

LESSON PLAN

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 1st Semester

PAPER NAME: Calculus & Geometry **PAPER CODE:** MTMMJ-MC-01

NAME OF TEACHER(S): RAKESH SARKAR(R.S.), Dr. TILAK KUMAR PAUL(T.K.P.)

Unit-1

Real-valued functions defined on an interval, limit of a function (Cauchy's definition). Algebra of limits. Continuity of a function at a point and in an interval. Properties of continuous functions(statement only) and its related problems on closed intervals. Hyperbolic functions, higher order derivatives, Leibnitz rule of successive differentiation and its applications to problems of type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$, concavity and inflection points, envelopes, asymptotes

Unit-2

Reduction formulae, derivations and illustrations of reduction formulae of the type integration of $\sin x$, $\cos x$, $\tan x$, $\sec x$, $(\log x)^n$, $\sin x \sin mx$, evaluation of definite integrals, integration as the limit of a sum, concept of improper integration, use of Beta and Gamma functions. parametric equations, parametrizing a curve, arc length, arc length of parametric curves, area of surface of revolution. Techniques of sketching conics..

Unit-3

Reflection properties of conics, translation and rotation of axes and second degree equations, reduction and classification of conics using the discriminant, Point of intersection of two intersecting straight lines. Angle between two lines, Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic. Equations of pair of tangents from an external point, chord of contact, Polar equations of straight lines and conics. Equation of chord joining two points. Equations of tangent and normal.

Unit-4

| Spheres, Cylindrical surfaces, Central conicoids, paraboloids, plane sections of conicoids, Generating lines, reduction and classification of quadrics. | | | |
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| Class | Topic | TEACHER | |
| Lecture 1 | Real-valued functions defined on an interval, limit of a function (Cauchy's definition). | Unit-1 | TKP |
| Lecture 2 | Algebra of limits. Continuity of a function at a point and in an interval. | | |
| Lecture 3 | Acquaintance with the important properties of continuous functions on closed intervals. | | |
| Lecture 4 | Hyperbolic functions, higher order derivatives | | |
| Lecture 5 | Leibnitz rule of successive differentiation | | |
| Lecture 6 | Applications of Leibnitz rule to problems of type $e^{ax} + b \sin x, e^{ax} + b \cos x, (ax+b)^n \sin x, (ax+b)^n \cos x,$ | | |
| Lecture 7 | concavity and inflection points | | |
| Lecture 8 | Envelopes, Asymptotes | | |
| Lecture 9 | Curve tracing in Cartesian coordinates | | |
| Lecture 10 | Curve tracing in polar coordinates of standard curves | | |
| Lecture 11 | L'Hospital's rule, applications in business, economics and life sciences. | | |
| Examination | Class Test-1 (Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | SA | |
| Lecture 12 | Reduction formulae | Unit-2 | RS |
| Lecture 13 | derivations and illustrations of reduction formulae of the type integration of $\sin n x, \cos n x, \tan n x,$ | | |
| Lecture 14 | derivations and illustrations of reduction formulae of the type integration of $\sec n x, (\log x)^n, \sin n x \sin m x,$ | | |
| Lecture 15 | evaluation of definite integrals | | |
| Lecture 16 | integration as the limit of a sum, | | |
| | | January-3 Classes December-3 Classes | |

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| Lecture 17 | concept of improper integration | | RS | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 17 and Assignment-2 | | RS | |
| Lecture 18 | Reflection properties of conics | Unit-3 | TKP | November-5 Classes, September-4 Classes |
| Lecture 19 | translation and rotation of axes | | TKP | |
| Lecture 20 | second degree equations | | TKP | |
| Lecture 21 | reduction and classification of conics using the discriminant-1 | | TKP | |
| Lecture 22 | reduction and classification of conics using the discriminant-2 | | TKP | |
| Lecture 23 | Angle between two lines | | TKP | |
| Lecture 24 | Equation of bisectors | | TKP | |
| Lecture 25 | Equation of two lines joining the origin to the points in which a line meets a conic. | | TKP | |
| Lecture 26 | Equations of pair of tangents from an external point | | TKP | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 18 to Lecturer 26 and Assignment-3 | | TKP | |
| Lecture 27 | Acquaintance of plane in 3D. | Unit-4 | RS | February 2 Classes, January-5 Classes December- 4 Classes |
| Lecture 27 | Acquaintance of straight line in 3D | | RS | |
| Lecture 28 | Spheres | | RS | |
| Lecture 29 | Cylindrical surfaces | | RS | |
| Lecture 30 | Central coincides | | RS | |
| Lecture 31 | paraboloids | | RS | |
| Lecture 32 | plane sections of coincides | | RS | |
| Lecture 33 | Generating lines | | RS | |

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| Lecture 34 | reduction and classification of quadrics-1 | | RS |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 27 to Lecturer 34 and Assignment-4 | | RS |

Graphical Demonstration (Teaching Aid)

1. Plotting of graphs of function e^{ax+b} , $\log(ax + b)$, $\sin(ax + b)$, $\cos(ax + b)$, $|ax + b|$ and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
4. Obtaining surface of revolution of curves.
5. Tracing of conics in Cartesian coordinates/polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using Cartesian coordinates.

Text/Reference Books:

1. S.L. Loney, The Elements of Coordinate Geometry, Macmillan and Co., 1895.
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson, 2005.
3. M.J. Strauss, G.L. Bradley and K.J. Smith, Calculus, 3rd Ed., Pearson Education, 2007.
4. H. Anton, I. Bivens and S. Davis, Calculus, 10th Ed., John Wiley and Sons Inc., 2012.

5. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer, 1989.
6. T.M. Apostol, Calculus (Volumes I & II), John Wiley & Sons, 1967.
7. S. Goldberg, Calculus and mathematical analysis.
8. S. Lang, A First Course in Calculus, Springer 1998.
9. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2nd ed., 2013.
10. R.J.T. Bell, An Elementary Treatise on Coordinate Geometry of Three Dimensions, Macmillan Publishers India Limited, 2000.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 1st Semester

PAPER NAME: Algebra

PAPER CODE: MTMMJ-MC-02

NAME OF TEACHER(S): MD SAHID ALAM(S.A.), POLY KARMAKAR(P.K.)

Unit-1

Polar representation of complex numbers, n -th roots of unity, De Moivre's theorem for rational indices and its applications. Inequality: The inequality involving $AM \geq GM \geq HM$, m^{th} power theorem, Cauchy-Schwartz inequality. Maximum and minimum values of a polynomials.

Unit-2

General properties of equations, Fundamental theorem of classical algebra(statement only) and its application, Transformation of equation, Descarte's rule of signs positive and negative rule, Strum's theorem, Relation between the roots and the coefficients of equations. Symmetric functions. Applications of symmetric function of the roots. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic (Cardon's) and biquadratic (Ferrari's). Properties of

the derived functions.

