Barrackpore Rastraguru Surendranath College

Teaching Plan

Department of Mathematics

2022-23

NAME OF THE PROGRAMME

B.SC. (HONOURS)INMATHEMATICS

PROGRAMME OUTCOME

After completion of the programme, a student of Department of Mathematics, will be able to

- demonstrate fundamental systematic knowledge of mathematics and its applications in engineering, science, technology and mathematical sciences;
- demonstrate educational skills in areas of analysis, geometry, algebra, mechanics, differential equations, etc;
- apply knowledge, understanding, and skills to identify the difficult/unsolved problems in mathematics and to collect the required information in possible range of sources and try to analyse and evaluate these problems using appropriate methodologies;
- fulfil learning requirements in mathematics, drawing from a range of contemporary research works and their applications in diverse areas of mathematical sciences;
- apply disciplinary knowledge and skills in mathematics in newer domains and uncharted areas;
- identify challenging problems in mathematics and obtain well-defined solutions;
- exhibit subject-specific transferable knowledge in mathematics relevant to job trends and employment opportunities.

Notes:
You can merge cells in between and add students' seminars and class tests / internal assessment.
For incorporating PO / CO at UG level, you may refer to your WBSU CBCS syllabus.
If not there you can refer to the UGC model syllabus
https://www.ugc.ac.in/ugc_notices.aspx?id=MTA3Nw==

<table>
<tr><td colspan="3">Semester</td><td colspan="5">I</td></tr>
<tr><td colspan="2">Course Title</td><td colspan="6">Calculus, Geometry and Ordinary
Differential Equation</td></tr>
<tr><td colspan="2">Course Code</td><td>MTMACOR01T</td><td colspan="2">Credit</td><td colspan="3">6</td></tr>
<tr><td colspan="2">Course Outcome</td><td colspan="6">On completion of the course, a student will be able to
calculate the higher order derivatives and apply them in proper situations;
acquire the concept of asymptotes and envelopes;
calculate limits in indeterminate forms by a repeated use of L'Hospital's rule;
determine concavity and convexity of a function from its graph and from its second derivative;
explain the properties of two and three dimensional shapes; trace a curve;
solve first order ordinary differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.</td></tr>
<tr><td colspan="8">Scheme of Instruction</td></tr>
<tr><td colspan="2">Total Duration</td><td>6 Months</td><td>Class/Week</td><td>6</td><td>Hours/week</td><td colspan="2">6</td></tr>
<tr><td colspan="2">Instruction Mode</td><td colspan="6">Lecture</td></tr>
<tr><td colspan="8">Scheme of Examination</td></tr>
<tr><td colspan="2">Maximum Score</td><td>75</td><td>Internal</td><td>25</td><td>End Semester</td><td colspan="2">50</td></tr>
<tr><td colspan="8">Course Mapping</td></tr>
<tr><td>Units</td><td colspan="3">Course Content</td><td colspan="4">Lecture Hour (Cumulative)</td></tr>
<tr><td>I& II</td><td colspan="3">Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of type</td><td colspan="4">24</td></tr>
</table>

(July)	$e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$. **Assignments & Internal Assessment.**	
Aug.	Concavity and inflection points, envelopes, asymptotes, curve tracing in Cartesian coordinates. **Assignments & Internal Assessment.**	24
Sep.	Tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences. **Assignments & Internal Assessment.**	24
Oct.	Reduction formulae, derivations and illustrations of reduction formulae for the integration of $\sin^n x$, $\cos^n x$. **Assignments & Internal Assessment.**	24
Nov.	Parametrizing a curve, arc length, arc length of parametric curves, area of surface of revolution. **Assignments & Internal Assessment.**	24
Dec.	**Assignments, Internal Assessment, Remedial Classes& Seminar.**	24
III & IV (July)	Reflection properties of conics, translation and rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics. **Assignments & Internal Assessment.**	24
Aug.	Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids. **Assignments & Internal Assessment.**	24
Sep.	Generating lines, classification of quadrics, Illustrations of graphing standard quadric surfaces like	24

	cone, ellipsoid. **Assignments & Internal Assessment.**	
Oct.	Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. **Assignments & Internal Assessment.**	24
Nov.	Exact differential equations and integrating factors, separable equations and equations reducible to this form. **Assignments, Remedial Classes, Seminar & Internal Assessment.**	24
Dec.	linear equation and Bernoulli equations, special integrating factors and transformations. **Assignments, Internal Assessment, Remedial Classes& Seminar.**	24

