Yashavantrao Chavan Institute of Science, Satara

Department of Mathematics

Syllabus for Autonomy

Subject:- Mathematics

M.Sc-I Semester-I

Paper: MT 101

Title of paper: Algebra – I

    i.   Specific Objectives: To study group and ring theory in details and basics and to introduce the concept of modulus over a ring.

    ii.   A brief note: (Notations and concepts are taken from books given in basic reading ; this should be taken in account for examination point of view).

Unit I.   : Simple groups, simplicity of A_n (n>5), Commutator subgroups, normal subgroup and subnormal series , Jordan-Holder theorem, Solvable groups, isomorphism theorems, Zassenhaus Lemma, Schreier refinement theorem.   **(15 L)**

Unit II.   : Group Action on a set, isometry subgroups, Burnside theorem, syllow's theorems, p-subgroups, class equation and applications**.**   **(15 L)**

Unit III.   :Rings of polynomials, Factorization of polynomials over fields, irreducible polynomials, Eisenstein criterion, ideals in F[x], unique factorization domain, principle ideal domain, Gauss lemma, Euclidean Domain**.**   **(15 L)**

Unit IV.   Modules, sub-modules, quotient modules, homomorphism and isomorphism theorems, Fundamental theorem for modules**.**   **(15 L)**

Recommended Reading:

    a) Basic Reading :-   1.A First course in Abstract Algebra by John Fraleigh
(3rd edition) Narosa publishing house New delhi
2. C. Musili, Ring and Modules, Narosa publishing house.
3. Joseph A.Gallian, Contempory Abstract Algebra, Narosa Publication
4th Edition ,1999

    b) Additional Reading :-1."Basic Abstract Algebra" by Bhattachary Jain and
Nagpal,2nd Edition ,Narosa Publication House New Delhi.
2.Topics in Algebra, I.N.Herstein, Vikas Publishing house

c) References Books:- 1. Basic Algebra by N.Jacobson,Hind Publishing Corporation 1984

2. Periodicals / Journals

NOTE:- i)The details of field work ,seminar ,Group discussion and Oral examination be given

whenever necessary. 1Hr per week for problem solving /tutorial/seminars

ii) General /Specific instructions for Laboratory safty should be given whenever necessary

Paper: MT 102

Title of paper: Advanced calculus

     i.   Specific Objectives: To study sequences of functions, Multivariables differential calculus ,Extremum problems.

     ii.   A brief note: (Notations and concepts are taken from books given in basic reading ; this should be taken in account for examination point of view).

Unit 1: Sequence of function: Pointwise convergence of sequence of function,Examples of sequence of real valued functions, Definition of uniform convergence, Uniform convergence and continuity,Cauchy condition for uniform convergence,Uniform convergence and Riemann Integration, Uniform convergence and Differentiation,double sequence, Uniform convergence and double sequence, Mean Convergence.

                                                                  (15 L)

Unit 2: Rearrangement of Series, subseries, double series , Rearrangement theorem for double series,Multification of series, Power series, Real Power series,The Taylors series generated by function,Bernstein's theorem,Binomial series,Abel's limit theorem ,Taubers theorem   **(15 L)**

Unit 3 : Multivariable differential Calculus: The Directional Derivative, The Directional Derivative and Continuity, Total Derivative, Total Derivative in terms of partial derivative ,The Matrix of linear function ,Jacobian Matrix,Chain Rule, Mean value function for differentiable function, A sufficient condition for differentiability, sufficient condition for equality of mixed partial derivatives, Taylors formula for functions R^n to R^1 ,The Inverse function theorem (statement only), Implicit function theorem (statement only) and their applications, Extrema of real valued function of one variable, Extrema of real valued function of several variables

                                                                  (15 L).

Unit 4:- Path and line integral, Multiple integral Double integral (Theorem without proof) Application to Area and Volume, (Theorem without proof) ,Greens theorem in the Plane.Applications of Green's theorem's. Change of variables Special case for transformation formula , Surface Integral ,Change of parametric representation.Other notations for Surface Integral, stokes theorem, Curl and divergence of the vector field ,Gauss divergence theorem

                                                         (15 L)

Recommended Reading :

        Basic reading:-   1) Mathematical Analysis, T.M.Apostol,second edition,

                          Narosa publishing   house

                    2) Advanced Calculus Vol II   by T.M.Apostol

Additional reading:-1) Principles of Mathematical Analysis, Walter Rudin third edition,McGraw Hill   book company

References Books : Methods of Real Analysis, Richard Goldberge, Blaisdell publishing company

NOTE: :- i) The details of field work ,seminar ,Group discussion and Oral examination be given whenever necessary. 1Hr per week for problem solving /tutorial/seminars

ii) General /Specific instructions for Laboratory safty should be given whenever necessary.