Unit-3

Equivalence relations and partitions, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set. Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm. Congruence relation between integers. Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Unit-4

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $Ax=b$, solution sets of linear systems, applications of linear systems, linear independence. Real Quadratic Form involving not more than three variables. Characteristic equation of square matrix of order not more than three determination of Eigen Values and Eigen Vectors. Cayley-Hamilton Theorem.

| Class | Topic | TEACHER | |
|-----------|---|---------|---|
| Lecture 1 | Polar representation of complex numbers. | Unit-1 | SA |
| Lecture 2 | De Moivre's theorem for rational indices and its applications. | | SA |
| Lecture 3 | Inequality: The inequality involving $AM \geq GM \geq HM$ | | SA |
| Lecture 4 | m-th power theorem, | | SA |
| Lecture 5 | Cauchy-Schwartz inequality. | | SA |
| Lecture 6 | Maximum and minimum values of a polynomials. | | SA |
| Lecture 7 | General properties of equations | | SA |
| Lecture 8 | Fundamental theorem of classical algebra(statement only) and its application. | | SA |
| | | | November-5 Classes, September-6 Classes |

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| Lecture 9 | Transformation of equation | | SA | |
| Lecture 10 | Descarte's rule of signs positive and negative rule | | SA | |
| Lecture 11 | Strum's theorem, | | SA | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | | SA | |
| Lecture 12 | Relation between the roots and the coefficients of equations. | Unit-2 | SA | January-3 Classes December-3 Classes |
| Lecture 13 | Symmetric functions. Applications of symmetric function of the roots. | | SA | |
| Lecture 14 | Solutions of reciprocal and binomial equations. | | SA | |
| Lecture 15 | Algebraic solutions of the cubic (Cardon's) | | SA | |
| Lecture 16 | Biquadratic (Ferrari's). | | SA | |
| Lecture 17 | Properties of the derived functions | | SA | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 17 and Assignment-2 | | SA | |
| Lecture 18 | Equivalence relations and partitions. | Unit-3 | PK | November-5 Classes, September-4 Classes |
| Lecture 19 | Functions, Composition of functions | | PK | |
| Lecture 20 | Invertible functions, One to one correspondence and cardinality of a set. | | PK | |
| Lecture 21 | Well-ordering property of positive integers, | | PK | |
| Lecture 22 | Division algorithm, | | PK | |
| Lecture 23 | Divisibility and Euclidean algorithm | | PK | |
| Lecture 24 | Congruence relation between integers. | | PK | |
| Lecture 25 | Principles of Mathematical Induction, | | PK | |
| Lecture 26 | statement of Fundamental Theorem of Arithmetic | | PK | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 18 to Lecturer 26 and Assignment-3 | | PK | |

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|--------------------|--|--------|----|--|
| Lecture 27 | Systems of linear equations, | Unit-4 | PK | February 2 Classes, January-5 Classes December- 4 Classes |
| Lecture 27 | Row reduction and echelon forms, vector equations, | | PK | |
| Lecture 28 | The matrix equation $Ax = b$, solution sets of linear systems. | | PK | |
| Lecture 29 | Applications of linear systems, linear independence. | | PK | |
| Lecture 30 | Real Quadratic Form involving not more than three variables | | PK | |
| Lecture 31 | Characteristic equation of square matrix of order not more than three determinations of Eigen Values and Eigen Vectors. | | PK | |
| Lecture 32 | Eigen Values and Eigen Vectors. | | PK | |
| Lecture 33 | Cayley-Hamilton Theorem. | | PK | |
| Lecture 34 | Cayley-Hamilton Theorem. | | PK | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 27 to Lecturer 34 and Assignment-4 | | PK | |

Text/Reference Books:

1. T. Andreescu and D. Andrica, Complex Numbers from A to . . . Z, Birkhauser Boston, 2008.
2. D.C. Lay, S.R. Lay and J.J. McDonald, Linear Algebra and its Applications, 5rd Ed., Pearson,2014.
3. K.B. Dutta, Matrix and linear algebra, Prentice Hall,2004.
4. K. Hoffman and R. Kunze, Linear algebra, Prentice Hall,1971.
5. W.S. Burnstine and A.W. Panton, Theory of equations, Nabu Press,2011.

6. S.H. Friedberg, A.J. Insel and L.E. Spence, Linear Algebra, 4th Ed., PHI, 2004.

7. S. Bernard and J.M. Child, Higher Algebra, Macmillan and Co. 1952.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS (Hons) 1st Semester

PAPER NAME: Algebra & Analytical Geometry

PAPER CODE : MTMMN-MnC-01

NAME OF TEACHER(S): RAKESH SARKAR (R.S.), Dr. TILAK KUMAR PAL (T.K.P.)

Unit-1

Integers, well ordering principle, principle of mathematical induction. Division algorithm ($a = bq + r$, $b \neq 0$, $0 \leq r < b$), greatest common divisor (g.c.d.) of two integers and its simple properties, co-prime integers, Euler's ϕ -function. Prime numbers, Euclid's theorem, fundamental theorem of arithmetic. Complex Numbers: De Moivre's Theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of a^z ($a \neq 0$).

Unit-2

Polynomials with real coefficients, Fundamental Theorem of Algebra (Statement only): The n -th degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occur in pairs). Existence of real roots, Descartes's rule of sign and application of intermediate value theorem. Relation between roots and coefficients, symmetric functions of roots. Cardan's method of solution of a cubic equation.

Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skewsymmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal matrices.

Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants.

Unit-3

Transformations of Rectangular axes : Translation, Rotation and their combinations. Invariants. General equation of second degree in x and y: Reduction to canonical forms. Classification of conic. Pair of straight lines: Condition that the general equation of second degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic.