Semester		**I**	
Course Title	Algebra		
Course Code	MTMACOR02T	**Credit**	**6**
Course Outcome	On completion of the course, a student will be able to • find roots of real or complex polynomials using various methods; • define and recognize relations, equivalence relations, partitions, and functions; • employ De Moivre's theorem in a number of applications to solve numerical problems; • recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank; • find eigen values and corresponding eigenvectors for a square		

	matrix.					
Scheme of Instruction						
Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6	
Instruction Mode	**Lecture**					
Scheme of Examination						
Maximum Score	75	**Internal**	25	**End Semester**	50	
Course Mapping						

Units	Course Content	Lecture Hour (Cumulative)
I & II July	Polar representation of complex numbers, n-th roots of unity, De Moivre's theorem for rational indices and its applications. **Assignments & Internal Assessment.**	24
Aug.	Theory of equations: Relation between roots and coefficients, Transformation of equation, Descartes rule of signs, Cubic (Cardan's method) and biquadratic equations (Ferrari's method). **Assignments & Internal Assessment.**	24
Sep.	Inequality: The inequality involving AM≥GM≥HM, Cauchy-Schwartz inequality, Equivalence relations and partitions. **Assignments & Internal Assessment.**	24
Oct.	Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set. Well-ordering property of positive integers. **Assignments & Internal Assessment.**	24
Nov	Division algorithm, Divisibility and Euclidean algorithm. Congruence relation between integers.	24

	Assignments & Internal Assessment.	
Dec.	Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic. **Assignments, Internal Assessment, Remedial Classes& Seminar.**	24
III &IV July	Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems. **Assignments & Internal Assessment.**	24
Aug.	Applications of linear systems, linear independence.Matrix, inverse of a matrix,characterizations of invertible matrices. **Assignments & Internal Assessment.**	24
Sep.	Characterizations of invertible matricesRank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix. **Assignments & Internal Assessment.**	24
Oct.	Eigen Vectors and Characteristic Equation of a matrix. **Assignments & Internal Assessment.**	24
Nov.	Cayley-Hamilton theorem and its use in finding the inverse of a matrix. **Assignments & Internal Assessment.**	24
Dec.	**Assignments, Internal Assessment, Remedial Classes& Seminar.**	24

Semester		**II**	
Course Title	**Real Analysis**		
Course Code	MTMACOR03T	**Credit**	**6**

Course Outcome	On completion of the course, a student will be able to • describe different properties of the real line R; • define and recognize bounded, convergent, divergent, Cauchy, and monotonic sequences, and calculate limit superior, limit inferior of bounded sequences; • apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Scheme of Instruction

Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				

Scheme of Examination

Maximum Score	75	**Internal**	25	**End Semester**	50

Course Mapping

Units	Course Content	Lecture Hour (Cumulative)
I , II & III (Jan.)	Review of Algebraic and Order Properties of ℝ, ε-neighbourhood of a point in ℝ. Idea of countable sets, uncountable sets and uncountability of ℝ. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets.Suprema and Infima.Completeness Property of ℝand its equivalent properties. **Assignments & Internal Assessment.**	24
Feb.	The Archimedean Property, Density of Rational (and Irrational) numbers in ℝ, Intervals. Limit points of a set, Isolated points, Open set, closed set, derived set,	24

	Illustrations of Bolzano-Weierstrass theorem for sets, compact sets in ℝ, Heine-BorelTheorem. **Assignments & Internal Assessment.**	
March	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, liminf, lim sup. Limit Theorems. Monotone Sequences, Monotone Convergence Theorem, Subsequences, Divergence Criteria. Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. **Assignments & Internal Assessment.**	24
April	Cauchy sequence, Cauchy's Convergence Criterion, Infinite series, convergence and divergence of infinite series, Cauchy Criterion. **Assignments & Internal Assessment.**	24
May	Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test. **Assignments, Remedial classes & Internal Assessment.**	24
June	Alternating series, Leibniz test. Absolute and Conditional convergence. **Assignments, Internal Assessment, Remedial Classes& Seminar.**	24

Semester	**II**
Course Title	**Differential Equation and Vector Calculus**

Course Code	**MTMACOR04T**		**Credit**		**6**

Course Outcome	On completion of the course, a student will be able to • compute exact solutions of solvable first order differential equations and linear differential equations of higher order using various methods; • apply Picard's method of obtaining successive approximations of solutions of first order differential equations, and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations; • describe the concept of a general solution of a linear differential equation of an arbitrary order, and also to obtain them using prescribed methods; • formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines; • do the phase plane analysis; • find the vector triple product and product of four vectors and use it to find the equation of straight lines, planes in vector form.