Paper: MT 103

Title of the Paper: Real Analysis

Specific Objectives : To introduce basic concepts and notations of Real Analysis viz. Lebesgue measure, Lebesgue Integral, measurable functions etc.

UNIT -1: Open Sets , Closed Sets and Borel sets, Lebesgue Outer measure, The sihma Algebra of Lebesgue Measurable Sets, Countable Additivity, Continuity and Borel-Cantelli Lemma, Non-measurable Sets**.**   (**15L**)

UNIT – 2: Sums, Product and Compositionof Measurable Functions , Sequential Pointwise limits and simple Approximation. Littlewood's Three Principles, Egoroff's theorem and Lusin's Theorem, Lebesgue Integration of a Bounded Measurable Function, Lebesgue Integration of a non- negative Measurable function.   (**15 L**)

UNIT-3 : The General Lebesgue Integral, Characterization of Riemann and Lebesgue Integrability, Differentiability of Monotone Functions, Lebesgue 's Theorem, Functions of Bounded Variations : Jordan's theorem**.**   (**15 L**)

UNIT-4: Absolutely Continious Functions , Integrating Derivatives: Differentiating Indefinite Integrals , Normed Linear Spaces, Inequalitiesof Young, Holder and Minkowski, The Riesz- Fischer Theorem.

(**15 L**)

Recommanded Reading :

 a) Basic Reading :-

   1)Royden, H.L. Fitzpateick P.M., Real Analysis (2009) 4th edition. Prentice Hall of India, New Delhi

 b) Additional Reading :-

    1) G. deBarra. Measure Theory and Integration (1981) McMillan, New York.

    2) Jain. P.K. and Gupta, V.P. Lebesgue measure and integration (1986) Wiley Easter Limited.

    3) Rudin W., Principles of Mathematical Analysis, (1964) McGraw- Hill Book Co.

Notes:- 1) the details of the field work, seminar < Group discussion and Oral examinatione given wherever necessary.   1 Hr per week for problem solving/ tutorial/ seminar

     2) General/ Specific instructions for Laboratory safety should be given wherever necessary

Paper :   **MT-104**

Title of the paper: **Differential Equations**

    Specific Objectives: **To study basic notations in Differential Equations and use the results in**

                 Developing advanced mathematics.

    A brief note: Theorems and proofs are expected to be prepared from an introduction nto ordinary

               Differential equations by E. A. Coddington.

Unit- 1: Linear Equations with constant coefficients:The second order homogeneous equations, Initial value problems for second order equations, Linear dependance and independence, A formula for the Wronskian, The non- homogeneous equations of order two, The homogeneous equations of order n**.**

                                                                        (15 L)

Unit -2: Initial value problems for the nth order equations< The non-homogeneous equations of nth order . Linear Equations with variable coefficients : Initial value problems for the homogeneous equations. Solutions of the homogeneous equations, The Wronskian and linear independence , Reduction of the of a homogeneous equation , The non-homogeneous equations,

                                                                  (15 L)

Unit-3: Green's function, Sturm Liouville's theory, Homogeneous equations with analytic coefficients< The Legendre equations. Linear equations with regular singular points: The Euler equations, Second order equations with regular singular points.   **(15 L)**

Unit -4 : The Bessel equation, Reguolar singular points at infinity , Existance and uniqueness of solutions: The method of successive approximations, The Lipschitz condition of the successive approximation. Convergence of the successive approximation.   **(15 L)**

Recommended Reading:

 a) Basic Reading:- 1) E.A. Coddington: An introduction to ordinary differential equations (1974)

                               Prentice Hall of India Pvt. Ltd.New Delhi.