Unit-4

Equations of pair of tangents from an external point, chord of contact, poles and polars in case of General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal. Three-dimensional coordinate system. Straight line, direction cosine, problems on straight lines. Equation of plane and elementary properties. Sphere and its tangent plane. Right circular cone.

| Class | Topic | TEACHER | |
|------------------|---|---------|--|
| Lecture 1 | Integers, well ordering principle. | Unit-1 | TKP |
| Lecture 2 | Principle of mathematical induction. | | TKP |
| Lecture 3 | Division algorithm ($a=bq+r$, $b \neq 0$, $0 \leq r < b$). | | TKP |
| Lecture 4 | greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers. | | TKP |
| Lecture 5 | Euler's ϕ -function. | | TKP |
| Lecture 6 | Prime numbers. | | TKP |
| Lecture 7 | Euclid's theorem, fundamental theorem of arithmetic. | | TKP |
| Lecture 8 | Complex Numbers: De Moivre's Theorem and its applications. | | TKP |
| Lecture 9 | Applications of De Moivre's Theorem. | | TKP |
| | | | November-5 Classes, September-6 Classes |

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|--------------------|--|--------|-----|---|
| Lecture 10 | Exponential, Sine, Cosine and Logarithm of a complex number. | | TKP | |
| Lecture 11 | Definition of az ($a \neq 0$). | | TKP | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | | TKP | |
| Lecture 12 | Polynomials with real coefficients, Fundamental Theorem of Algebra (Statement only): The n-th degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occur in pairs). | Unit-2 | RS | January-3 Classes December-3 Classes |
| Lecture 13 | Nature of roots of an equation (surd or complex roots occur in pairs). Existence of real roots, Descarte's rule of sign and application of intermediate value theorem. | | RS | |
| Lecture 14 | Relation between roots and coefficients, symmetric functions of roots. Cardan's method of solution of a cubic equation. | | RS | |
| Lecture 15 | Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. | | RS | |
| Lecture 16 | System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skewsymmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal matrices. | | RS | |
| Lecture 17 | Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants. | | RS | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 17 and Assignment-2 | | RS | |
| Lecture 18 | Transformations of Rectangular axes . | Unit-3 | TKP | November-3 Classes, September-4 |
| Lecture 19 | Translation, Rotation and their combinations . | | TKP | |
| Lecture 20 | General equation of second degree in x and y . | | TKP | |
| Lecture 21 | Reduction to canonical forms. | | TKP | |

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|--------------------|---|--------|-----|--|
| Lecture 22 | Classification of conic. | | TKP | |
| Lecture 23 | Pair of straight lines: Condition that the general equation of second degree in x and y may represent two straight lines. | | TKP | |
| Lecture 24 | Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. | | TKP | |
| Lecture 25 | Equation of bisectors. | | TKP | |
| Lecture 26 | Equation of two lines joining the origin to the points in which a line meets a conic. | | TKP | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 18 to Lecturer 26 and Assignment-3 | | TKP | |
| Lecture 27 | Equations of pair of tangents from an external point, chord of contact, poles and polars in case of General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola. | Unit-4 | RS | February 2 Classes, January-5 Classes December-4 Classes |
| Lecture 27 | Polar equation of straight lines and circles. | | RS | |
| Lecture 28 | Polar equation of a conic referred to a focus as pole. | | RS | |
| Lecture 29 | Equation of chord joining two points. | | RS | |
| Lecture 30 | Equations of tangent and normal. | | RS | |
| Lecture 31 | Three-dimensional coordinate system. | | RS | |
| Lecture 32 | Straight line, direction cosine, problems on straight lines. | | RS | |
| Lecture 33 | Equation of plane and elementary properties. | | RS | |
| Lecture 34 | Sphere and its tangent plane. Right circular cone. | | RS | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 27 to Lecturer 34 and Assignment-4 | | | |

Text/Reference Books:

1. S. L. Loney, The Elements of Coordinate Geometry, Macmillan and Co., 1895.
2. S. Bernard and J.M. Child, Higher Algebra, Macmillan and Co., 1952.
3. T. Andreescu and D. Andrica, Complex Numbers from A to...Z, Birkhauser, 2006.
4. D.C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. K.B. Dutta, Matrix and Linear algebra, Prentice-Hall of India Pvt.Ltd., 2004.
6. W.S. Burnside and A.W. Panton, The Theory of equations, Dublin University Press, 1954.
7. R.J.T. Bell, An elementary treatise on coordinate geometry of three dimensions, Macmillan and Co.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 1st Semester

PAPER NAME: Number Theory & Boolean Algebra

PAPER CODE: MTMMJ-SEC-01

NAME OF TEACHER(S): **POLY KARMAKAR(P.K.),MD. SAHID ALAM(S.A.)**

Unit-1

Integers: Principle of Mathematical Induction. Division Algorithm. Representation of integer in an arbitrary base. Prime Integers. Fundamental theorem of Arithmetic. Euclid's Theorem. Linear Diophantine equations.

Congruences: Congruence relation on integers, Basic properties of this relation. Linear Congruence. Chinese Remainder Theorem, System of Linear Congruences.

Unit-2

Application of Congruences: Divisibility test. Computer file, Storage and Hashing functions. Round-Robin Tournaments. Check-digit in an ISBN, Universal Product code, Major Credit Cards. Error detecting capability.

Congruence Classes: Addition and Multiplication of Congruence Classes. Fermat's little Theorem. Euler's Theorem. Wilson's Theorem. Some simple applications.

Unit-3

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

Unit-4

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Logic Gates, switching circuits and applications of switching circuits.

| Class | Topic | TEACHER | |
|------------------|---|---------|--|
| Lecture 1 | Integers: Principle of Mathematical Induction. | Unit-1 | SA |
| Lecture 2 | Division Algorithm. | | SA |
| Lecture 3 | Representation of integer in an arbitrary base. | | SA |
| Lecture 4 | Prime Integers. | | SA |
| Lecture 5 | Fundamental theorem of Arithmetic. | | SA |
| Lecture 6 | Euclid's Theorem. | | SA |
| | | | November-5 Classes, September-6 Classes |

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|--------------------|--|--------|----|--|
| Lecture 7 | Linear Diophantine equations. | | SA | |
| Lecture 8 | Congruences: Congruence relation on integers, Basic properties of this relation. | | SA | |
| Lecture 9 | Linear Congruence. | | SA | |
| Lecture 10 | Chinese Remainder Theorem. | | SA | |
| Lecture 11 | System of Linear Congruences. | | SA | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | | SA | |
| Lecture 12 | Application of Congruences: Divisibility test. Computer file, Storage and Hashing functions. | Unit-2 | SA | January-3 Classes December-3 Classes |
| Lecture 13 | Round-Robin Tournaments. Check-digit in an ISBN, Universal Product code, Major Credit Cards. | | SA | |
| Lecture 14 | Error detecting capability. | | SA | |
| Lecture 15 | Congruence Classes: Addition and Multiplication of Congruence Classes. | | SA | |
| Lecture 16 | Fermat's little Theorem. Euler's Theorem. | | SA | |
| Lecture 17 | Wilson's Theorem. Some simple applications. | | SA | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 17 and Assignment-2 | | SA | |
| Lecture 18 | Definition, examples and basic properties of ordered sets. | Unit-3 | PK | November-5 Classes, September-4 Classes |
| Lecture 19 | Maps between ordered sets. | | PK | |
| Lecture 20 | Duality principle. | | PK | |
| Lecture 21 | Lattices as ordered sets. | | PK | |
| Lecture 22 | Lattices as algebraic structures | | PK | |
| Lecture 23 | Sublattices, products and homomorphisms. | | PK | |

