Deccan Education Society's

FERGUSSON COLLEGE, PUNE

(AUTONOMOUS)

SYLLABUS UNDER AUTONOMY
THIRD YEAR B.Sc. (MATHEMATICS)
SEMESTER - V

SYLLABUS FOR T. Y. B. Sc.

Academic Year 2018-2019

Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE 411004
Scheme of Course Structure (Faculty of Science)
2018-2019
T. Y. B. Sc. - Mathematics

Semester	Course Code	Title	Paper No.	Credits	Exam (I / E)	Marks (50 / 50)
V	MTS3501	Metric Spaces	I	03	I and E	50 and 50
	MTS3502	Real Analysis - I	II	03	I and E	50 and 50
	MTS3503	Mathematics Problem Course - I	III	03	I and E	50 and 50
	MTS 3504	Group Theory	IV	03	I and E	50 and 50
	MTS 3505	Partial Differential Equation	V	03	I and E	50 and 50
	MTS 3506	Mathematics Problem Course - II	VI	03	I and E	50 and 50
	MTS3507	Operations Research	Any Two	02	I and E	50 and 50
	MTS3508	Number Theory		02	I and E	50 and 50
	MTS3509	C-programming - I		02	I and E	50 and 50
	MTS3510	Dynamical Systems		02	I and E	50 and 50
	MTS3511	Financial Mathematics - I		02	I and E	50 and 50
	MTS3512	Lattice Theory		02	I and E	50 and 50
	MTS3521	Mathematics Practical – I	Practical - I	02	I and E	50 and 50
VI	MTS3601	Complex Analysis	I	03	I and E	50 and 50
	MTS3602	Real Analysis - II	II	03	I and E	50 and 50
	MTS3603	Mathematics Problem Course - III	III	03	I and E	50 and 50
	MTS3604	Ring Theory	IV	03	I and E	50 and 50
	MTS3605	Differential Geometry	V	03	I and E	50 and 50
	MTS3606	Mathematics Problem Course - IV	VI	03	I and E	50 and 50
	MTS3607	Optimization Techniques	Any Two	02	I and E	50 and 50
	MTS3608	Computational Geometry		02	I and E	50 and 50
	MTS3609	C-Programming - II		02	I and E	50 and 50
	MTS3610	Lebesgue Integration		02	I and E	50 and 50
	MTS3611	Financial Mathematics - II		02	I and E	50 and 50
	MTS3612	Graph Theory		02	I and E	50 and 50
	MTS3621	Mathematics Practical - II	Practical - II	02	I and E	50 and 50

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V MATHEMATICS PAPER - I TITLE - METRIC SPACES PAPER CODE - MTS3501 [CREDITS - 3]		
	Title and Contents	**No. of Lectures**
Unit - I	**Introduction of Metric Spaces** 1.1 Definition and examples of metric spaces 1.2 Young's inequality, Holder's inequality, Minkowski inequality, Cauchy-Schwartz inequality 1.3 Open balls and open sets, Hausdorff property, Structure of open sets in R 1.4 Equivalent metrics, necessary and sufficient conditions for equivalence of metrics	10
Unit - II	**Convergence in Metric Spaces** 2.1 Convergent sequences 2.2 Limit points and cluster points, closure of a set, Bolzano Weierstrass Theorem 2.3 Cauchy sequences 2.4 Completeness, Completeness of R; R^n 2.5 Bounded sets 2.6 Dense sets, dense subsets of R 2.7 Boundary of a set, Basis for metric space	8
Unit - III	**Continuous functions on metric space** 3.1 Continuous functions, composition of continuous functions, space of continuous functions 3.2 Characterisations of continuity 3.3 Urysohn's lemma for metric spaces, Gluing lemma for metric spaces, Tietze extension theorem for metric spaces (statement only) 3.4 Uniform continuity, limit of a function, open and closed maps	10
Unit - IV	**Connectedness** 4.1 Connected spaces. 4.2 Continuous image of connected space is connected 4.3 Connected subsets of R, Intermediate value theorem 4.4 Cartesian product of connected spaces	6
Unit - V	**Compactness** 5.1 Compact spaces and their properties, Heine-Borel Theorem for R, closed rectangle in R^2 is compact 5.2 Continuous functions on compact metric spaces 5.3 Characterizations of compact metric spaces, Arzela-Ascoli theorem (statement only), Finite intersection property and compactness	6
Unit - VI	**Complete metric spaces** 6.1 Definition and examples of complete metric spaces 6.2 Nested interval theorem, Cantors intersection property 6.3 Completion of metric space (statement only) 6.4 Baire category theorem (statement only) 6.5 Banach's contraction principle	8

Text Book:

Topology of Metric Spaces by S. Kumaresan, Narosa Publishing House, 2005. Sections 1.11.2 (except the Sections 1.2.51 to 1.2.65), 2.1, 2.2, 2.3, 2.4, 2.5 and 2.7, 3.1, 3.2 (upto 3.2.32 only), 3.3, 3.4, 3.5, 4.1, 4.2, (Proposition 4.2.13 without proof) and 4.3 (Theorem 4.3.24 without proof), 5.1 and 6.1 (Theorems 6.1.1, 6.1.3, 6.1.11, without proofs).