                          2) G. Birkoff and G.G. Rota: Ordinary Differential equations, John Willey and Sons

b) Additional Reading :- G.F.Simmons Differential equationswith Applications and Historical note,

                         McGraw Hill,Inc. New York. (1972)

c) Reference Books:- 1) E.A. Coddington and Levinson: Theory of Ordinary Differential equations

McGraw Hill, New York(1964)

NOTE :1) The details of field work, seminar, Group Discussion and Oral examination be given wherever

necessary . **1 Hr per week is for problem solving/ Tutorials/ seminars.**

2) General/ Specific instructions for laboratory safety should be given wherever necessary.

Paper- MT105

Title of Paper: Classical mechanics

(i) **Specific Objectives:** To study the mathematical artifact and learn sometime about the art of applying mathematical knowledge to solve problems arises in the real world.

(ii) **A brief note:- Theorems and proofs are expected to be prepared from books given in basic readings.**

(iii)**UNIT** **No. of Lectures**

UNIT-I: Mechanics of a particle, Mechanics of a system of particles, conservation theorems, conservative force with examples, constraints, Generalised co-ordinates, D'Alembert's Principle, Lagrange's equations of motion , the forms of Lagrange's equation for non-conservative system and partially conservative and partially non-conservative system, Lagrangian for charged particle in electromagnetic field, kinetic energy as a homogeneous function of generalised velocities, Non-conservation of total energy due to the existence of non-conservative forces. Cyclic co-ordinates and generalised momentum, conservation theorems, motion of a particle under central force and first integral. **(15 L)**

UNIT-II: Functionals , basic lemma in calculus of variations, Euler-Lagrange's equations , first integrals of Euler-Lagrange's equations, the case of several dependent variables Undetrmined end conditions, Geodesics in a plane and space, the minimum surface of revolution , the problem of Brachistochrone, Isoperimetric problems, problem of maximum enclosed area, shape of a hanging rope. Hamilton's principle for conservative and non-conservative systems, Derivation of Hamilton's principle from D'Alembert's principle, Lagrange's equations of motion for conservative and non-conservative systems from Hamilton's principle. Lagrange's equations of motion for non-conservative systems(method of Lagrange's undtermined multipliers) **(15 L)**

UNIT –III : Hamiltonian function, Hamiltonian Canonical equations of motion, Derivation of Hamilton's equations from variational principle, Physical significance of Hamiltonian, the principle of least action, Jacobi's form of the least action principle, cyclic co-ordinates and Routh's procedure. Orthogonal transformations, Properties of transformation matrix, infinitesimal rotations. **(15 L)**

UNIT –IV: The Kinematics of rigid body motion: The independent co-ordinates of rigid body, the Eulerian angles, Euler's theorem on motion of rigid body, Angular momentum and kinetic energy of a rigid body with one point fixed, the inertia tensor and moment of inertia, Euler's equations of motion, Caley- Klein parameters, Matrix of transformation in Caley Klein parameters, Relations between Eulerian angles and Caley-Klein parameters**. (15 L)**

(iv)**Recommended Reading :**

a) **Basic Reading:-**

1) Goldstein, H. Classical Mechanics .(1980),Narosa Publishing House, New Delhi.

2) Weinstock: Calculus of Variations with applications to Physics and Engineering (International Series in Pure and Applied Mathematics).(1952),Mc Graw Hill Book Company, New York.

b) Additional Reading:- 1) Whittaker, E.T. A treatise on the Analytical Dynamics o f particles and rigid bodies.(1965), Cambridge University Press.

2) Rana , N.C. and Joag, P.S. Classical mechanics. (1991) Tata McGraw Hills, New Delhi.

c) **References:-**

i)Books: 1) Bhatia , V.B.Classical Mechanics with Introduction to Non-linear Oscillation and Chaos.(1997), Narosa publishing House.
2) Gupta, A.S. Calculus of Variations with applications (1997), Prntice Hall of India.
3)Gelfand, I.M. and Fomin, S.V. Callculus of variations (1963), Prentice Hall of India.
4)Mondal , C.R. Classical Mechanics (2001), Prentice Hall of India.
ii) Periodicals /Journals: Nil

M.Sc-I Semester-II

Paper :- MT-201

Title of Paper :- Linear Algebra

(i)   **Specific Objectives :-** To introduce basic notions in Linear Algebra and use the results in developing advanced mathematics.