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| Examination | Class Test-3(Tutorial Exam) on Lecturer 18 to Lecturer 26 and Assignment-3 | | PK |
| Lecture 27 | Definition, examples and properties of modular and distributive lattices. | Unit-4 | PK |
| Lecture 27 | Boolean algebras. | | PK |
| Lecture 28 | Boolean polynomials, minimal and maximal forms of Boolean polynomials | | PK |
| Lecture 29 | Quinn-McCluskey method, Kar-naugh diagrams. | | PK |
| Lecture 30 | Logic Gates. | | PK |
| Lecture 31 | Switching circuits and applications of switching circuits. | | PK |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 27 to Lecturer 34 and Assignment-4 | | PK |

Text/Reference Books:

1. B.A. Davey and H.A. Priestley, Introduction to Lattices and Order, Cambridge University Press, 1990.
2. E.G. Goodaire and M.M. Parmenter, Discrete Mathematics with Graph Theory, (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. R. Lidl and G. Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. D.M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.
5. N. Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007

6. G.A. Jones and J.M. Jones, Elementary Number Theory, Springer International Edition.
7. N. Koblitz, A course in number theory and cryptography, Springer-Verlag, 2nd edition.
8. K.H. Rosen, Elementary Number Theory & Its Applications, AT&T Bell Laboratories, Addition-Wesley Publishing Company, 3rd Edition.
9. K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, 2nd edition, Springer-verlag.
10. R.A. Mollin, Advanced Number Theory with Applications, CRC Press, A Chapman & Hall Book.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 2nd Semester

PAPER NAME: Real Analysis-I

PAPER CODE: MTMMJ-MC-03

NAME OF TEACHER(S): POLY KARMAKAR(P.K.),MD. SAHID ALAM(S.A.)

Unit-1

Development of real numbers. The algebraic properties of \mathbb{R} , rational and irrational numbers, the order properties of \mathbb{R} . Absolute value and the real line, bounded and unbounded sets in \mathbb{R} , supremum and infimum, neighbourhood of a point. The completeness property of \mathbb{R} , the Archimedean property, density of rational numbers in \mathbb{R} , nested intervals property, binary representation of real numbers, uncountability of \mathbb{R} . Closed set, open set, closure & interior of a subset of the real line.

Unit-2

Sequences, the limit of a sequence and the notion of convergence, bounded sequences, limit theorems, squeeze theorem, monotone sequences, monotone convergence theorem. Subsequences, monotone subsequence theorem and the Bolzano-Weierstrass theorem, the divergence criterion, limit superior and limit inferior of a sequence, Cauchy sequences, Cauchy's convergence criterion. Infinite series, convergence and divergence of infinite series. Tests for Convergence: Comparison test, root test, ratio test, integral test. Alternating series, absolute and conditional convergence.

Unit-3

Sequential criterion for limits, divergence criteria. Limit theorems, infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation finite intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorems.

Unit-4

Differentiability of a function at a point and in an interval, Caratheodory's theorem, chain rule, derivative of inverse functions, algebra of differentiable functions. Mean value theorems, Rolle's Theorem, Lagrange's mean value theorem. Applications of mean

value theorem to inequalities, relative extreme and approximation of polynomials. The intermediate value property of derivatives, Darboux's theorem. L'Hospital's rule. Taylor's theorem and its application. Expansion of functions.

| Class | Topic | TEACHER | |
|-------------|---|---------|-------------------|
| Lecture 1 | Development of real numbers. The algebraic properties of \mathbb{R} , rational and irrational numbers, the order properties of \mathbb{R} . | P K | March-5 Classes |
| Lecture 2 | Absolute value and the real line, bounded and unbounded sets in \mathbb{R} , supremum and infimum, neighbourhood of a point. | P K | |
| Lecture 3 | The completeness property of \mathbb{R} , the Archimedean property, density of rational numbers in \mathbb{R} . | P K | |
| Lecture 4 | Nested intervals property, binary representation of real numbers. | P K | |
| Lecture 5 | Exercise solve | P K | |
| Lecture 6 | Discussion | P K | |
| Lecture 7 | Uncountability of \mathbb{R} | P K | |
| Lecture 8 | Closed set, open set. | P K | April-6 Classes |
| Lecture 9 | Closure & interior of a subset of the real line. | P K | |
| Lecture 10 | Exercise solve | P K | |
| Lecture 11 | Discussion | P K | |
| Examination | Class Test-1 (Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | PK | |
| Lecture 12 | Sequences, the limit of a sequence and the notion of convergence. | S A | Classes, May-6 |
| Lecture 13 | Bounded sequences, limit theorems, squeeze theorem, monotone sequences, monotone convergence theorem | S A | |

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| Lecture 14 | Subsequences, monotone subsequence theorem | | S A | |
| Lecture 15 | The Bolzano-Weierstrass theorem, the divergence criterion | | S A | |
| Lecture 16 | Limits superior and limit inferior of a sequence | | S A | |
| Lecture 17 | Cauchy sequences, Cauchy's convergence criterion | | S A | |
| Lecture 18 | Infinite series, convergence and divergence of infinite series. | | S A | |
| Lecture 19 | Tests for Convergence: Comparison test | | S A | |
| Lecture 20 | Root test, ratio test, integral test. | | S A | |
| Lecture 21 | Alternating series, absolute and conditional convergence | | S A | |
| Lecture 22 | Exercise solve | | S A | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 22 and Assignment-2 | | SA | |
| Lecture 23 | Sequential criterion for limits | Unit-3 | S A | April-6 Classes, March-5 Classes |
| Lecture 24 | Divergence criteria | | S A | |
| Lecture 25 | Limit theorems, infinite limits and limits at infinity | | S A | |
| Lecture 26 | Continuous functions, | | S A | |
| Lecture 27 | Sequential criterion for continuity and discontinuity. | | S A | |

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|--------------------|--|--------|--------|----------------------------------|
| Lecture 27 | Algebra of continuous functions. | | S A | |
| Lecture 28 | Continuous functions on an interval | | S A | |
| Lecture 29 | Intermediate value theorem, location of roots theorem, | | S A | |
| Lecture 30 | Preservation of intervals theorem. | | S A | |
| Lecture 31 | Uniform continuity | | S A | |
| Lecture 32 | Non-uniform continuity criteria | | S A | |
| Lecture 33 | Uniform continuity theorems. | | S A | |
| Lecture 34 | Exercise solve | | S A | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 23 to Lecturer 34 and Assignment-3 | | SA | |
| Lecture 35 | Differentiability of a function at a point and in an interval, | Unit-4 | P K | June-6 Classes, May-6 Classes |
| Lecture 36 | Caratheodory's theorem, chain rule | | P K | |
| Lecture 37 | Derivative of inverse functions, algebra of differentiable functions. | | P | |

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| Lecture 38 | Mean value theorems | | P K |
| Lecture 39 | Rolle's Theorem, Lagrange's mean value theorem. | | P K |
| Lecture 40 | Applications of mean value theorem to inequalities | | P K |
| Lecture 41 | Relative extremum and approximation of polynomials. | | P K |
| Lecture 42 | The intermediate value property of derivatives | | P K |
| Lecture 43 | Darboux's theorem. L'Hospital's rule. | | P K |
| Lecture 44 | Taylor's theorem and its application. | | P K |
| Lecture 45 | Expansion of functions. | | P K |
| Lecture 46 | Exercise solve | | P K |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 46 and Assignment-4 | | PK |

Graphical Demonstration (Teaching Aid)

1. Plotting of recursive sequences.
2. Study the convergence of sequences through plotting.
3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
4. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
5. Cauchy's root test by plotting n -th roots, Ratio test by plotting the ratio of n -th and $(n + 1)$ -th term.