Reference Books:

1. Satish Shirali, Harkrishan L. Vasudeva, Metric Spaces, Springer International Edition, First Indian Reprint, 2009.
2. Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd., 1970.
3. Micheal O. Searcoid, Metric Spaces, Springer International Edition, Fourth Indian Reprint, 2014.
4. G. F. Simmons, Topology of Metric Spaces.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - II
TITLE – REAL ANALYSIS - I
PAPER CODE - MTS3502

[CREDITS -3]

		Title and Contents	**No. of Lectures**
Unit - I	1.1	Algebraic Structure of R Field Structure, Ordered Field, Boundedness, Supremum and Infimum, Order, Completeness, Archimedean property, Count-able and uncountable subsets of R; LUB axiom, Schroeder-Berstein theorem	6
Unit - II	2.1	Convergence of Sequences Real Sequences, Bounded Sequences, Mono-tonic Sequences, Subsequences, Convergent Sequences, Cauchy Sequences, Criteria for the convergence of Sequences, Algebra of Convergent Sequences	12
	2.2	Squeeze Theorem, Every Monotonic bounded sequence is convergent	
	2.3	Bolzano Weierstass theorem, Cauchy's First and Second Theorem on Limits, Schroder Berstein theorem	
Unit - III	3.1	Convergence of Series Infinite Series, Convergence criteria, Cauchy Convergence criteria	4
Unit - IV	4.1	Tests for Convergence Comparison test, Cauchy root test, D'Alembert's ratio test, Integral Test	6
Unit - V	5.1	Alternating Series Alternating Series, Leibnitz test, Absoluteand Conditional Convergence, tests for convergence (Abel test and Dirichlet Test), rearrangement of terms	4
Unit - VI	6.1	Continuity Concept of limit, Continuous functions, Algebra of Continuous functions, Types of discontinuity, Uniform Continuity	4
Unit - VII	7.1	Riemann Integrable Functions Integral as a Limit of Riemann Sums, Necessary and sufficient conditions for Riemann integrability	4
Unit - VIII	8.1	Properties of Riemann Integrable Functions: Algebra of Integrable functions, Special class of integrable functions (monotone functions and continuous functions). The Fundamental Theorem of Calculus, Mean Value theorems and their applications.	8

Text-Books:

1 Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd., (1970).
2 Ajitkumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2010.

Reference Books:

1. Tom Apostol, Mathematical Analysis, 2nd Edition, Prentice Hall of India, 1994.
2. D. Somasundaram and B. Choudhari, A first course in Mathematical Analysis, Narosa Publishing House, 1997.
3. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 4th Edition, John Wiley, 2012.
4. W. Rudin, Principles of Mathematical Analysis.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - III
TITLE - PROBLEM COURSE
PAPER CODE - MTS3503

[CREDITS - 3]

Based on MTS3501 and MTS3502

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - IV
TITLE - GROUP THEORY
PAPER CODE - MTS3504

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Groups** 1.1 Groups: definition an examples 1.2 Abelian group, finite group, infinite group 1.3 Properties of groups 1.4 Order of an element - definition, examples, properties 1.5 Examples of groups including Z, Q, R, C, Klein 4-group, Group of quaternions, integers modulo n under addition and multiplication, S^1, $GL_n(R)$; $SL_n(F_p)$, $SL_n(R)$, O_n (= the group of n x n real orthogonal matrices), B_n (= the group of n x n non-singular upper triangular matrices), the group of one-one and onto functions from a set S to itself A(S); and groups of symmetries of plane figures such as D_4 and S_3, $GL_n(F_p)$ the integers modulo under addition and multiplication 1.6 Uniqueness of identity, inverse, etc.	
Unit - II	**Subgroups** 2.1 Subgroups: definition, necessary and sufficient conditions, examples on finding subgroups of finite groups, union and intersection of subgroups 2.2 Cosets: definition and properties 2.3 Lagrange's theorem and corollaries 2.4 HK is a subgroup of G if and only if HK = KH 2.5 Order of HK 2.6 Subgroup generated by an element of the group	10
Unit - III	**Cyclic groups** Definition, Examples of cyclic groups such as Z and the group μ_n of the n-th roots of unity, properties 3.1 Every cyclic group is abelian 3.2 If G = (a), then G = (a^{-1}) 3.3 Every subgroup of a cyclic group is cyclic 3.4 Let G be a cyclic group of order n. Let G = (a): The element a^s ϵ G generates a cyclic group of order n/gcd(n, s) 3.5 Let G = (a) and o(G) = n, Then (a^m) = G if and only if (m, n) = 1 3.6 An element m in Z^*_n is a generator of Z^*_n if and only if (m, n) = 1	4
Unit - IV	**Normal Subgroups** 4.1 Definition. Properties with examples i. If G is an abelian group, then every subgroup of G is a normal sub-group ii. N is a normal subgroup of G if and only if gNg^{-1} = N for every g ϵ G iii. The subgroup N of G is a normal subgroup of G if and	8

