"Dissemination of Education for Knowledge, Science and Culture"
- Shikshanmaharshi Dr. Bapuji Salunkhe

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

DEPARTMENT OF MATHEMATICS

M.Sc. Part - I
Semester-I & II

SYLLABUS

Under Choice Based Credit System

to be implemented from Academic Year 2021-22

M.Sc. I (Sem -I and II) Mathematics
Course Structure
Semester I

Paper No.	Course code	Title of Old Paper	Title of New Paper	Percentage of Change (%)	No. of Credits
I	CP-1170A	Algebra	Algebra	0	5
II	CP-1171A	Advanced Calculus	Advanced Calculus	**0**	**5**
III	CP-1172A	Complex Analysis	Complex Analysis	**0**	**5**
IV	CP-1173A	Ordinary Differential Equation	Ordinary Differential Equation	**0**	**5**
V	CP-1174A	Classical Mechanics	Classical Mechanics	**0**	**5**

Semester II

Paper No.	Course code	Title of Old Paper	Title of New Paper	Percentage of Change (%)	No. of Credits	Paper No.
I	CP-1175B	Linear Algebra	Linear Algebra	0	5	5
II	CP-1176B	Measure and integration	Integral Equations	100	**5**	5
III	CP-1177B	General Topology	General Topology	0	**5**	5
IV	CP-1178B	Partial Differential Equation	Partial Differential Equation	0	**5**	5
V	CP-1179B	Numerical Analysis	Numerical Analysis	0	**5**	5

M.Sc. Mathematics Part – I CBCS
Semester - I Paper- I
Algebra (CP-1170A)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Check solvability of groups via Sylow's theorems.

CO2: Check irreducibility of polynomial over any field.

CO3: Familiar with theory of modules.

CO4: Apply the basic concepts of field theory, including field extensions and finite fields.

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credits**
Module 1	Simple groups, simplicity of A_n ($n > 5$), Commutator subgroups, normal subgroup and subnormal series, Jordan-Holder theorem, Solvable groups, Nilpotent group, isomorphism theorems (Statement only), Zassenhaus Lemma, Schreier refinement theorem.	15	1
Module 2	Group action on a set, isometry subgroups, Burnside theorem, Direct product and semidirect product of groups , Syllow's theorems, p-subgroups, Group of order 2p and pq, Class equation and applications	15	1
Module 3	Ring of Polynomials, Factorization of polynomials over fields, irreducible polynomials, Eisenstein criterion, ideals in F[x], unique factorization domain, principal ideal domain, Gauss lemma, Euclidean Domain.	15	1
Module 4	Modules, sub-modules, quotient modules, homomorphism and isomorphism theorems, fundamental theorem for modules, completely reducible modules, free modules.	15	1
Module 5	Examples, Problems, assignments, seminars etc. based on units I to IV above.	15	1

Reference Books:

1) Fraleigh, J.B., A First course in Abstract Algebra, (3rd edition) Narosa publishing house,New Delhi.
2) Gallian J.A., Abstract Algebra, Narosa Publications, 4th Edition, 1999.
3) Herstein I.N., Topics in Algebra, Vikas Publishing house.

M.Sc. Mathematics Part – I CBCS
Semester - I Paper- II
Advanced Calculus (CP-1171A)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to –

CO1: Make use of Greens Theorem, Stokes Theorems for an arc rectification of curve.
CO2: Analyze convergence of sequences and series of functions.
CO3: find the directional derivative of function of several variables.
CO4: optimize function of several variables

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credits**
Module 1	Functions of Bounded Variation& Rectifiable Curves – Introduction, Properties of monotonic functions, functions of Bounded Variation(B.V.), Total Variation(T.V.), additiveproperty of T.V., T.V. on [a, x] as function of x, function of B.V. expressed as the difference of increasing functions, continuous functions of B.V., curves & paths, 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	1
Module 2	Sequences and series of functions - Pointwise convergence of sequences of functions, 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 sequences, mean convergence. Multiplication of series, Power series, multiplication of power series, substitution theorem, reciprocal of power series, The Taylor series generated by function, Binomial series.	15	1
Module 3	Multivariable differential Calculus: The Directional derivatives, directional derivatives and continuity, total derivative, total derivatives expressed in terms of partial derivatives, The matrix of linear function, Jacobin matrix, Chain rule, mean value theorem for differentiable functions, A sufficient condition for differentiability,	15	1

	sufficient condition for equality of mixed partial derivatives, Taylor's formula for functions from Rn to R1. The inverse function theorem (Statement only		
Module 4	Implicit Functions - The implicit function theorem (Statement only) and their applications. Extrema of real valued functions of one variable, Extrema of real valued functions of several variables.	15	1
Module 5	Examples, Problems, assignments, seminars etc. based on units I to IV.	12	1