Scheme of Instruction

Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				

Scheme of Examination

Maximum Score	75	**Internal**	25	**End Semester**	50

Course Mapping

Units	Course Content	Lecture Hour (Cumulative)
I,II,III & IV (Jan)	Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and	24

	applications. **Assignments & Internal Assessment.**	
(Feb)	Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters. **Assignments & Internal Assessment.**	24
March	System of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. **Assignments & Internal Assessment.**	24
April	Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, Equilibrium points, Interpretation of the phase plane. **Assignments & Internal Assessment.**	24
May	Power series solution of a differential equation about an ordinary point, solution about a regular singular point.Triple product, introduction to vector functions. **Assignments & Internal Assessment.**	24
June	Operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions. **Assignments, Internal Assessment, Remedial Classes& Seminar.**	24

<table>
<tr><td colspan="3">Semester</td><td colspan="5">III</td></tr>
<tr><td>Course Title</td><td colspan="7">Theory of Real Functions</td></tr>
<tr><td>Course Code</td><td colspan="2">MTMACOR05T</td><td colspan="2">Credit</td><td colspan="3">6</td></tr>
<tr><td>Course Outcome</td><td colspan="7">Upon completion of this course, the student will be able to understand the basics of Real Functions and improve the logical thinking.</td></tr>
<tr><td colspan="8">Scheme of Instruction</td></tr>
<tr><td>Total Duration</td><td>6 Months</td><td>Class/Week</td><td>6</td><td>Hours/week</td><td colspan="3">6</td></tr>
<tr><td>Instruction Mode</td><td colspan="7">Lecture</td></tr>
<tr><td colspan="8">Scheme of Examination</td></tr>
<tr><td>Maximum Score</td><td>75</td><td>Internal</td><td>25</td><td>End Semester</td><td colspan="3">50</td></tr>
<tr><td colspan="8">Course Mapping</td></tr>
</table>

Units	Course Content	Lecture Hour (Cumulative)
I (July)	Limits of functions (ε - δ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. **Assignments & Internal Assessment.**	24
Aug.	Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity.	24

	Assignments & Internal Assessment.	
Sep.	Algebra of continuous functions, Continuous functions on an interval, intermediate value theorem, location of roots theorem. **Assignments & Internal Assessment.**	24
Oct.	Preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria. **Assignments & Internal Assessment.**	24
Nov.	Uniform continuity theorem. **Assignments & Internal Assessment.**	24
Dec.	**Assignments, Internal Assessment, Remedial Classes& Seminar.**	24
II July	Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. **Assignments & Internal Assessment.**	24
Aug.	Relative extrema, interior extremum, theorem **Assignments & Internal Assessment.**	24
Sep.	Rolle's theorem, Mean value theorem, Intermediate value property of derivatives, Darboux's theorem. **Assignments & Internal Assessment.**	24
Oct.	Mean value theorem, intermediate value property of derivatives, Darboux's theorem. **Assignments & Internal Assessment.**	24

Nov.	Applications of mean value theorem to inequalities and approximation of polynomials. **Assignments & Internal Assessment.**	24
Dec.	**Assignments, Internal Assessment, Remedial Classes& Seminar.**	24
III July	Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder. **Assignments & Internal Assessment.**	24
Aug.	Taylor's theorem with Cauchy's form of remainder. **Assignments & Internal Assessment.**	24
Sep.	Application of Taylor's theorem to convex functions, relative extrema. **Assignments & Internal Assessment.**	24
Oct.	Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions. **Assignments & Internal Assessment.**	24
Nov.	ln(1 + x), 1/ax+b and $(1 + x)^n$. Application of Taylor's theorem to inequalities. **Assignments & Internal Assessment.**	24
Dec.	**Assignments, Internal Assessment, Remedial Classes& Seminar.**	24

Semester		**III**	
Course Title	**Group Theory–I**		
Course Code	**MTMACOR06T**	**Credit**	**6**
Course Outcome	There is a scope, for applying the acquired knowledge of the above		

	methods/ tools of Group Theory-I, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions.

Scheme of Instruction

Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				

Scheme of Examination

Maximum Score	75	**Internal**	25	**End Semester**	50

Course Mapping

Units	Course Content	Lecture Hour (Cumulative)
I to V July	Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups. **Assignments & Internal Assessment.**	24
Aug.	Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. **Assignments & Internal Assessment.**	24
Sep.	Properties of cyclic groups, classification of subgroups of cyclic groups, Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group. **Assignments & Internal Assessment.**	24

Oct.	Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem. **Assignments & Internal Assessment.**	24
Nov	External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. **Assignments & Internal Assessment.**	24
Dec.	Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems. **Assignments & Internal Assessment.**	24