	only if every left coset of N in G is a right coset of N in G iv. A subgroup N of G is a normal subgroup of G if and only if the product of two right cosets of N in G is again a right coset of N in G v. If H is a subgroup of index 2 in G then H is a normal subgroup of G vi. If H is the only subgroup of G of a fixed finite order then H is a normal subgroup of G 4.2 Quotient groups and example	
Unit - V	**Homomorphism and Isomorphism** 5.1 Homomorphism and Isomorphism: definition, examples, establish iso-morphism of two finite groups 5.2 Fundamental Theorem of homomorphisms of groups 5.3 The group Z/nZ of residue classes (mod n) 5.4 Cauchy's theorem and Sylow's theorem for Finite Abelian Groups 5.5 Results such as inverse image under a homomorphism of a subgroup and of a normal subgroup 5.6 Characterization of cyclic groups (as being isomorphic to Z or Z/nZ for some positive integer n.) 5.7 Automorphims 5.8 Cayley's Theorem for finite groups 5.9 Classification of groups of order less equal 8	12
Unit - VI	**Permutation Groups** 6.1 Definition of S_n and detailed discussion of the group S_3 6.2 Cycles and transpositions, even and odd permutations 6.3 Order of permutation 6.4 Properties: (i) $o(S_n) = n!$ (ii) A_n is a subgroup of S_n. 6.5 Discussion of the group A_4 including converse of Lagrange's theorem does not hold in A_4 6.6 Conjugacy classes in S_n	6

Textbook:

I. N. Herstein, Topics in Algebra, Wiley, 1990. § 2.1 to § 2.10

Reference Books:

1. M. Artin, Algebra, Prentice Hall of India, New Delhi, 1994.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpal, Basic Abstract Algebra, Second Ed., Foundation Books, New Delhi, 1995.
3. J. B. Fraleigh, A First Course in Abstract Algebra, Third Ed., Narosa, New Delhi, 1990.
4. N. S. Gopalakrishnan, University Algebra, Second Ed., New Age International, New Delhi, 1986.
5. D. A. R. Wallace, Groups, Rings and Fields, Springer-Verlag, London, 1998.
6. I. N. Herstein, Abstract Algebra.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - V
TITLE - PARTIAL DIFFERENTIAL EQUATION
PAPER CODE - MTS3505

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**First Order Partial Differential Equations** 1.1 Curves and surfaces 1.2 Genesis of First Order Partial Differential Equations 1.3 Classification of Integrals 1.4 Linear Equations of the First Order 1.5 Paffian Differential Equations 1.6 Compatible Systems 1.7 Charpit's Method 1.8 Jacobi's Method 1.9 Integral Surfaces through a given curve	30
Unit - II	**Second Order Partial Differential Equations** 2.1 Genesis of Second order Partial Differential Equations 2.2 Classification of Second Order Partial Differential Equations by using Discriminant (Problems Only)	8
Unit - III	3.1 Applications of Partial Differential Equations	10

Text Book:

T. Amaranath, An Elementary Course in Partial Differential Equations, Narosa Publishing, House, 2nd Edition, 2003 (Reprint, 2006).

Topics: Chapter 1 - Sec. - 1.1 to 1.11, Chapter 2 - Sec. 2.1 to 2.2

Reference Books:

1. Ian Sneddon, Element of Partial Differential Equations, McGraw-Hill Book Company, McGraw-Hill Book Company.
2. Frank Ayres Jr., Differential Equations, McGraw-Hill Book Company, SI Edition, International Edition, 1972.
3. Ravi P. Agarwal and Donal O'Regan, Ordinary and Partial Differential Equations, Springer, First Edition 2009.
4. W. E. Williams, Partial Differential Equations, Clarendon Press, Oxford, 1980.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - VI
TITLE - PROBLEM COURSE
PAPER CODE - MTS3506

[CREDITS - 3]

Based on MTS 3504 and MTS 3505

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - VII
TITLE - OPERATIONS RESEARCH
PAPER CODE - MTS3507

[CREDITS - 3]

	Title and Contents	No. of Lectures
Unit - I	**Modelling with Linear Programming** 1.1 Two variable LP Model 1.2 Graphical LP solution 1.3 Selected LP Applications 1.4 Graphical Sensitivity analysis	8
Unit - II	**The Simplex Method** 2.1 LP Model in equation form 2.2 Transition from graphical to algebraic solutions, the simplex method 2.3 Artificial starting solutions	16
Unit - III	**Duality** 3.1 Definition of the dual problem, primal dual relationship	6
Unit – I V	**Transportation Model** 4.1 Definition of the Transportation model, the Transportation Algorithm	6
Unit - V	**The Assignment Model** 5.1 The Hungarian method, Simplex explanation of the Hungarian method	6

Text Book:

Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd, New Delhi.