Reference Books:

1) Malik S.C., Arora S., Mathematical Analysis, New Age International Publishers.
2) Goldberg R., Methods of Real Analysis, Blaisdell

M.Sc. Mathematics Part – I CBCS
Semester - I Paper- III
Complex Analysis (CP-1172A)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1**:** Know how to check given complex valued function is analytic or not.

CO2: Find power series expansion of an analytic function with radius of convergence.

CO3: Find zeros and singularities of complex valued functions.

CO4: Evaluate integral of complex valued functions along given curve.

Unit	Syllabus	Lectures/ Teaching Hours	Credits
Module 1	Power series, radius of convergence, analytic functions, zeros of an analytic function,Cauchy-Riemann equations, Harmonic functions, Mobius transformations, line integral.	15	1
Module 2	Power series representation of analytical function, zeros of an analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem, the index of closed curve, Cauchy's theorem and integral formula, Morera's theorem.	15	1
Module 3	Counting zero's, The open mapping theorem, Goursat's Theorem, Classification of singularities, Laurent series development, Casorati-weierstrass theorem, residues, residues theorem ,evaluation of real integrals.	15	1
Module 4	The argument principle , Rouche's theorem, the maximum principle, Schwarz's lemma and its applications to characterize conformal maps.	15	1
Module 5	Examples, Problems, assignments, seminars etc. based on units I to IV above.	15	1

Reference Books :-

1) Ahlfors L.V. : Complex Analysis (Mc Graw Hill).
2) Churchill R.V., Brown J.W.: Complex Variables and Applications (McGraw Hill).
3) Ponnusamy S., Herb Silverman, Complex variables with applicationsanalysis,Birkhauser,2006
4) Ponnusamy S., Foundations of complex analysis, Narosa publishing House.

M.Sc. Mathematics Part – I CBCS

Semester - I

Ordinary Differential Equations (CP-1173A)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Find the linearly independent and hence general solutions of given differential equations.

CO2: Find series solutions of Bessel's and Legendre's differential equations.

CO3: Apply Picard's successive approximation method to find approximate solution of initial value problem.

CO4: Apply the Lipschitz condition of successive approximation.

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credi ts**
Module 1	Linear Equations with constant coefficients: The second order homogeneous equation, Initial value problems for second order equations, Linear dependence and independence, A formula for the Wronskian, The non-homogeneous equations of order two, The homogeneous equations of order n.	15	1
Module 2	Initial value problems for the nth order equations, The non-homogeneous equation 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 order of a homogeneous equation, The non-homogenous equations.	15	1
Module 3	Sturm Liouville theory, Homogeneous equations with analytic coefficients, The Legendre equations. Linear Equations with regular singular points: The Euler equations, Secondorder equations with regular singular points.	15	1
Module 4	The Bessel equation, Regular singular points at infinity, Existence and uniqueness ofsolutions: The method of successive approximations, The Lipschitz condition of the successive approximation. Convergence of the successive approximation. Existence and Uniqueness ofsolutions to systems, Existence and Uniqueness for linear systems, Equ. of order n.	15	1
Module 5	Examples, Seminars, Group Discussion on above units, Oral examinations.	15	1

References Books:-

1) Coddington E.A. and Levinson: Theory of ordinary differential equations McGraw Hill,New York(1955)
2) Rainvills E.D.,Elementary differential equations,The Macmillan comp., New York. (1964)

M.Sc. Mathematics Part – I CBCS
Semester - I
Classical Mechanics (CP-1174A)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Analyze motion of system of particles through Lagrangian & Hamiltonian principles.
CO2: Apply principle of variation of calculus for extremization of problem.
CO3: Study motion of rigid body.
CO4: Lagrangian and Hamiltonian formulation of Classical Mechanics.