Semester			**III**		
Course Title	**Numerical Methods**				
Course Code	**MTMACOR07T**		**Credit**	**6**	
Course Outcome	After completion of the course, the student is expected to : • understand basic theories of numerical analysis, • formulate and solve numerically problems from different branches of science, • grow insight on computational procedures.				
Scheme of Instruction					
Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture & Practical**				
Scheme of Examination					

Maximum Score	75	**Internal**	25	**End Semester**	50

Course Mapping

Units	**Course Content**	**Lecture Hour (Cumulative)**
I to VI (July)	Algorithms, Convergence, Errors: Relative, Absolute. Round off, Truncation, Transcendental and Polynomial equations: Bisection method. **Assignments & Internal Assessment.**	24
Aug.	Newton's method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods. **Assignments & Internal Assessment.**	24
Sep.	System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis, LU Decomposition. **Assignments & Internal Assessment.**	24
Oct.	Interpolation: Lagrange and Newton's methods, Error bounds, Finite difference operators. Gregory forward and backward difference interpolations.Numerical differentiation: Methods based on interpolations; methods based on finite differences. **Assignments & Internal Assessment.**	24
Nov	Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Weddle's rule, Boole's rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's 1/3rd rule, Gauss quadrature formula. The algebraic eigenvalue problem: Power method.	24

	Assignments & Internal Assessment.	
Dec.	Ordinary Differential Equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four. **Assignments & Internal Assessment.**	24

Semester		**IV**			
Course Title	Riemann Integration and Series of Functions				
Course Code	**MTMACOR08T**	**Credit**	**6**		
Course Outcome	Upon completion of this course, the student will be able to understand the basics of Riemann Integration, Series of functions and improve the logical thinking.				
Scheme of Instruction					
Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				
Scheme of Examination					
Maximum Score	75	**Internal**	25	**End Semester**	50
Course Mapping					

Units	Course Content	Lecture Hour (Cumulative)
I (Jan)	Riemann integration: inequalities of upper and lower sums, Darbaux integration. **Assignments & Internal Assessment.**	24
Feb	Darbaux theorem, Riemann conditions of integrability. **Assignments & Internal Assessment.**	24
Mar	Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions. **Assignments & Internal Assessment.**	24
April	Riemann integrability of monotone and continuous functions, Properties of the Riemann integral. **Assignments & Internal Assessment.**	24
May	Definition and integrability of piecewise continuous and monotone functions. **Assignments & Internal Assessment.**	24
June	Intermediate Value theorem for Integrals, Fundamental theorem of Integral Calculus. **Assignments, Seminar & Internal Assessment.**	24
II & III (Jan)	Improper integrals, Convergence of Beta and Gamma functions. **Assignments & Internal Assessment.**	24
Feb	Pointwise and uniform convergence of sequence of functions. **Assignments & Internal Assessment.**	24

Mar	Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. **Assignments & Internal Assessment.**	24
April	Series of functions, Theorems on the continuity and derivability of the sum function of a series of functions. **Assignments & Internal Assessment.**	24
May	Cauchy criterion for uniform convergence and Weierstrass M-Test. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24
IV & **V**(Jan)	Fourier series: Definition of Fourier coefficients and series. **Assignments & Internal Assessment.**	24
Feb	Reimann Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. **Assignments & Internal Assessment.**	24
Mar	Examples of Fourier expansions and summation results for series. **Assignments & Internal Assessment.**	24
April	Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series. **Assignments & Internal Assessment.**	24
May	Abel's Theorem; Weierstrass Approximation Theorem. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24

Semester	**IV**

Course Title	Multivariate Calculus				
Course Code	**MTMACOR09T**	**Credit**	**6**		
Course Outcome	Upon completion of this course, the student will be able to understand the basics of Multivariate Calculusand improve the logical thinking.				
Scheme of Instruction					
Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				
Scheme of Examination					
Maximum Score	75	**Internal**	25	**End Semester**	50
Course Mapping					

Units	Course Content	Lecture Hour (Cumulative)
I (Jan)	Functions of several variables, limit and continuity of functions of two or more variables Partial differentiation. **Assignments & Internal Assessment.**	24
Feb	Total differentiability and differentiability, sufficient condition for differentiability. **Assignments & Internal Assessment.**	24
March	Chain rule for one and two independent parameters, Directional derivatives the gradient. **Assignments & Internal Assessment.**	24

April	Maximal and normal property of gradient, tangent planes, extreme of functions of two variables. **Assignments & Internal Assessment.**	24
May	Method of Lagrange multipliers, constrained optimization problems. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24
II (Jan)	Double integration over rectangular region, double integration over non-rectangular region. **Assignments & Internal Assessment.**	24
Feb	Double integrals in polar co-ordinates, Triple integrals. **Assignments & Internal Assessment.**	24
March	Triple integral over a parallelepiped and solid regions. **Assignments & Internal Assessment.**	24
April	Volume by triple integrals, , cylindrical and spherical coordinates. **Assignments & Internal Assessment.**	24
May	Change of variables in double integrals and triple integrals. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24
III & IV	Definition of vector field, divergence and curl. **Assignments & Internal Assessment.**	24