Ch. 2: 2.1, 2.2, 2.3(2.3.4, 2.3.5, 2.3.6)
Ch. 3: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 (3.6.1)
Ch. 4: 4.1, 4.2
Ch. 5: 5.1, 5.3 (5.3.1, 5.3.2, 5.3.3), 5.4 (5.4.1, 5.4.2)

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research (Eighth Edition), Tata McGraw-Hill.
2. J. K. Sharma, Operations Research (Theory and Applications, second edition, 2006), Macmillan India Ltd.
3. Hira and Gupta, Operations Research.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - VIII
TITLE: NUMBER THEORY
PAPER CODE: MTS3508

[CREDITS - 3]

	Title and Contents	No. of Lectures
Unit - I	**Divisibility** 1.1 Divisibility in Integers, Division Algorithm 1.2 GCD, LCM, Fundamental Theorem of Arithmetic 1.3 Infinitude of Primes, Mersene Numbers and Fermat Numbers	8
Unit - II	**Congruences** 2.1 Definition, Properties of Congruences, Residue classes, complete and reduced residue system, their properties, Fermats theorem. Euler's theorem, Wilsons theorem, $x^2 \equiv 1 \pmod{p}$ has a solution if and only if p = 2 or 1 (mod 4); where p is a prime. Linear congruences of degree 1 and Chinese remainder theorem.	12
Unit - III	3.1 **Techniques of numerical Calculations and Public-key Cryptography**	8
Unit - IV	**Greatest integer function** 4.1 Arithmetic functions Euler's function, the number of divisors d(n), sum of divisors б(n); Ω(n) 4.2 Multiplicative functions, Mobius function 4.3 Mobius inversion formula	10
Unit - V	**Quadratic Reciprocity** 5.1 Quadratic residues, Legendres symbol and its properties, Law of quadratic reciprocity	10

Text Book:

I. Niven, H. Zuckerman and H. L. Montgomery, An Introduction to Theory of Numbers, 5th Edition, John Wiley and Sons. (§1.1- §1.3, §2.1 - §2.5, §3.1 - §3.3, §4.1 -§4.3.)

Reference Book:

David M. Burton, Elementary Number Theory (Second Ed.), Universal Book Stall, New Delhi, 1991.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - IX
TITLE - C-PROGRAMMING - I
PAPER CODE - MTS3509

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Introductory Concepts** 1.1 Introduction to Computers, computer characteristics, Types of Programming Languages, Introduction to C	2
Unit - II	**C Fundamentals** 2.1 The character set, Identifier and keywords, Data types, Constants, Variables and Arrays, Declarations, Expressions, Statements, Symbolic constants	2
Unit - III	**Operators and Expressions** 3.1 Arithmetic operators, Unary operators, Relational and Logical operators, Assignment operators, Conditional Operator, Library functions	6
Unit - IV	**Data Input and Outputs** 4.1 Preliminaries, Single character input-getchar() function, Single character output-putchar() function, Writing output data-print function, Formatted input-output, Get and put functions	6
Unit - V	**Preparing and Running a Program** 5.1 Planning and writing a C Program 5.2 Compiling and Executing the Program	10
Unit - VI	**Control Statements** 6.1 Preliminaries, The while statement, The do-while statement, The for statement, Nested loops, The if-else statement, The switch statement, The break statement, The continue statement, The comma operator	8
Unit - VII	**Functions** 7.1 A brief overview, Defining a function, Accessing a function, Passing arguments to a function, Specifying argument data types, Function prototypes, Recursion	6
Unit - VIII	**Arrays** 8.1 Defining an array, Processing an array, Passing arrays to a function, Multidimensional arrays, Arrays and strings	4
Unit - IX	**Program Structures** 9.1 Storage classes, Automatic variables, External variables, Static variables	4
Unit - X	**Pointers** 10.1 Fundamentals, Pointer declarations, Passing pointer to a function, Pointer and one dimensional arrays, Dynamic memory allocation, Operations on pointers, Pointers and multidimensional arrays, Array of pointers, Pointer to function, Passing functions to other functions, More about pointer declarations	6

Text Book:

Let us C by Yashavant Kanetkar.

Reference Books:

1. Programming with C by Byron S. Gottfried, Schaum’s Outline Series.
2. The C Programming Language by Brian W. Kernighan, Dennis M. Ritchie.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V MATHEMATICS PAPER - X TITLE - DYNAMICAL SYSTEM PAPER CODE - MTS3510 [CREDITS - 3]		
	Title and Contents	**No. of Lectures**
Unit - I	**First Order Equations** 1.1 Examples of first order equations 1.2 The logistic population model 1.3 The constant harvesting and bifurcation 1.4 Periodic harvesting and periodic solutions 1.5 Computing the Poincare map	6
Unit - II	**The Planar Systems** 2.1 Second order equations 2.2 Planar systems 2.3 Preliminaries from algebra 2.4 Planar linear systems 2.5 Eigenvalues and eigenvectors 2.6 Solving linear systems 2.7 The linearity principle	12
Unit - III	**Phase Portraits for Planar Systems** 3.1 Real distinct eigenvalues 3.2 Complex eigenvalues 3.3 Repeated eigenvalues 3.4 Changing coordinates	10
Unit - IV	**Classification of Planar Systems** 4.1 The trace-determinant plane 4.2 Dynamical classifications	4
Unit - V	**Higher Dimensional Linear Algebra** 5.1 Preliminaries from linear algebra 5.2 Eigenvalues and eigenvectors 5.3 Complex eigenvalues 5.4 Bases and subspaces 5.5 Repeated eigenvalues 5.6 Genericity	8
Unit - VI	. **Higher Dimensional Linear Systems** 6.1 Distinct eigenvalues 6.2 Harmonic oscillators 6.3 Repeated eigenvalues 6.4 The exponential of a matrix **6.5** Nonautonomous linear systems	8

Text Book:

Morris W. Hirsch, Stephen Smale, Robert L. Devaney, Differential Equations, Dynamical Systems and An Introduction to Chaos, Elsevier, Third Edition.