Unit	Syllabus	Lectures/ Teaching Hours	Credits
Module 1	Mechanics of a particle, Mechanics of a system of particles, conservation theorems,constraints, Generalised coordinates, D' Alembert's Principle, Lagrange's equations of motion,simple applications of Lagrangian formulation, Kinetic energy as a homogeneous function ofgeneralised velocities, Non-conservation of total energy due to the existence of non-conservativeforces. Cyclic co-ordinates and generalised momentum, conservation theorems.	15	1
Module 2	Functional, basic lemma in calculus of variations, Euler-Lagrange's equations, firstintegrals of Euler- Lagrange's equations, the case of several dependent variables Undeterminedend conditions, Geodesics in a plane and space, the minimum surface of revolution, the problemof Brachistochrone, Isoperimetric problems, problem of maximum enclosed area. Hamilton's Principle, Derivation of Hamilton's principle from D'Alembert's principle, Lagrange'sequations of motion from Hamilton's principle. Lagrange's equations of motion for non conservative systems (Method of Langrange's undetermined multipliers)	15	1
Module 3	Hamiltonian function, Hamilton's canonical equations of motion, Derivation of Hamilton's equations from variational principle, Physical significance of Hamiltonian, theprinciple of least action, cyclic co-ordinates and Routh's procedure. Orthogonal transformations, Properties of transformation matrix, infinitesimal rotations.	15	1
Module 4	The Kinematics of rigid body motion: The independent co-ordinates of a rigid body, the Eulerian angles, Euler's theorem on motion of rigid body, Angular momentum and kineticenergy of a rigid body with	15	1

	one point fixed,the inertia tensor and moment of inertia, Euler's equations of motion, Cayley- Klein parameters, Matrix of transformation in Cayley-Klein parameters, Relations between Eulerian angles and Cayley- Klein parameters.		
Module 5	Examples, Seminars, Group Discussion on above units, Oral examinations	15	1

Reference Books:

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.

M.Sc. Mathematics Part – I CBCS
Semester - II
Linear Algebra (CP-1175B)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Understand basic notions in linear algebra and use the results in developing advanced mathematics.

CO2: Study the properties of vector spaces, linear transformations, algebra of linear transformations and inner product spaces in detail

CO3: Construct canonical forms and bilinear forms.

CO4: Apply knowledge of vector space, linear transformations, canonical forms and bilinear transformations.

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credi ts**
Module 1	Direct sum of a vector space, Dual Spaces, Annihilator of a subspace, Quotient Spaces,Algebra of Linear transformations.	15	1
Module 2	Adjoint of a linear transformation, Inner product spaces, Eigen values and eigenvectors of a linear transformation, Diagonalization, Invariant subspaces.	15	1
Module 3	Canonical forms, Similarity of linear transformations, Reduction to triangular forms, Nilpotent transformations, Primary decomposition theorem, Jordan blocks and Jordan forms, Invariants of linear transformations.	15	1
Module 4	Hermitian, Self adjoint, Unitary and normal linear transformation, Symmetric bilinearforms, skew symmetric bilinear forms, Group preserving bilinear forms.	15	1
Module 5	Examples, Seminars, Group Discussion on above units, Oral examinations	15	1

Reference Books:

1. Rao A. R. and Bhimashankaran P., Linear Algebra, Hidustan Book Agency (200)
2. Singh Surjit, Linear Algebra, Vikas publishing House (1997)

M.Sc. Mathematics Part – I CBCS

Semester - II

Integral Equations (CP-1176B)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Solve linear Volterra and Fredholm integral equations using appropriate methods.

CO2: Understand the relationship between integral and differential equations and transform one type into another

CO3: Find out the iterate kernel and Resolvent kernel of Volterra, Fredholm integral equation.

CO4: Formulate and solve initial and boundary value problems for the heat and wave equations in spherical and cylindrical coordinates.

Unit	Syllabus	Lectures/ Teaching Hours	Credits
Module 1	Classification of linear integral equations, Conversion of initial value problem toVolterra integral equation, Conversion of boundary value problem to Fredholm integral equation,Separable kernel, Fredholm integral equation with separable kernel, Fredholm alternative. Homogeneous Fredholm equations and eigen functions.	15	1
Module 2	Solutions of Fredholm integral equations by: Successive approximations Method, Successive substitution Method, Adomian decomposition method, Modified decomposition method, Resolvent kernel of Fredholm equations and its properties, Solutions of Volterra integral equations: Successive approximations method, Neumann series, Successive substitution Method	15	1
Module 3	Solution of Volterra integral equations by Adomian decomposition method, and themodified decomposition method, Resolvent kernel of Volterra equations and its properties,Convolution type kernels, Applications of Laplace and Fourier transforms to solutions ofVolterra integral equations, Symmetric Kernels: Fundamental properties of eigenvalues andeigenfunctions for symmetric kernels, expansion in eigenfunctions & bilinear form.	15	1
Module 4	Hilbert Schmidt Theorem and its consequences, Solution of symmetric integral equations, Operator method in the theory of integral equations, Solution of Volterra and Fredholm integrodifferential equations by Adomian decomposition method,	15	1