Text/Reference Books:

1. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., Wiley, 2000.
2. G.G. Bilodeau, P.R. Thie and G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2009.
3. B.S. Thomson, A.M. Bruckner and J.B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian, A First Course in Real Analysis, Springer, 1998.
5. T.M. Apostol, Mathematical Analysis, Narosa, 2002.
6. R. Courant and F. John, Introduction to Calculus and Analysis, Vol I, Springer, 1999.
7. W. Rudin, Principles of Mathematical Analysis, McGraw Hill, 2017.
8. C.C. Pugh, Real Mathematical Analysis, Springer, 2002.
9. T. Tao, Analysis I, Hindustan Book Agency, 2006
10. S. Goldberg, Calculus and mathematical analysis.
11. H.R. Beyer, Calculus and Analysis, Wiley, 2010.
12. S. Lang, Undergraduate Analysis, Springer, 2nd Ed., 1997.
13. A. Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 2nd Semester

PAPER NAME: Abstract Algebra **PAPER CODE:** MTMMJ-MC-04

NAME OF TEACHER(S): RAKESH SARKAR(R.S.),Dr. TILAK KUMAR PAL(T.K.P.)

Unit-1

Definition and examples of groups, elementary properties of groups. Subgroups and examples of subgroups, centralizer, normalizer, center of a group. Properties of cyclic groups, classification of subgroups of cyclic groups. Permutation group, cycle notation for permutations, properties of permutations, even and odd permutations, alternating group. Cosets, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem. Normal subgroup and quotient group.

Unit-2

Group homomorphisms, properties of homomorphisms, properties of isomorphisms. First, Second, and Third isomorphism theorems. External direct product of a finite number of groups, Cauchy's theorem for finite abelian groups. Cayley's theorem.

Unit-3

Definition and examples of rings, elementary properties of rings, subrings, integral domains and fields, characteristic of a ring. Ring homomorphisms, properties of ringhomomorphisms. First Isomorphism theorem. Isomorphism theorems II and III (statement only), field of quotients. Elementary properties of field, Introduction to polynomial ring.

Unit-4

Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

| Class | Topic | TEACHER | |
|-------------|---|---------|-----|
| Lecture 1 | Definition and examples of groups. | Unit-1 | TKP |
| Lecture 2 | Elementary properties of groups. | | |
| Lecture 3 | Subgroups and examples of subgroups. | | |
| Lecture 4 | centralizer, normalizer, center of a group. | | |
| Lecture 5 | Properties of cyclic groups, | | |
| Lecture 6 | classification of subgroups of cyclic groups | | |
| Lecture 7 | Permutation group, cycle notation for permutations, | | |
| Lecture 8 | properties of permutations, even and odd permutations, | | |
| Lecture 9 | alternating group , examples | | |
| Lecture 10 | Cosets, properties of cosets, | | |
| Lecture 11 | Lagrange's theorem and consequences including Fermat's Little theorem. | | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | TKP | |
| Lecture 12 | Normal subgroup and quotient group. | Unit-2 | TKP |
| Lecture 13 | Group homomorphisms, properties of homomorphisms, | | |
| Lecture 14 | properties of isomorphisms. | | |
| Lecture 15 | First isomorphism theorems. | | |
| Lecture 16 | Second isomorphism theorems. | | |
| Lecture 17 | Third isomorphism theorems. | TKP | |

April-6 Classes, March-5 Classes

June-5 Classes, May-6 Classes

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|--------------------|--|--------|-----|-------------------------|
| Lecture 18 | External direct product of a finite number of groups, | | TKP | |
| Lecture 19 | Cauchy's theorem for finite abelian groups. | | TKP | |
| Lecture 20 | Cayley's theorem and its application | | TKP | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 20 and Assignment-2 | | TKP | |
| Lecture 21 | Definition and examples of rings, | Unit-3 | RS | March-5 Classes |
| Lecture 22 | elementary properties of rings, | | RS | |
| Lecture 23 | Subrings, some properties and | | RS | |
| Lecture 24 | Integral domains and properties. | | RS | |
| Lecture 25 | characteristic of a ring | | RS | |
| Lecture 26 | Fields and their properties | | RS | |
| Lecture 27 | Ring homomorphisms, properties of ringhomomorphisms. | | RS | |
| Lecture 27 | First Isomorphism theorem. | Unit-3 | RS | April-6 Classes, |
| Lecture 29 | Isomorphism theorems II and III (statement only), | | RS | |
| Lecture 30 | field of quotients. Elementary properties of field, | | RS | |
| Lecture 31 | Introduction to polynomial ring. | | RS | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 21 to Lecturer 31 and Assignment-3 | | RS | |
| Lecture 32 | Definition of Ideal, example | Unit-4 | RS | June-5 Classes, May- |
| Lecture 33 | ideal generated by a subset of a ring, | | RS | |
| Lecture 34 | factor rings, and its example | | RS | |

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|--------------------|---|--|----|--|
| Lecture 35 | operations on ideals, | | RS | |
| Lecture 36 | Prime and its properties | | RS | |
| Lecture 37 | Definition of maximal ideals and some theorem | | RS | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 37 and Assignment-4 | | RS | |

Text/Reference Books:

1. J.B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. J.A. Gallian, Contemporary Abstract Algebra, 8th Ed., Houghton Mi_in, 2012.
4. J.J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, 1975.
6. D.S. Malik, J.M. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw,Hill, 1996.
7. D.S. Dummit and R.M. Foote, Fundamentals of Abstract Algebra, 3rd Ed., Wiley, 2003.
8. M.K. Sen, S. Ghosh, P. Mukhopadhyay and S.K. Maiti, Topics in Abstract Algebra, 3rd ed. University press, 2019.

PROGRAM NAME: B.Sc. (Honours)

COURSE:MATHEMATICS(Hons) 1st Semester

PAPER NAME: Algebra & Analytical Geometry

PAPER CODE : MTMMN-MnC-02

NAME OF TEACHER(S):RAKESH SARKAR (R.S.), Dr. TILAK KUMAR PAL (T.K.P.)