Reference Books:

1. Lawrence Perko, Differential Equations and Dynamical Systems, Springer, Third Edition, Texts in Applied Mathematics.
1. James D. Meiss, Differential Dynamical Systems. SIAM.
2. Harry Dym, Linear Algebra in Action, AMS.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - XI
TITLE - FINANCIAL MATHEMATICS - I
PAPER CODE - MTS3511

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Basic Concepts** 1.1 Arbitrage, return and interest, time value of money, bonds, shares and indices, Models and assumptions.	10
Unit - II	**Deterministic cash flows** 2.1 Net present value, internal rate of return, a comparison of IRR and NPV, bonds: price and yield, clean and dirty price, price yield curves, duration, term structure of interest rates, immunization, convexity.	12
Unit - III	**Random cash flows** 3.1 Random returns, Portfolio diagrams and efficiency, feasible set, Markowitz model, capital asset pricing model, diversification, CAMP as a pricing formula.	12
Unit - IV	**Forward and futures** 4.1 Forward and futures, Forward and futures price, value of a future contract, method of replicating portfolios, hedging with futures, currency futures, stock index futures.	14

Text Book:

Amber Habib - Universities Press - The Calculus of Finance.

Reference Books:

1. Steven Roman - Springer - Introduction to the Mathematics of Finance.
1. John Hul - Option Futures and other derivatives.
2. Kolb - Futures and Derivatives.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - V
MATHEMATICS PAPER - XII
TITLE - LATTICE THEORY
PAPER CODE - MTS3512

[CREDITS - 3]

	Title and Contents	No. of Lectures
Unit - I	**Lattices** 1.1 Properties and examples of lattices 1.2 Distributive Lattices 1.3 Boolean Algebras 1.4 Boolean Polynomials 1.5 Ideals, Filters, and Equations 1.6 Minimal Forms of Boolean Polynomials	36
Unit - II	**Applications of Lattices** 2.1 Switching Circuits 2.2 Applications of Switching Circuits 2.3 More applications of Boolean Algebras	12

Text Book:

R. Lidl, G. Pilz, Applied Abstract Algebra, 2nd Edition, Springer - Verlag, New York Inc. (2004, First Indian Reprint).

Reference Book:

G. Gratzer, General Lattice Theory, Academic Press, Inc.

Deccan Education Society's

FERGUSSON COLLEGE, PUNE

(AUTONOMOUS)

SYLLABUS UNDER AUTONOMY

THIRD YEAR B.Sc. (MATHEMATICS)

SEMESTER - VI

SYLLABUS FOR T. Y. B. Sc.

Academic Year 2018-2019

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - I
TITLE - COMPLEX ANALYSIS
PAPER CODE - MTS3601

[CREDITS - 3]

		Title and Contents	No. of Lectures
Unit - I	1.1	Complex Numbers, Revision, Algebra of complex numbers, Exponential Form, Products and powers in exponential form, Arguments of products and quotients, Roots of complex numbers, Roots of unity, Examples.	4
Unit - II	2.1	Analytic functions of Complex Variables, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulas, Cauchy - Riemann Equations, Sufficient Conditions for differentiability, Polar coordinates, Harmonic functions	10
Unit - III	3.1	Elementary Functions, The Exponential functions, The Logarithmic function, Branches and derivatives of logarithms, Some identities involving logarithms, Complex exponents, Trigonometric functions, Hyperbolic functions, Inverse trigonometric and hyperbolic functions	8
Unit - IV	4.1	Integrals Derivatives of functions, Definite integrals of functions, Contours, Contour integral, Examples, Upper bounds for moduli of contour integrals, Anti-derivatives, Examples, Cauchy-Goursat's Theorem (without proof), Simply and multiply Collected domains. Cauchy integral formula. Derivatives of analytic functions. Liouville's Theorem and Fundamental Theorem of Algebra, Maximum modulus principle	12
Unit - V	5.1	Series Convergence of sequences, Convergence of series, Taylor Series (without proof), examples, Laurent Series (without proof), region of convergence, examples	4
Unit - VI	6.1	Residues and Poles Cauchy residue theorem, using a single residue, Three types of isolated singular points, Residues at poles, Zeros of analytic functions, Zeros and poles, Applications to real integrals.	10

Text Book:

J. W. Brown and R. V. Churchill, Complex Variables and Applications, International Student Edition, 2009. (Eighth Edition).

Chapter 1: Section 1 to 10
Chapter 2: Section 12, 15 to 26
Chapter 3: Section 29 to 36
Chapter 4: Section 37 to 46 and 48 to 53
Chapter 5: Section 55 to 57, 59 to 60, 62
Chapter 6: Section 68 to 76

Reference Books:

1. S. Ponnusamy, Complex Analysis, Second Edition (Narosa).
1. J. M. Howie, Complex Analysis, (Springer, 2003).
2. S. Lang, Complex Analysis, (Springer, Verlag).
4. A. R. Shastri, An Introduction to Complex Analysis, (MacMillan).