Jan		
Feb	Line integrals, Applications of line integrals: Mass and Work. **Assignments & Internal Assessment.**	24
March	Fundamental theorem for line integrals, conservative vector fields, independence. **Assignments & Internal Assessment.**	24
April	Green's theorem, surface integrals, integrals over parametrically defined surfaces. **Assignments & Internal Assessment.**	24
May	Stoke's theorem, The Divergence theorem. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24

Semester		**IV**	
Course Title	**Ring Theory and Linear Algebra I**		
Course Code	**MTMACOR10T**	**Credit**	**6**
Course Outcome	On completion of the course, a student will be able to • describe the fundamental concepts in ring theory such as of the ideals, quotient rings, integral domains, and fields; • demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples; • identify matrices with linear transformations; • compute eigenvalues and eigenvectors of linear transformations.		

Scheme of Instruction					
Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				

Scheme of Examination					
Maximum Score	75	**Internal**	25	**End Semester**	50

Course Mapping

Units	Course Content	Lecture Hour (Cumulative)
I & II Jan	Definition and examples of rings, properties of rings, subrings. **Assignments & Internal Assessment.**	24
Feb	Integral domains and fields, characteristic of a ring. **Assignments & Internal Assessment.**	24
March	Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. **Assignments & Internal Assessment.**	24
April	Ring homomorphisms, properties of ring homomorphisms. **Assignments & Internal Assessment.**	24
May	Isomorphism theorems I, II and III, field of quotients. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24
III &	Vector spaces, subspaces, algebra of subspaces, quotient	24

IV Jan	spaces. **Assignments & Internal Assessment.**	
Feb	linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. **Assignments & Internal Assessment.**	24
March	Introduction to linear transformations, Subspaces, dimension of subspaces, null space, range, rank and nullity of a linear transformation. **Assignments & Internal Assessment.**	24
April	matrix representation of a linear transformation, algebra of linear transformations. **Assignments & Internal Assessment.**	24
May	Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24

	Semester	**V**	
Course Title	**Partial Differential Equations, Applications of Ordinary Differential Equations**		
Course Code	**MTMACOR11T**	**Credit**	**6**

<table>
<tr><td>Course Outcome</td><td colspan="5">At the end of this course a student should be able to :
• learn to solve different types of ODE & PDE,
• test the stability of the solution, formulate and solve problems from allied branches of science.</td></tr>
<tr><td colspan="6">Scheme of Instruction</td></tr>
<tr><td>Total Duration</td><td>6 Months</td><td>Class/Week</td><td>6</td><td>Hours/week</td><td>6</td></tr>
<tr><td>Instruction Mode</td><td colspan="5">Lecture</td></tr>
<tr><td colspan="6">Scheme of Examination</td></tr>
<tr><td>Maximum Score</td><td>75</td><td>Internal</td><td>25</td><td>End Semester</td><td>50</td></tr>
<tr><td colspan="6">Course Mapping</td></tr>
</table>

Units	Course Content	Lecture Hour (Cumulative)
I & II July	Partial Differential Equations – Basic concepts and Definitions. Mathematical Problems. First- Order Equations: Classification. **Assignments & Internal Assessment.**	24
Aug.	Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. **Assignments & Internal Assessment.**	24
Sep.	Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differentialequations.	24

	Assignments & Internal Assessment.	
Oct.	Derivation of Heat equation, Wave equation and Laplace equation. **Assignments & Internal Assessment.**	24
Nov.	Classification of second order linear equations as hyperbolic, parabolic or elliptic. **Assignments & Internal Assessment.**	24
Dec.	Reduction of second order Linear Equations to canonical forms. **Assignments & Internal Assessment.**	24
III & IV July	The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string, Initial Boundary Value Problems. **Assignments & Internal Assessment.**	24
Aug.	Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end. Equations with non-homogeneous, boundary conditions. Non-Homogeneous Wave Equation. **Assignments & Internal Assessment.**	24
Sep.	Method of separation of variables, Solving the Vibrating String Problem. Solving the Heat Conductionproblem. **Assignments & Internal Assessment.**	24
Oct.	Central force. Constrained motion, varying mass, tangent and normal components of acceleration. **Assignments & Internal Assessment.**	24

Nov.	Modelling ballistics and planetary motion, Kepler's secondlaw. **Assignments & Internal Assessment.**	24
Dec.	**Assignment, Seminar, Internal Assessment & Tutorial.**	24