Unit-1

Integers, well ordering principle, principle of mathematical induction. Division algorithm ($a = bq + r$, $b \neq 0$, $0 \leq r < b$), greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers, Euler's ϕ -function. Prime numbers, Euclid's theorem, fundamental theorem of arithmetic. Complex Numbers: De Moivre's Theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of a^z ($a \neq 0$).

Unit-2

Polynomials with real coefficients, Fundamental Theorem of Algebra (Statement only): The n -th degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occur in pairs). Existence of real roots, Descartes's rule of sign and application of intermediate value theorem. Relation between roots and coefficients, symmetric functions of roots. Cardan's method of solution of a cubic equation.

Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skewsymmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal matrices.

Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants.

Unit-3

Transformations of Rectangular axes : Translation, Rotation and their combinations. Invariants. General equation of second degree in x and y : Reduction to canonical forms. Classification of conic. Pair of straight lines: Condition that the general equation of second degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic.

Unit-4

Equations of pair of tangents from an external point, chord of contact, poles and polars in case of

General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal. Three-dimensional coordinate system. Straight line, direction cosine, problems on straight lines. Equation of plane and elementary properties. Sphere and its tangent plane. Right circular cone.

| Class | Topic | TEACHER | | |
|--------------------|--|---------|-----|---|
| Lecture 1 | Integers, well ordering principle. | Unit-1 | TKP | November-5 Classes, September-6 Classes |
| Lecture 2 | Principle of mathematical induction. | | | |
| Lecture 3 | Division algorithm ($a=bq+r$, $b \neq 0$, $0 \leq r < b$). | | | |
| Lecture 4 | greatest common divisor(g.c.d.) of two integers and its simple properties, co-prime integers. | | | |
| Lecture 5 | Euler's ϕ -function. | | | |
| Lecture 6 | Prime numbers. | | | |
| Lecture 7 | Euclid's theorem, fundamental theorem of arithmetic. | | | |
| Lecture 8 | Complex Numbers: De Moivre's Theorem and its applications. | | | |
| Lecture 9 | Applications of De Moivre's Theorem. | | | |
| Lecture 10 | Exponential, Sine, Cosine and Logarithm of a complex number. | | | |
| Lecture 11 | Definition of a^z ($a \neq 0$). | | | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | TKP | | |
| Lecture 12 | Polynomials with real coefficients, Fundamental Theorem of Algebra (Statement only): The n-th degree polynomial equation has exactly n roots. Nature of roots of an equation (surd or complex roots occur in pairs). | Unit-2 | RS | January-3 Classes December-3 |
| Lecture 13 | Nature of roots of an equation (surd or complex roots occur in pairs). Existence of real roots, Descarte's rule of sign and application of intermediate value theorem. | | | |

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|--------------------|--|--------|-----|---|
| Lecture 14 | Relation between roots and coefficients, symmetric functions of roots. Cardan's method of solution of a cubic equation. | | RS | |
| Lecture 15 | Matrices with real and complex entries. Inverse of a matrix. Elementary row operations and row reduced Echelon matrix. Rank of a matrix. | | RS | |
| Lecture 16 | System of linear equation, consistency and inconsistency of system of linear equation, solution of system of linear equations. Symmetric, skewsymmetric, Hermitian, Skew-Hermitian, Unitary and orthogonal matrices. | | RS | |
| Lecture 17 | Determinant and its basic properties. Laplace expansion of determinant. Singular and non singular matrix, rank of a matrix in terms of determinants. | | RS | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 17 and Assignment-2 | | RS | |
| Lecture 18 | Transformations of Rectangular axes . | Unit-3 | TKP | November-5 Classes, September-4 Classes |
| Lecture 19 | Translation, Rotation and their combinations . | | TKP | |
| Lecture 20 | General equation of second degree in x and y . | | TKP | |
| Lecture 21 | Reduction to canonical forms. | | TKP | |
| Lecture 22 | Classification of conic. | | TKP | |
| Lecture 23 | Pair of straight lines: Condition that the general equation of second degree in x and y may represent two straight lines. | | TKP | |
| Lecture 24 | Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. | | TKP | |
| Lecture 25 | Equation of bisectors. | | TKP | |
| Lecture 26 | Equation of two lines joining the origin to the points in which a line meets a conic. | | TKP | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 18 to Lecturer 26 and Assignment-3 | | TKP | |

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|--------------------|---|--------|----|---|
| Lecture 27 | Equations of pair of tangents from an external point, chord of contact, poles and polars in case of General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola. | Unit-4 | RS | December- January-5 Classes February 2 Classes 4 Classes |
| Lecture 27 | Polar equation of straight lines and circles. | | RS | |
| Lecture 28 | Polar equation of a conic referred to a focus as pole. | | RS | |
| Lecture 29 | Equation of chord joining two points. | | RS | |
| Lecture 30 | Equations of tangent and normal. | | RS | |
| Lecture 31 | Three-dimensional coordinate system. | | RS | |
| Lecture 32 | Straight line, direction cosine, problems on straight lines. | | RS | |
| Lecture 33 | Equation of plane and elementary properties. | | RS | |
| Lecture 34 | Sphere and its tangent plane. Right circular cone. | | RS | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 27 to Lecturer 34 and Assignment-4 | | RS | |

Text/Reference Books:

1. S. L. Loney, The Elements of Coordinate Geometry, Macmillan and Co., 1895.
2. S. Bernard and J.M. Child, Higher Algebra, Macmillan and Co., 1952.
3. T. Andreescu and D. Andrica, Complex Numbers from A to...Z, Birkhauser, 2006.
4. D.C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. K.B. Dutta, Matrix and Linear algebra, Prentice-Hall of India Pvt.Ltd., 2004.

6. W.S. Burnside and A.W. Panton, The Theory of equations, Dublin University Press, 1954.
7. R.J.T. Bell, An elementary treatise on coordinate geometry of three dimensions, Macmillan and Co.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 2nd Semester

PAPER NAME: Set Theory

PAPER CODE: MTMMJ-SEC-02

NAME OF TEACHER(S): Dr. TILAK KUMAR PAL (T.K.P.), MD SAHID ALAM(S.A.)

Unit-1

Sets, subsets, Set operations, The laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

Unit-2

Difference and Symmetric difference of two sets. Set identities, Generalized unions and intersections. Cardinality of a set, Concept of Countable and Uncountable set.