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - II
TITLE - REAL ANALYSIS - II
PAPER CODE - MTS3602

[CREDITS - 3]

		Title and Contents	No. of Lectures
Unit - I	1.1	Sequences of functions, Point-wise Convergence, Uniform Convergence	8
Unit - II	2.1	Series of functions, Point-wise Convergence, Uniform Convergence, Weirestrass M-test, Term by term Integration, Term by term differentiation, Power series, radius of convergence	12
Unit - III	3.1	Elementary Functions and their properties	12
Unit - IV	4.1	Improper Integrals of first and second kind, Gamma functions, Beta function	8
Unit - V	5.1	Differentiation under the integral sign	4

Text Book:

1. Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd., (1970).
2. Ajitkumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2010.

Reference Books:

1. Apostol, Advanced Calculus, 2nd Edition, Prentice Hall of India, 1994.
2. D. Somasundaram and B. Choudhari, A first course in Mathematical Analysis, Narosa Publishing House, 1997.
3. R. G. Bartle and D. R. Scherbert, Introduction to Real Analysis, 4th Edition, John Wiley, 2012.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - III
TITLE - PROBLEM COURSE
PAPER CODE - MTS3603

[CREDITS - 3]

Problem Course based on Paper MTS3601 and MTS3602.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - IV
TITLE - RING THEORY
PAPER CODE - MTS3604

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Introduction to Ring** 1.1 Definition of ring and examples, Definition of field and examples, Definition of integral domain and examples, examples Z, Q, R, Zn, Z[x], Q[x], R[x], C[x], Z[i] etc., uniqueness of unit and inverse, subring, subring test	6
Unit - II	**Integral Domain** 2.1 Zero divisors, cancellation law, finite integral domains are fields, Zp is a field, $Z_3[i]$ is field with nine elements, $Q[\sqrt[2]{2}]$; characteristic of a ring, characteristic of a ring with unity, characteristic of integral domain	6
Unit - III	**Ideals and factor rings:** 3.1 Ideal, ideal test, examples, factor rings, existence of factor rings, prime ideal, maximal ideal, R=A is an integral domain if and only if A is prime ideal, R=A is a field if and only if A is maximal ideal	16
Unit - IV	**Ring Homomorphism:** 4.1 Homomorphism, isomorphism, examples, properties of homomorphisms, kernel and ideals, first isomorphism theorem for rings, ideals are kernels, homomorphism from Z to a ring with unity, a ring with unity contains Zn or Z; Zm is homomorphic image of Z; a field contains Zp or Q field of quotients	6
Unit - V	**Polynomial Rings** 5.1 Ring of polynomials over R, D is integral domain implies D[x] is integral domain, the division algorithm for F [x] (Field), the remainder theorem, the factor theorem, polynomials of degree n have at most n zeros (over field), PID, F [x] is PID (F Field), criterion for I = <g(x)>, Fundamental theorem of Algebra	8
Unit - VI	**Factorization of polynomials** 6.1 Irreducible polynomial, reducible polynomial, reducibility test for degrees 2 and 3; content of polynomial, primitive polynomial, Gauss's lemma, irreducible over Q implies irreducible over Z; irreducibility tests, mod p test, Eisentein's criterion, irreducibility of p^{th} cyclotomic polynomials, p(x) is irreducible if and only if <p(x)> is maximal, F [x]/<p(x)> is a field if p(x) is irreducible over F; if p(x) is irreducible and p(x)|a(x)b(x); then p(x)|a(x) or p(x)|b(x); unique factorization in Z[x].	8
Unit - VII	**Divisibility in integral domain** 7.1 Associates, irreducible, prime, prime implies irreducible, PID implies irreducible is same as prime, UFD, ACC for PID, PID implies UFD, F [x] is UFD (Field), ED, ED implies PID, ED implies UFD, D is UFD implies D[x] is UFD	8

Text Book:

John B. Fraleigh, A First Course in Abstract Algebra, Seventh Edition, Pearson. Articles: Section 18 to Section 23, Section 26, Section 27, Section 45, Section 46, Section 47.

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra, (4th Edition), Narosa Publishing House.
2. I. N. Herstein. Abstract Algebra, (3rd Edition), Prentice Hall of India, 1996.
3. N. S. Gopalkrishnan, University of Algebra, Wiley Eastern, 1986.
4. C. Musili, Rings and Modules, Narosa Publishing House, 1992.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - V
TITLE - DIFFERENTIAL GEOMETRY
PAPER CODE - MTS3605

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Curves in the plane and in space** 1.1 What is a curve? 1.2 Arc-length 1.3 Reparametrization 1.4 Level curves vs. Parametrized curves	4
Unit - II	**How much does a curve curve?** 2.1 Curvature 2.2 Plane curves 2.3 Space curves	8
Unit - III	**Global Properties of curves** 3.1 Simple closed curves 3.2 The Isoperimetric Inequality 3.3 The Four Vertex Theorem	8
Unit - IV	**Surfaces in three dimensions** 4.1 What is a Surface? 4.2 Smooth Surfaces 4.3 Tangents, Normals and Orientability 4.4 Examples of Surfaces 4.5 Quadric Surfaces	8
Unit - V	**The first fundamental form** 5.1 Lengths of curves on surfaces 5.2 Isometries of Surfaces 5.3 Conformal mappings of surfaces 5.4 Surface area 5.5 Equiareal maps and a Theorem of Archimedes	10
Unit - VI	**Curvature of surfaces** 6.1 The Second Fundamental Form 6.2 The curvature of Curves of a Surface 6.3 The Normal and Principal Curvatures 6.4 Geometric Interpretation of Principal Curvatures	10

Text Book:

Andrew Pressley: Elementary Differential Geometry, Springer International Edition, Indian Reprint 2004.

