Kuhn-Tucker (KKT) conditions.

Textbook

1 Hamdy A. Taha, Operations Research: An Introduction, Pearson, Ninth Edition (2012).

Sections: 2.1, 2.2, 3.1, 3.3, 3.4, 3.6 (3.6.1 only); 3.5, 4.1, 4.2, 4.3, 4.4 (4.4.1 only); 5.1, 5.2, 5.3, 5.4; 20.1 (20.1.1 only), 20.2.

Reference Books

1 KantiSwarup, Gupta P.K., and Man Mohan, Operations Research, (2004), S. Chand & sons.

2 G. Hadley, Linear Programming, Addition Wesley Publ. (1962).

3 F. S. Hillier and G. J. Lieberman, Introduction to Operations Research, Mcgraw-Hill Higher Education, (2001).

PS03EMTH40: Problems and Exercises in Mathematics I

Students will be required to prepare him/herself for any five of the following courses at the level up to M.Sc. third semester of Sardar Patel University for problems and exercises. The regular teaching involves intensive problem sessions followed by problem assignments; and the examination would consist of problems only. Algebra, Topology, Real Analysis, Complex Analysis, Functional Analysis, Differential Geometry, Classical Mechanics, Linear Algebra, Differential Equations.

PS03EMTH41: Relativity I

Unit I Historical background and postulates of special relativity, relativity of simultaneity, Michelson Morley experiment, Special Lorentz transformation, consequences of special Lorentz transformation, addition of velocities, special Gelien transformation.

Unit II Aberration of light, Doppler Effect, space-time interval, four dimensional formulation, poincare structure of spacetime, Minkonski structure of spacetime

Unit III Covariance four dimensional form, principle of covariance, proper time, four dimensional vectors (Displacement velocity) , mass of moving particle, covariant form of Newtonian's law, momentum 4-vector, relativistic kinetic energy, equivalence of mass and energy.

Unit IV Principle of equivalence, brief introduction of general relativity, definition of tensor, fundamental tensor of spacetime, Christoffel symbols, geodesic equation, gravity as geometric phenomena.

Textbook

1 Resnick, R., Introduction to Special Relativity, Wiley
(2.1, 2.7, C)

2 Banerji, S. and Banerjee, A. The Special Theory of Relativity, Prentice-Hall of India,
Delhi, 2012
(2.1, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.4, 3.5, 3.6, 3.7)

3 Adler, R., Bazin, M. And Schiffer, M. Introduction to General Relativity, McGraw-Hill LTD. 1975.
(1.1, 1.2, 1.3, 1.4, 1.7, 1.8, 2.2, 2.3, 2.3, 4.3)

PS03EMTH42: Topology II

Unit I	Neighbourhoods, neighbourhood base at a point, Product spaces and the weak topology Inadequacy of sequences, directed set, net, convergence and clustering of a net, characterization of closure and continuity using net, subnet, ultranet.
Unit II	Filter, filter base, convergence and clustering of a filter, finer filter, ultra filter, free and fixed filter, characterization of closure and continuity using filter.
Unit III	Filter generated by a net, a net based on a filter, and their convergence. Characterization of compact spaces using nets and filters, Tychonoff Theorem.
Unit IV	Homotopy of functions from one topological space to another, path homotopy, product of two paths and its algebraic structure, loop, Fundamental group relative to the base point, isomorphism of fundamental groups, simply connected space, homomorphism induced by a continuous map.

Textbook

1 Willards, S., General Topology, Dover Publication, New York, 1970
Sections: 4, 8, 10, 11, 12 17 (only 17.4 and 17.8)

2 Munkres, J., Topology: A First Course, 2/e, Prentice Hall of India Pvt. Ltd. New Delhi, 2003.
Sections: 51, 52

Reference Books

1 Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw-Hill Co., Tokyo, 1963.