Unit-3

Relation: Cartesian Product of sets. Composition of relations, Types of relations, Partitions, Equivalence

Relations, Examples of congruence modulo relation and examples in \mathbb{Z} . Binary operations on set, Functions.
Unit-4
 Partial ordering relations, Poset, n-ary relations, Hasse diagram, greatest and least element in a poset. Lattice, distributive lattice.

| Class | Topic | TEACHER | |
|--------------------|---|---------|---|
| Lecture 1 | Sets, subsets, Set operations. | Unit-1 | November-5 Classes, September-6 Classes |
| Lecture 2 | The laws of set theory and Venn diagrams. | | |
| Lecture 3 | Examples of finite and infinite sets. | | |
| Lecture 4 | Finite sets and counting principle. | | |
| Lecture 5 | Empty set, properties of empty set. | | |
| Lecture 6 | Standard set operations. | | |
| Lecture 7 | Classes of sets. | | |
| Lecture 8 | Power set of a set. | | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 8 and Assignment-1 | SA | |
| Lecture 9 | Difference and Symmetric difference of two sets. | Unit-2 | November-5 Classes, December-3 |
| Lecture 10 | Set identities, Generalized unions and intersections. | | |
| Lecture 11 | Cardinality of a set, | | |
| Lecture 12 | Concept of Countable and Uncountable set. | | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 9 to Lecturer 12 and Assignment-2 | SA | |
| Lecture 13 | Relation: Cartesian Product of sets. | Unit-3 | TKP Classes, Septe |
| Lecture 14 | Composition of relations, Types of relations. | | |

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| Lecture 15 | Partitions, Equivalence Relations. | | TKP | |
| Lecture 16 | Examples of congruence modulo relation and examples in Z . | | TKP | |
| Lecture 17 | Binary operations on set, Functions. | | TKP | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 13 to Lecturer 17 and Assignment-3 | | TKP | |
| Lecture 18 | Partial ordering relations. | Unit-4 | TKP | February 2 Classes, January-5 Classes |
| Lecture 19 | Poset, n-ary relations, | | TKP | |
| Lecture 20 | Lattice, distributive lattice. | | TKP | |
| Lecture 21 | Hasse diagram, | | TKP | |
| Lecture 22 | Greatest and least element in a poset. | | TKP | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 18 to Lecturer 22 and Assignment-4 | | TKP | |

Text/Reference Books:

1. R.P. Grimaldi, Discrete and combinatorial mathematics: An Applied Introduction, Pearson Education, 2004.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

PROGRAM NAME: B.Sc. (Honours)
COURSE: MATHEMATICS(Hons) 3rd Semester
PAPER NAME: Real Analysis II **PAPER CODE:** DC05

NAME OF TEACHER(S): MD SAHID ALAM(S.A), POLY KAMAKAR(P.K.)

Unit-1

Properties of monotone functions. Functions of bounded variation, total variation, continuous functions of bounded variation. Curves and paths, rectifiable paths and arc length.

Unit-2

Riemann integration: upper and lower sums, upper and lower integral, definition and conditions of integrability. Riemann integrability of monotone and continuous functions, elementary properties of the Riemann integral. Intermediate Value theorems for Integrals. Fundamental theorem of Integral Calculus, change of variables.

Unit-3

Periodic function, Fourier coefficient & Fourier series, convergence, Bessel's inequality, Parseval's inequality, Dirichlet's condition, example of Fourier series. Improper integrals: Range of integration, finite or infinite. Necessary and sufficient condition for convergence of improper integral. Tests of convergence: Comparison and M-test. Absolute and non-absolute convergence and inter-relations. Statement of Abel's and Dirichlet's test for convergence on the integral of a product. Convergence and working knowledge of Beta and Gamma function and their inter-relation.

Unit-4

Pointwise and uniform convergence of sequence of functions. Theorems on continuity,

differentiability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and differentiability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

| Class | Topic | TEACHER | |
|--------------------|--|---------|------------------|
| Lecture 1 | Properties of monotone functions. | Unit-1 | July-6 Classes |
| Lecture 2 | Functions of bounded variation with examples | | |
| Lecture 3 | Total variation, Calculate total variation | | |
| Lecture 4 | Continuous functions of bounded variation | | |
| Lecture 5 | Curves and paths, | | |
| Lecture 6 | rectifiable paths and arc length | | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 6 and Assignment-1 | SA | |
| Lecture 7 | Riemann integration | Unit-2 | August-9 Classes |
| Lecture 8 | Upper and lower sums, | | |
| Lecture 9 | Upper and lower integral, | | |
| Lecture 10 | Definition and conditions of integrability. | | |
| Lecture 11 | Riemann integrability of monotone and continuous functions, | | |
| Lecture 12 | Elementary properties of the Riemann integral. | | |
| Lecture 13 | Intermediate Value theorems for Integrals. | | |

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| Lecture 14 | Fundamental theorem of Integral Calculus, | | PK | |
| Lecture 15 | Change of variables. | | PK | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 7 to Lecturer 15 and Assignment-2 | | PK | |
| Lecture 16 | Periodic function examples | Unit-3 | SA | November-5 Classes, September -6 Classes |
| Lecture 17 | Fourier coefficient & Fourier series | | SA | |
| Lecture 18 | convergence, Bessel's inequality | | SA | |
| Lecture 19 | Parseval's inequality, Dirichlet's condition, | | SA | |
| Lecture 20 | example of Fourier series. | | SA | |
| Lecture 21 | Necessary and sufficient condition for convergence of improper integral. | | SA | |
| Lecture 22 | Tests of convergence: Comparison and M-test. | | SA | |
| Lecture 23 | Absolute and non-absolute convergence and inter-relations. | | SA | |
| Lecture 24 | Statement of Abel's and Dirichlet's test for convergence on the integral of a product. | | SA | |
| Lecture 25 | Convergence and working knowledge of Beta | | SA | |
| Lecture 26 | Convergence and working knowledge Gamma function and their inter-relation. | | SA | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 16 to Lecturer 26 and Assignment-3 | | SA | |
| Lecture 27 | Pointwise and uniform convergence of sequence of functions. | Unit -4 | PK | Nov emb |

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|--------------------|---|--|----|--------------------|
| Lecture 28 | Theorems on continuity, | | PK | |
| Lecture 29 | differentiability and the limit function of a sequence of functions | | PK | |
| Lecture 30 | Integrability of the limit function of a sequence of functions | | PK | December-6 Classes |
| Lecture 31 | Series of functions; | | PK | |
| Lecture 32 | Theorem of Continuity of the sum function of a series of functions; | | PK | |
| Lecture 33 | differentiability of the sum function of a series of functions; | | PK | |
| Lecture 34 | Cauchy criterion for uniform convergence | | PK | |
| Lecture 35 | Weierstrass M-Test. | | PK | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 35 and Assignment-4 | | PK | |

Reference Books

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
3. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer, 2006.
5. T.M. Apostol, Mathematical Analysis, Narosa Publishing House
6. R. Courant and F. John, Introduction to Calculus and Analysis, Vol II, Springer
7. W. Rudin, Principles of Mathematical Analysis, McGraw Hill, 2017.