Semester			**V**		
Course Title	**Group Theory II**				
Course Code	**MTMACOR12T**	**Credit**	**6**		
Course Outcome	On completion of the course, a student will be able to • describe inner automorphisms and their properties; • extend group structure to finite permutation groups (Cayley's Theorem); • prove and apply Sylow's Theorems; • generate groups with given specific conditions; • investigate symmetry using group theory.				
Scheme of Instruction					
Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				
Scheme of Examination					
Maximum Score	75	**Internal**	25	**End Semester**	50
Course Mapping					

Units	Course Content	Lecture Hour (Cumulative)
I & II July	Automorphism, inner automorphism, automorphism groups. **Assignments & Internal Assessment.**	24
Aug.	automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. **Assignments & Internal Assessment.**	24
Sep.	Characteristic subgroups, Commutator subgroup and its properties. **Assignments & Internal Assessment.**	24
Oct.	Properties of external direct products, the group of units modulo n as an external direct product, internal direct products. **Assignments & Internal Assessment.**	24
Nov	Fundamental Theorem of finite abelian groups. **Assignments & Internal Assessment.**	24
Dec.	**Assignment, Seminar, Internal Assessment & Tutorial.**	24
III & IV July	Group actions, stabilizers and kernels, permutation representation associated with a given group action. **Assignments & Internal Assessment.**	24
Aug.	Applications of group actions. Generalized Cayley's theorem. Index theorem. **Assignments & Internal Assessment.**	24
Sep.	Groups acting on themselves by conjugation, class	24

	equation and consequences, conjugacy in Sn. **Assignments & Internal Assessment.**	
Oct.	p-groups, Sylow's theorems and consequences, **Assignments & Internal Assessment.**	24
Nov.	Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests. **Assignments & Internal Assessment.**	24
Dec.	**Assignment, Seminar, Internal Assessment & Tutorial.**	24

Semester		**V**	
Course Title	**Linear Programming**		
Course Code	**MTMADSE01T**	**Credit**	**6**
Course Outcome	On completion of the course, a student will be able to • analyse and solve linear programming models of real life situations; • provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points; • apply the simplex method to solve LPP's; • describe the relationships between the primal and dual problems; • describe the applications of transportation, assignment and two-person zero-sum game problems.		
Scheme of Instruction			

Total Duration	6 Months	Class/Week	6	Hours/week	6
Instruction Mode	Lecture				
Scheme of Examination					
Maximum Score	75	Internal	25	End Semester	50
Course Mapping					

Units	Course Content	Lecture Hour (Cumulative)
I,II&III (July)	Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness. **Assignments & Internal Assessment.**	24
Aug.	The simplex algorithm, simplex method in tableau format, introduction toartificial variables, two-phase method. Big-M method and theircomparison. **Assignments & Internal Assessment.**	24
Sep.	Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution. **Assignments & Internal Assessment.**	24
Oct.	Algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. **Assignments & Internal Assessment.**	24

Nov.	Game theory: Formulation of two person zero sum games, solving two person zero sum games. **Assignments & Internal Assessment.**	24
Dec.	Games with mixed strategies, graphical solution procedure, linear programming solution of games. **Assignments & Internal Assessment.**	24

<table>
<tr><td colspan="3">Semester</td><td colspan="3">V</td></tr>
<tr><td>Course Title</td><td colspan="5"></td></tr>
<tr><td>Course Code</td><td colspan="2">MTMADSE02T</td><td colspan="2">Credit</td><td></td></tr>
<tr><td>Course Outcome</td><td colspan="5"></td></tr>
<tr><td colspan="6">Scheme of Instruction</td></tr>
<tr><td>Total Duration</td><td></td><td>Class/Week</td><td></td><td>Hours/week</td><td></td></tr>
<tr><td>Instruction Mode</td><td colspan="5"></td></tr>
<tr><td colspan="6">Scheme of Examination</td></tr>
<tr><td>Maximum Score</td><td></td><td>Internal</td><td></td><td>End Semester</td><td></td></tr>
<tr><td colspan="6">Course Mapping</td></tr>
</table>

Units	Course Content	Lecture Hour (Cumulative)

Semester		**V**	
Course Title	**Probability and Statistics**		
Course Code	MTMADSE03T	**Credit**	**6**
Course Outcome	On completion of the course, a student will be able to • identify distributions in the study of the joint behaviour of two random variables;		