(ii)   **A brief note :- Theorems and proofs are expected to be prepared from Topics in Algebra by Herstein I .N and Linear Algebra by Hoffiman , Kenneth and Kunze R.**

(iii)   **UNITS**   **No. of Lectures**

    UNIT-I : Direct sum of a vector space, Dual Spaces . Annihilator of a subspace, Quotient Spaces. Algebra of Linear trasformation.   **(15 L)**

    UNIT-II : Adjoint of a Linear Transformation, Inner product spaces, eigen values and eigen vectors of a linear transformation. Diagonalization. Invariant subspaces.   **(15 L)**

     UNIT-III :   Canonical forms, Similarity of Linear transformations, Reduction to Triangular forms , Nilpotent transformation, Primary decomposition theorem, Jordan blocks and Jordan forms , Invariants of Linear transformations**.**   **(15 L)**

     UNIT-IV : Hermitian, Self adjoint, Unitary and normal Linear trasformation, symmetric bilinear forms, skew symmetric bilinear forms , group preserving bilinear forms   **(15 L)**

(iv)   **Recommended reading:**

a) Basic Reading :- (i) Herstein I.N. : Topics in Algebra , Second Edition, Willey eastern Ltd.

                   (ii) Hoffman Kenneth and Kunze R : Linear Algebra, Prentice hall of India, Pvt. Ltd.,1984

b) Additional Reading : Sahi and Bist, Linear algebra , Narosa Publishing House.

c) Reference Books : 1) A.R. Rao and P. Bhimashankaran, Linear Algebra, Hindustan Book Agency(2000)

                   2) Surjit Sing, Linear Algebra , Vikas Publishing House(1997)

 v) Periodicals /Journals: Nil

Paper :   MT 202

Title of Paper :- Topology

  (i)   **Specific Objectives** :   :To introduce several topological spaces with their different
                    Properties.

  (ii)   **A brief note :-**   : Theorems and proofs are expected to be prepared from
                    Foundation of General Topology by W.J.Pervin.

Unit –I :   Topological Spaces, Examples, Open Sets, Closed sets, Neighborhoods, Bases, Subbases,
        Limit Points,Closer Interior,Various ways of defining topologies, Hereditary properties.
                                                  (15 L)

Unit –II   Continuous functions,Homeomorphisms,Topological properties,Compact Spaces,
       Connected spaces ,Connected subspsces of real lines, Components, Separation axioms T_0 ,
       T_1 , T_2 axioms.   **(15 L)**

Unit –III   First and second axioms spaces, Separable Spaces, Lindelof spaces,Regular and normal
       Spaces, Product Spaces (For T_0,T_1,T_2 Compact and Connected)   **(15 L)**

Unit IV   Completely regular and completely normal Spaces,Urysohn Lemma and Urysohn
       Metrization theorem   **(15 L)**

     Recommended Reading:

     a) Basic Reading : W.J.Pervin, Foundations of General Topology , Academic Press, New
      York,3rd edition,1970.

     b) Additional Reading:
            1)G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw
          Hill Book Company , New Delhi,1963.
            2) J.R. Munkers, Topology : A first Course, Prentice Hall of India Pvt.Ltd.

     c) References:-
       1) K.D. Joshi, General Topology.
       2) Willard, Topology, Academic press

Paper: MT 203

Title of the Paper: Complex Analysis

Specific Objectives : To introduce basic notion in complex Analysis and use the result in developing advanced mathematics.

A brief note: Theorems and proofs are expected to be prepared from Functions of one Variable by J.B.Conway ; this should be taken in to account for examination point of view.

Unit 1: Power series , Radius of convergence, Bilinear Transformation, Analytic functions , Cauchy's-Riemann equations, Harmonic functions, Power series representation of analytic functions.

(15 L)

Unit   2: Zeros of Analytic functions, Cauchy's theorem, Moreras theorem, cauchy's Integral formula, Cauchy's inequality' Liouville's Theorem, Fundamental theorem of algebra, Maximum modulus theorem,Open mapping theorem.

(15 L)

Unit   3: Laurent series expansion theorem, Cauchyresidue theorem, classification of singularities, Evaluation of integral, The argument principle, Rouche's theorem.

(15 L)

Unit 4: Conformal maps, Normal families, Hurwitz theorem, Riemann mapping theorem.