Chapters: 1, 2, 3, 4.1 - 4.5, 5 and 6.

Reference Book:

John A. Thorpe: Differential Geometry, Springer International Edition, Indian Reprint 2004.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - VI
TITLE - PROBLEM COURSE
PAPER CODE - MTS3606

[CREDITS - 3]

Problem Course based on Paper MTS3604 and MTS3605

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - VII
TITLE - OPTIMIZATION TECHNIQUES
PAPER CODE - MTS3607

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Network Models** 1.1 CPM and PERT, Network representation, Critical Path Computations, Construction of the time schedule, Linear programming formulation of CPM, PERT calculations	12
Unit - II	**Decision Analysis and Games** 2.1 Decision under uncertainty, Game theory, some basic terminologies, optimal solution of two person zero sum game, Solution of mixed strategy games, graphical solution of games, linear programming solution of games	12
Unit - III	**Replacement and Maintenance Models** 3.1 Introduction, Types of failure, Replacement of items whose efficiency deteriorates with time	8
Unit - IV	**Sequencing Problems** 4.1 Introduction, Notation, terminology and assumptions, processing n jobs through two machines, processing jobs through three machines	6
Unit - V	**Classical Optimization Theory** 5.1 Unconstrained problems, Necessary and sufficient conditions, Newton Raphson method, Constrained problems, Equality constraints (Lagrangian)	10

Text Books:

1. Hamdy A. Taha, Operation Research (Eighth Edition, 2009), Prentice Hall of India Pvt. Ltd., New Delhi.
   Ch.6: 6.5 (6.5.1 to 6.5.5).
   Ch.13: 13.3, 13.4 (13.4.1, 13.4.2, 13.4.3).
   Ch.18: 18.1 (18.1.1, 18.1.2), 18.2 (18.2.1).
2. J. K. Sharma, Operations Research (Theory and Applications, Second Edition, 2006), Macmillan India Ltd.
   Ch.17: 17.1, 17.2, 17.3.
   Ch.20: 20.1, 20.2, 20.3, 20.4.

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research (Eighth Edition), Tata McGraw-Hill.
2. Hira and Gupta, Operations Research.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - VIII
TITLE - COMPUTATIONAL GEOMETRY
PAPER CODE - MTS3608

[CREDITS - 3]

	Title and Contents	No. of Lectures
Unit - I	**Two dimensional Transformations** 1.1 Introduction, Representation of Points, Transformations and Matrices, Transformation of Points, Transformation of Straight Lines, Midpoint Transformation, Transformation of Parallel Lines, Transformation of Intersecting Lines, Rotation, Reflection, Scaling, Combined Transformations, Transformation of the Unit Square, Solid Body Transformation, Translations and Homogeneous Co-ordinates, Rotation About an Arbitrary Point, Reflection through an Arbitrary Line, Projection - A Geometric Interpretation of Homogeneous Coordinates, Overall Scaling, Points at Infinity.	10
Unit - II	**Three Dimensional Transformations** 2.1 Three Dimensional Scaling, Three Dimensional Shearing, Three Dimensional Rotation, Three Dimensional Reflection, Three Dimensional Translation, Multiple Transformations, Rotations about an axis parallel to a coordinate axis, Rotation about an Arbitrary Axis in Space, Reflection through an Arbitrary Plane. Affine and Perspective Geometry, Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformations. Techniques for generating perspective views, vanishing points.	12
Unit - III	**Plane Curves** 3.1 Curve representation, non-parametric curves, parametric curves, parametric representation of a circle, parametric representation of an Ellipse, parametric representation of a Parabola, parametric representation of a Hyperbola	12
Unit - IV	**Space Curves** 4.1 Representation of space curves, cubic splines, normalized cubic splines, alternate cubic spline end conditions. Parabolic blending, generalized parabolic blending, Bezier curves, B-spline curves, end conditions for periodic B-spline curves, B-spline curve Fit, B-spline curve subdivision, Rational B-spline curves	12

Text Book:

D.F. Rogers, J. Alan Adams, Mathematical Elements of Computer Graphics, Second Edition, McGraw-Hill Publishing Company, §2.2 to §2.20, §3.1 to §3.15, §3.17, §4.1 to §4.8, §5.8.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - IX
TITLE - C-PROGRAMMING - II
PAPER CODE - MTS3609

[CREDITS - 3]