	Green's function:Definition, Construction of Green's function & its use in solving boundary value problem.		
Module 5	Examples, Seminars, Group Discussion on above units, Oral examinations	15	1

Reference Books:

1) Chambers L.G., Integral Equations-A Short Course, International Text Book Comp., 1976.
2) Krasnov M.A., et.al. Problems and exercises in Integral equations, Mir Publishers, 1971.
3) Cochran J.A., The Analysis of Linear Integral Equations, Mc Graw Hill Publications,1972.
4) Green C.D., Integral Equation Methods, Thomas Nelson and sons, 1969.

M.Sc. Mathematics Part – I CBCS

Semester - II

General Topology (CP-1177B)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Find different topologies on a given set and study their properties.

CO2: Check continuity of functions through different topological approaches

CO3: The student is able to apply his or her knowledge of general topology to formulate and solve problems of a topological nature in mathematics and other fields where topological issues arise.

CO4: To acquaint students with homeomorphism and some topological properties like connectedness, compactness

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credits**
Module 1	Topological spaces, Examples, Limit points, Closed sets and closure, Interior, exterior, Neighborhoods, Different ways of defining topologies , Bases, Subbases, Subspaces of topological space. Hereditary properties	15	1
Module 2	Connected Spaces, Components, Connected subspaces of real lines, Compact Spaces, One point compactification, Continuous Functions, Homeomorphisms, Topological properties.	15	1
Module 3	Separation axioms: To, T1, T2-spaces, First and second axioms spaces, Separable Spaces, Lindelof spaces, Regular and T3 -Spaces, Normal and T4-Spaces.	15	1
Module 4	Completely Regular and T3 1/2-Spaces , Completely Normal and T5 -Spaces , Product Spaces (ForTo, T1, T2, -compact, and connected spaces), Urysohn lemma and Urysohn metrization theorem.	15	1
Module 5	Examples, Problems, assignments, seminars etc. based on units I to IV above.	15	1

Reference Books:

1) Munkers J. R., Topology: A First Course, Prentice Hall of India Pvt. Ltd.
2) Simmons G. F., Introduction to Topology and Modern Analysis, Mc Graw Hill BookCompany, New Delhi, 1963.
3) Joshi K. D., General Topology.
4) Willard, Topology, Academic press.

M.Sc. Mathematics Part – I CBCS
Semester - II
Partial Differential Equations (CP-1178B)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Classify given second order partial differential equations.

CO2: Use different method to solve boundary value problem specially use wave equations, Heat equations.

CO3**:** Understand what are well-posed initial (and/or boundary) value problems for classical PDEs such as the wave equation, the Laplace equation and the heat (diffusion) equation

CO4: Technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credits**
Module 1	Curves and surfaces, First order Partial Differential Equations, , classification of first order partial differential equations, classifications of Integrals, Linear equations of first order. Pfaffian differential equations, Criteria of Integrability of a Pfaffian differential equation. Compatible systems of first order partial differential equations.	15	1
Module 2	Charpits method, Jacobi method of solving partial differential equations, Cauchy Problem, Integral surfaces through a given curve for a linear partial differential equations, for a non-linear partial differential equations, Method of characteristics to find the integral surface of aquasi linear partial differential equations.	15	1
Module 3	Second order Partial Differential Equations. Origin of Partial differential equation, wave equations, Heat equation. Classification of second order partial differential equation. Vibration of an infinite string (both ends are not fixed) Physical Meaning of the solution of the wave equation. Vibration of an semi infinite string, Vibration of a string of finite length, Method of separation of variables, Uniqueness of solution of wave equation. Heat conduction Problems with finite rod and infinite rod, Cauchy problems	15	1
Module 4	Families to equipotential surfaces, Laplace equation,	15	1