(15 L)

Recommended Reading :

 Basic Reading: J.B.Conway**:** Functions of one complex variable (3rd Edotion) Narosa publication House.

 Additional Reading : Alfors L.V.: Complex Analysis, McGraw 1979.

 Reference: i) Herb Silverman, Complex Analysis

Paper : MT 204

Title of the Paper: Numerical Analysis

   iii) Specific Objectives: To analyse methods used to solve mathematical problems   numerically.

   iv) Units and No. Of Lectures

Unit 1

Algebraic and transcendental equations:

Rate of convergence of Secant Metho, Regula _Falsi Method and Newton-Raphson Method. Bairstow method.

  System of linear equations: Matrix factorization methods (Doo little reduction, Crout reduction) Eigen Values and eigen vectors , Gerschgorin theorem, Brauer theorem, jacobi Method for symmetric matrices.

                                                        (15L)

Unit 2

Numerical Integration: Error estimates of trapezoidal and Simpson's Numerical Integration rule.

  Gauss- Legendre integration Methods (n= 1,2) , Lobatto Integration Method (n=2) , Radau Integration method (n=2) and their error estimates.   **(15 L)**

Unit 3

Runge – Kutta Method : second order methods , The coefficient tableau, Third order methods (without proof) , order conditions, Fourth order methods (without proof) , Implicit Runge- kutta methods, Stability characteristics.

Taylor Series Methods: Introduction to Taylor series methods, Manipulation of Power Series, an example of a Taylor series solution.   **(15 L)**

Unit 4

Linear multistep methods : Adams Methods, General form of linear multistep methods, Predictor- corrector Adams methods, Starting Methods.

Analysis of linear multistep methods: Convergence, consistancy, Sufficient condition for convergence, Stability characteristics**.**   **(15 L)**

Unit 5

Problems, assignments, seminars, etc. Based on units 1-4 above

vi) Recommandede Reading:

  a)Basic Reading:

    1. Numerical methodsfor scientific and Engineering computation, M. K. Jain ,S. R. K.lyengar, R.K.Jain, New Age international Limited Publishers , 6th edition (for units 1 and 2)

    2. Numerical methods for ordinary differential equations, J.C. Butcher, JohnWiley & sons Ltd, 2nd Edition (For units 3and 4)

  b) Additional Reading:

    1) Discrete variable methods in ordinary differential equations, P. Henrici, John Wiley & Sons Ltd.

    2) Introductory methods of Numerical analysis' S.S. Sastry, Prentice Hall of India New Delhi.

    3) Numerical Mathematics

    4) Numerical Solutions of Differential equations by M. K. Jain.

Paper: MT-205
Title of the Paper :- Differntial Geometry

Specific Objectives: To study the geometry of curves and to develope the calculus on the surfaces we introduce curves and basic notion of surfaces.

A brief note:- Theorems and proofs are expected to be prepared from books given in basic readings.

Unit – I

Vector Space, Euclidean Space in R^3. Tangent Vectors and vector fields, Frame fields, Natural Frame Fields, Directional Derivatives, Curve in R^3 and reparametrization of curves, Standard curves, Speed of curve,length of curve, 1-forms, differential forms**.   (15 L)**

Unit –II

The Frenet Formulae for unit speed curve,. Frenet approximation of curves, Arbitrary Speed Curves,Frenet formula's for arbitrary speed curves, Co-variant Derivative, Isometries in R^3 , Orthogonal Transformations. **.**

(15 L)

Unit-III

Co-ordinate Patches, Surface in R^3 , Simple Surface, Cylinder Surface, Surface of Revolution, parametrization of a region, parametrization of a cylinder and surface of revolution, Smooth overlaping patches, Tangent and normal vector fields on a surface.   **(15 L)**

Unit-IV

The Shape operator of surface M in R^3, Normal curvature,Principal curvature, Gaussian and mean curvatures, Umbilic Points, Fundamental forms of a surface, Computational Techniques, Special curves on surface, Asymptotic and Geodesic Curves**.   (15 L)**

Recommended Reading:

Basic Reading: O'Neill , B. : Elementary Differential Geometry, Academic Press,Revised Edition,2006.

Reference Books :

1) D. Somasundaram: Differential Geometry – First Course, Narosa Publishing House, New Delhi , 2010
2) Nirmala Prakash: Differential Geometry, TMH, 1981