<table>
<tr><td></td><td colspan="5">establish a formulation helping to predict one variable in terms of the other,i.e., correlation and linear regression;
prove and apply central limit theorem.</td></tr>
<tr><td colspan="6">Scheme of Instruction</td></tr>
<tr><td>Total Duration</td><td>6 Months</td><td>Class/Week</td><td>6</td><td>Hours/week</td><td>6</td></tr>
<tr><td>Instruction Mode</td><td colspan="5">Lecture</td></tr>
<tr><td colspan="6">Scheme of Examination</td></tr>
<tr><td>Maximum Score</td><td>75</td><td>Internal</td><td>25</td><td>End Semester</td><td>50</td></tr>
<tr><td colspan="6">Course Mapping</td></tr>
</table>

Units	Course Content	Lecture Hour (Cumulative)
I, II, III &IV (July)	Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution .function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function. **Assignments & Internal Assessment.**	24
Aug.	Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. **Assignments & Internal Assessment.**	24
Sep.	Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations.	24

	Assignments & Internal Assessment.	
Oct.	Independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf)and calculation of covariance (from jmgf), linear regression for twovariables. **Assignments & Internal Assessment.**	24
Nov.	Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central Limit theorem for independent and identically distributed random variables with finite variance. **Assignments & Internal Assessment.**	24
Dec.	Markov Chains, Chapman-Kolmogorov equations, classification ofstates, Random Samples, Sampling Distributions, Estimation of parameters, Testing of hypothesis. **Assignments & Internal Assessment.**	24

Semester		**VI**	
Course Title	Metric Spaces and ComplexAnalysis		
Course Code	MTMACOR13T	**Credit**	**6**
Course Outcome	On completion of the course, a student will be able to • describe several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano-Weierstrass property, compactness, and connectedness; • identify complex numbers as points of R 2 and stereographic projection of complex plane on the Riemann sphere; • describe the differentiability and analyticity of complex functions leading to the CauchyRiemann equations; • apply the Cauchy-Goursat theorem and Cauchy integral formula in		

	evaluation of contour integrals; • apply Liouville's theorem in fundamental theorem of algebra; • evaluate Taylor and Laurent series expansions of analytic functions; • classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

Scheme of Instruction

Total Duration	6 Months	**Class/Week**	6	**Hours/week**	6
Instruction Mode	**Lecture**				

Scheme of Examination

Maximum Score	75	**Internal**	25	**End Semester**	50

Course Mapping

Units	Course Content	Lecture Hour (Cumulative)
I & II Jan	Metric spaces: Definition and examples. Open and closed balls, neighborhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set. **Assignments & Internal Assessment.**	24
Feb	Subspaces, dense sets, separable spaces. Sequences in Metric Spaces, Cauchy sequences. Complete Metric Spaces, Cantor's theorem. **Assignments & Internal Assessment.**	24
March	Continuous mappings, sequential criterion and other characterizations of continuity, Uniform continuity, Connectedness, connected subsets of R. **Assignments & Internal Assessment.**	24

April	Compactness: Sequential compactness, Heine-Borel property, Totally bounded spaces, finite intersection property, and continuous functions on compact sets. **Assignments & Internal Assessment.**	24
May	Homeomorphism, Contraction mappings, Banach Fixed point Theorem and its application to ordinary differential equation. **Assignments & Internal Assessment.**	24
June	**Assignment, Seminar, Internal Assessment & Tutorial.**	24
III, IV, V& VI (Jan)	Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. **Assignments & Internal Assessment.**	24
Feb	Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. **Assignments & Internal Assessment.**	24
March	Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, and definite integrals of functions. **Assignments & Internal Assessment.**	24
April	Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula. **Assignments & Internal Assessment.**	24
May	Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and seriesTaylor series and its examples. **Assignments & Internal Assessment.**	24

June	Laurent series and its examples, absolute and uniform convergence of power series. **Assignments & Internal Assessment.**	24

Semester			**VI**		
Course Title	MTMACOR14T				
Course Code	**Ring Theory and Linear Algebra II**	**Credit**		**6**	
Course Outcome	On completion of the course, a student will be able to • describe polynomial rings, principal ideal domain, Euclidean domain and unique factorization domain, and their relationships; • check reducibility of a polynomial; • describe dual basis and find the connections between dual basis and linear transformations; • describe the concept of minimal polynomial; • develop an idea about inner product space and proceed to normed linear spaces; • use Gram-Schmidt process to find orthogonal set of non-null vectors from any arbitrary set of vectors.				
Scheme of Instruction					
Total Duration	6 months	**Class/Week**	6	**Hours/week**	6
Instruction Mode					
Scheme of Examination					
Maximum Score	75	**Internal**	25	**End Semester**	50
Course Mapping					