	Solution of Laplace equation, Laplace equation in polar form, Laplace equation in spherical polar coordinates. Kelvin's inversion theorem. Boundary Value Problems: Dirichlets problems and Neumann problems. maximum and minimum principles, Stability theorem		
Module 5	Examples, Problems, assignments, seminars etc. based on units I to IV above.	15	1

Reference Books:

1) Sneddon I. N.,: Elements of Partial Differential Equations, McGraw Hill Int.
2) Frite John: Partial Differential Equations

M.Sc. Mathematics Part – I CBCS
Semester - II
Numerical Analysis (CP-1179B)

Theory: 60Hour **Credits -05**

Course Outcomes: After the completion of the course the student will be able to -

CO1: Solve linear and non-linear equations by various numerical methods

CO2: Find numerical integrations along with error computations.

CO3: Solve initial value problems by different numerical methods.

CO4: Find rate of convergence of various numerical methods.

Unit	**Syllabus**	**Lectures/ Teaching Hours**	**Credits**
Module 1	Rate of convergence of Secant Method, Regula -Falsi Method and Newton-Raphson Method. Bairstow method, Matrix factorization methods (Doo little reduction, Crout reduction) Eigen Values and eigenvectors, Gerschgorin theorem, Breuer theorem, Jacobi Method for symmetric matrices.	15	1
Module 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	1
Module 3	Runge – Kutta Method: second order methods, the coefficient tableau, third ordermethods (without proof), order conditions, Fourth order methods (without proof), ImplicitRunge- kutta methods, Stability characteristics, Taylor Series Methods: Introduction to Taylorseries methods, Manipulation of Power Series, an example of a Taylor series solution.	15	1
Module 4	Linear multistep methods: Adams Methods, General form of linear multistep methods, Predictor- corrector Adams methods, Starting Methods , Analysis of linear multistep methods: Convergence, consistency, sufficient condition for convergence, Stability characteristics.	15	1
Module 5	Examples, Seminars, Group Discussion on above units, Oral examinations	15	1

Reference Books:

1) Jain M. K.,. Iyengar S. R. K, Jain R. K., 'Numerical methods for scientific and Engineering Computation', New Age International Limited Publishers 1993.(For Unit 1and Unit 2).
2) Butcher J.C., Numerical Methods for Ordinary Differential equations, John Wiley andsons Ltd., 2nd Edition. .(For Unit 3 and Unit 4).

SCHEME OF MARKING (THEROY)

Sem.	CP	Marks	Evaluation	Answer Books	Standard of passing
I	CP1170 ATO CP1174 A	90	Semesterwise	As per Instruction	35% (36 marks)
II	CP1175B TO CP1179B	90	Semesterwise	As per Instruction	35% (36 marks)

SCHEME OF MARKING (CIE) Continuous Internal Evaluation

Sem.	**CP**	**Marks**	**Evaluation**	**Sections**	**Answer Books**	**Standard of passing**
I	CP 1170 ATO CP 1174 A	30	Concurrent	-	As per Instruction	35% (12 marks)
II	CP1175 ATO CP1179 A	30	Concurrent	-	As per Instruction	35% (12 marks)

***A separate passing is mandatory**

Nature of Question Paper

Instructions: *1) Questions* ***No. 1*** *is* ***compulsory****.*

2) Attempt any ***four*** *questions from que. no. 2 to que. no. 7.*

3) All questions carry equal marks.

4) Figures to right indicates full marks.

5) Use of log table/calculator is allowed.

Time: 3 hours *Total Marks: 90*

Q. 1. A) Choose correct alternative. (2 Marks each) 08

i)

A) B) C) D)

ii)

A) B) C) D)

iii)

A) B) C) D)

iv)

A) B) C) D)

B) Fill in the blanks. (2 Marks each) 10

Q.2. A) **18**

B)

C)

OR

A) **18**

B)

Q.3. A) **18**

B

)

C

) **18**

OR

A)

B)

Q.4 A) **18**

B)

C)

OR

A) **18**

B)

Q.5. A) **18**

B)

C)

OR

A) **18**

B)

Q.6. A) **18**

B)

C)

OR

A) **18**

B)

Q.7. A) **18**

B)

C)

OR

A) **18**

B)

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REMARK:

Note that the distribution of marks for A, B, C or A, B (Q.N.2 to Q.N.-7)may vary according to the nature of question.