	Title and Contents	No. of Lectures
Unit - I	**Sorting** 1.1 Selection sorts, Insertion sorts, Bubble sorts.	6
Unit - II	**Structures and Unions** 2.1 Defining a structure, Processing a structure, User-defined data types (typedef), Structures and pointers, Passing structure to a function, Self-referential structures, Unions	10
Unit - III	**Stacks** 3.1 Definition and examples, Representing stacks in C, An example of post x and pre x	10
Unit - IV	**Queues and list** 4.1 The queue and its sequential representation, linked lists, lists in C, an example: Simulation using linked lists, other list structure	10
Unit -- V	**Tree** 5.1 Binary trees, binary tree representations, an example: The Huffman Algorithm, representing lists as binary trees, trees and their applications, an example: Game Theory	12

Text Books:

1. Let us C by Yashavant Kanetkar.
2. Data Structures through C by Yashavant Kanetkar.

Reference Books:

1. Programming with C, by Byron S. Gottfried Schaum’s Outline Series.
2. The C Programming Language by Brian W. Kernighan, Dennis M. Ritchie.
3. Data Structures using C by Aaron M. Tenenbaum, Yedidyah Langsam and Moshe J. Augenstein.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - X
TITLE - LEBESGUE INTEGRATION OVER R
PAPER CODE - MTS3610

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Measurable Sets** 1.1 Length of open sets and closed sets 1.2 Inner and outer measure. 1.3 Measurable sets. 1.4 Properties of measurable sets	6
Unit - II	2.1 Measurable Functions	10
Unit - III	**The Lebesgue Integrals** 3.1 Definition and example of the Lebesgue integrals for bounded functions 3.2 Properties of Lebesgue integrals for bounded measurable functions 3.3 The Lebesgue integral for unbonded functions 3.4 Some fundamental theorems	10
Unit - IV	Fourier Series 4.1 Definition and examples of Fourier Series 4.2 Formulation of convergence problems, Parseval's theorem	10

Text Book:

Richard R. Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. Pvt. Ltd., (1970). (Chapter No. 11, 11.1 to 11.8, 12.1, 12.2. Theorem No. 11.1B and 11.1C, 11.8D).

Reference Books:

1. Apostol, Advanced Calculus, 2^{nd} Edition, Prentice Hall of India, 1994.
2. D. Somasundaram and B. Choudhari, A first course in Mathematical Analysis, Narosa Publishing House, 1997.
3. R. G. Bartle and D. R. Scherbert, Introduction to Real Analysis, 4^{th} Edition, John Wiley, 2012.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - XI
TITLE - FINANCIAL MATHEMATICS - II
PAPER CODE - MTS3611

[CREDITS - 3]

	Title and Contents	No. of Lectures
Unit - I	**Stock price models** 1.1 Lognormal model, geometric Brownian model, suit-ability of GBM for stock prices, binomial tree model	12
Unit - II	**Options** 2.1 Call options, put options, put-call parity, binomial options pricing model, pricing American options, factor influencing option premiums, options on assets with dividends, dynamic hedging, risk-neutral valuation	12
Unit - III	**The black-scholes model** 3.1 Risk-neutral valuation, the black-scholes formula, options on futures, options on assets with dividends, black-scholes and BOPM, implied volatility, dynamic hedging, the greeks, the black-scholes PDE, speculating with options	12
Unit - IV	**Value at risk** 4.1 Definition of value at risk, linear model, quadratic model, Monte Carlo simulation, the martingale	12

Textbook:

Amber Habib, The Calculus of Finance, Universities Press, Hyderabad, 2011.

Reference Book:

Steven Roman, Introduction to the Mathematics of Finance, Springer.

T. Y. B. Sc. (MATHEMATICS) SEMESTER - VI
MATHEMATICS PAPER - XII
TITLE - GRAPH THEORY
PAPER CODE - MTS3612

[CREDITS - 3]

	Title and Contents	**No. of Lectures**
Unit - I	**Introduction** Definitions, examples of various types of graphs, degree of a graph, connected graph, sub graphs, isomorphism of graphs, matrix representation of a graph, three puzzles	10
Unit - II	**Paths and cycles** Definitions, walk, trail, path, cycle, vertex connectivity, connected graph, edge connectivity, Eulerian trail, Eulerian graphs, Hamiltonian cycle, Hamiltonian graphs	10
Unit - III	**Trees** Definitions, Properties of trees, Cayley's theorem, matrix-tree theorem (without proof), Counting trees, applications - The minimum connector problem	10
Unit - IV	**Planarity** Planar graph, Euler's formula, infinite graph	8
Unit - V	**Colouring graphs** Colouring vertices, k-vertex colourable graph, chromatic number of a graph, Brook's theorem, colouring edges, k-edge colourable graph, chromatic polynomial of a graph	10

Text Book:

R. J. Wilson, Introduction to Graph Theory, 4th Edition, Pearson Education, 2003.

Reference Books:

1. A First Look at Graph Theory, John Clark and Derek Allan Holton, Allied Publishers Ltd., 1991.
2. Graph Theory, Hararay, Narosa Publishers, New Delhi (1989).
3. Graph Theory, Narsing Deo, Prentice Hall of India Pvt. Ltd. (1987).
4. Basic Graph Theory, K. R. Parthsarathy, Tata McGraw-Hill Publisher Co. Ltd.