Units	**Course Content**	**Lecture Hour (Cumulative)**

I, II & III (Jan)	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials. **Assignments & Internal Assessment.**	24
Feb	Reducibility tests, irreducibility tests, Eisenstein criterion, and unique factorization in Z [x]. Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains. **Assignments & Internal Assessment.**	24
March	Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigen spaces of a linear operator. **Assignments & Internal Assessment.**	24
April	Diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms. **Assignments & Internal Assessment.**	24
May	Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator. **Assignments & Internal Assessment.**	24
June	Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem. **Assignments & Internal Assessment.**	24

<table>
<tr><td colspan="3">Semester</td><td colspan="3">VI</td></tr>
<tr><td>Course Title</td><td colspan="5">Theory of Equations</td></tr>
<tr><td>Course Code</td><td>MTMADSE04T</td><td colspan="2">Credit</td><td colspan="2">6</td></tr>
<tr><td>Course Outcome</td><td colspan="5">The students can able to study of the different methods that can be implied to find out the unknown values and solve a mathematical equation. The most important one is the problem solving strategies you learn by working through them.</td></tr>
<tr><td colspan="6">Scheme of Instruction</td></tr>
<tr><td>Total Duration</td><td>6 Months</td><td>Class/Week</td><td>6</td><td>Hours/week</td><td>6</td></tr>
<tr><td>Instruction Mode</td><td colspan="5">Lecture</td></tr>
<tr><td colspan="6">Scheme of Examination</td></tr>
<tr><td>Maximum Score</td><td>75</td><td>Internal</td><td>25</td><td>End Semester</td><td>50</td></tr>
<tr><td colspan="6">Course Mapping</td></tr>
<tr><td>Units</td><td colspan="3">Course Content</td><td colspan="2">Lecture Hour (Cumulative)</td></tr>
<tr><td>I,II,III &IV
(Jan)</td><td colspan="3">General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials.
Assignments & Internal Assessment.</td><td colspan="2">24</td></tr>
<tr><td>Feb</td><td colspan="3">General properties of equations, Descarte’s rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.
Assignments & Internal Assessment.</td><td colspan="2">24</td></tr>
</table>

March	Symmetric functions. Applications of symmetric function of the roots. Transformation of equations. Solutions of reciprocal and binomial equations. **Assignments & Internal Assessment.**	24
April	Algebraic solutions of the cubic (Cardan's method) and biquadratic (Ferrari's method). Properties of the derived functions. **Assignments & Internal Assessment.**	24
May	Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneousproducts, limits of the roots of equations. **Assignments & Internal Assessment.**	24
June	Separation of the roots of equations, Strums theorem. Applications of Strum's theorem, Conditions for reality of the roots of an equation. Solution of numerical equations. **Assignments & Internal Assessment.**	24

	Semester	**VI**	
Course Title			
Course Code	MTMADSE05T	**Credit**	
Course Outcome			

Scheme of Instruction					
Total Duration		**Class/Week**		**Hours/week**	
Instruction Mode					
Scheme of Examination					
Maximum Score		**Internal**		**End Semester**	
Course Mapping					

Units	Course Content	Lecture Hour (Cumulative)

<table>
<tr><td colspan="3">Semester</td><td colspan="3">VI</td></tr>
<tr><td>Course Title</td><td colspan="5">Mechanics</td></tr>
<tr><td>Course Code</td><td colspan="2">MTMADSE06T</td><td colspan="2">Credit</td><td>6</td></tr>
<tr><td>Course Outcome</td><td colspan="5">On completion of the course, a student will be able to
describe necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body;
determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight;
solve problems about the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles;
learn that a particle moving under a central force describes a plane curve and know the Kepler’s laws of the planetary motions.</td></tr>
<tr><td colspan="6">Scheme of Instruction</td></tr>
<tr><td>Total Duration</td><td>6 Months</td><td>Class/Week</td><td>6</td><td>Hours/week</td><td>6</td></tr>
<tr><td>Instruction Mode</td><td colspan="5">Lecture</td></tr>
<tr><td colspan="6">Scheme of Examination</td></tr>
<tr><td>Maximum Score</td><td>75</td><td>Internal</td><td>25</td><td>End Semester</td><td>50</td></tr>
</table>

Course Mapping		
Units	**Course Content**	**Lecture Hour (Cumulative)**
I, II & III (Jan)	Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Forces in three dimensions. **Assignments & Internal Assessment.**	24
Feb	General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium. **Assignments & Internal Assessment.**	24
March	Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law. **Assignments & Internal Assessment.**	24
April	Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution. **Assignments & Internal Assessment.**	24
May	Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's Principle. Motion about a fixed axis. Compound pendulum. **Assignments & Internal Assessment.**	24
June	Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and	24

	energy. **Assignments & Internal Assessment.**	