8. T. Tao, Analysis II, Hindustan Book Agency, 2006
9. S. Shirali and H.L. Vasudeva, Metric Spaces, Springer, 2006.
10. G.G. Bilodeau , P.R. Thie and G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
11. B.S. Thomson, A.M. Bruckner and J.B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
12. C.C. Pugh, Real Mathematical Analysis, Springer, 2002.
13. H.R. Beyer, Calculus and Analysis, Wiley, 2010.
14. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.
15. S. Goldberg, Calculus and Mathematical Analysis.
16. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
17. S. Lang, Undergraduate Analysis, 2nd Ed., Springer, 1997.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS (Hons) 3rd Semester

PAPER NAME: Linear Algebra **PAPER CODE:** DC06

NAME OF TEACHER(S): POLY KAMAKAR (P.K.)

Unit-1

Definition and examples of vector spaces, subspaces, linear combination of vectors, linear span, linear dependence and independence, bases and dimension.

Unit-2

Linear transformations, null space, range, rank and nullity of a linear transformation,

matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Unit-3

Linear operator and its eigenvalue and eigenvectors, characteristic equation, eigenspace, algebraic and geometric multiplicity of eigenvalues. Diagonalization, conditions for diagonalizability. Invariant subspace and Cayley-Hamilton theorem, simple application of Cayley-Hamilton Theorem.

Unit-4

Inner products and norms, special emphasis on Euclidean spaces. Orthogonal and orthonormal vectors, Gram-Schmidt orthogonalisation process, orthogonal complements. The adjoint of a linear operator, unitary, orthogonal and normal operators.

| Class | Topic | TEACHER | |
|------------------|--|---------|----------------|
| Lecture 1 | Definition and examples of vector spaces | Unit-1 | July-7 Classes |
| Lecture 2 | Subspaces | | |
| Lecture 3 | Linear combination of vectors | | |
| Lecture 4 | Linear span, | | |
| Lecture 5 | Linear dependence and independence | | |
| Lecture 6 | Bases | | |
| Lecture 7 | Dimension | | |
| Lecture 8 | Linear transformations | Unit-1 | August |

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| Lecture 9 | Null space, range | | PK | |
| Lecture 10 | Rank of a linear transformation | | PK | |
| Lecture 11 | Nullity of a linear transformation | | PK | |
| Lecture 12 | Discussion | | PK | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 12 and Assignment-21 | | PK | |
| Lecture 13 | Matrixrepresentationofalineartransformation | Unit-2 | PK | September -6 Classes, August-5 Classes |
| Lecture 14 | Application of matrixrepresentationofalineartransformation | | PK | |
| Lecture 15 | Algebraoflineartransformations | | PK | |
| Lecture 16 | Isomorphisms | | PK | |
| Lecture 17 | Isomorphism theorems, | | PK | |
| Lecture 18 | Invertibility | | PK | |
| Lecture 19 | Isomorphisms | | PK | |
| Lecture 20 | Change of coordinatematrix | | PK | |
| Lecture 21 | Application of change of coordinatematrix | | PK | |
| Lecture 22 | Discussion | | PK | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 22 and Assignment-2 | | PK | |
| Lecture 23 | Linearoperator | Unit-3 | PK | November-9 Classes, October -3 |
| Lecture 24 | Linearoperator's eigenvalue | | PK | |
| Lecture 25 | Linearoperator's eigenvectors | | PK | |

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|--------------------|---|--------|----|--|
| Lecture 26 | Characteristic equation | | PK | |
| Lecture 27 | Eigenspace | | PK | |
| Lecture 27 | Algebraic multiplicity of eigenvalues | | PK | |
| Lecture 28 | Geometric multiplicity of eigenvalues | | PK | |
| Lecture 29 | Diagonalization | | PK | |
| Lecture 30 | Conditions for diagonalizability | | PK | |
| Lecture 31 | Application of diagonalizability | | PK | |
| Lecture 32 | Cayley-Hamilton theorem | | PK | |
| Lecture 33 | Application of Cayley-Hamilton Theorem. | | PK | |
| Lecture 34 | Discussion | | PK | |
| Examination | Class Test-3 (Tutorial Exam) on Lecturer 23 to Lecturer 34 and Assignment-3 | | PK | |
| Lecture 35 | Inner products | Unit-4 | PK | January -2 Classes, December -9 Classes |
| Lecture 36 | Norms | | PK | |
| Lecture 37 | Special emphasis on Euclidean spaces | | PK | |
| Lecture 38 | Orthogonal vectors | | PK | |
| Lecture 39 | Orthonormal vectors | | PK | |
| Lecture 40 | Gram-Schmidt orthogonalisation process | | PK | |
| Lecture 41 | Orthogonal complements | | PK | |

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| Lecture 42 | The adjoint of a linear operator | | PK |
| Lecture 43 | Unitary , Orthogonal operators | | PK |
| Lecture 44 | Normal operators. | | PK |
| Lecture 45 | Discussion | | PK |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 45 and Assignment-4 | | PK |

Reference Books

1. S.H. Friedberg, A.J. Insel and L.E. Spence, Linear Algebra, 4th Ed., PHI,2004.
2. J.B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson,2002.
3. M. Artin, Abstract Algebra, 2nd Ed., Pearson,2011.
4. A.R. Rao and P. Bhimasankaram, Linear Algebra, Hindustan Book Agency,2000.
5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer,2005.
6. G. Strang, Linear Algebra and its Applications, Thomson,2007.
7. S. Kumaresan, Linear Algebra- A Geometric Approach, PHI,1999.
8. K. Hoffman and R.A. Kunze, Linear Algebra, 2nd Ed., PHI,1971.
9. S. Axler, Linear Algebra Done Right, Springer,2014.
10. S.J. Leon, Linear Algebra with Applications, Pearson,2015.
11. J.S. Golan, Foundations of Linear Algebra, Springer,1995.

PROGRAM NAME: B.Sc. (Honours)
COURSE: MATHEMATICS(Hons) 3rd Semester
PAPER NAME: Multivariate Calculus & Vector Calculus **PAPER CODE:** DC07
NAME OF TEACHER(S): RAKESH SARKAR(R.S.), POLY KAMAKAR(P.K.)

Unit-1

Functions of several variables, limit and continuity of functions of two or more variables, directional derivative and partial differentiation, Schwartz's & Young's theorem and Euler's theorem for homogenous function, total differentiability and Jacobian, sufficient condition for differentiability, Mean value theorem, Taylor's theorem, Implicit function theorem (statement only), the gradient, tangent planes. Chain rule for one and two independent parameters. Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Unit-2

Double integration over rectangular region, double integration over non-rectangular region, changing the order of integration. Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

Unit-3

Triple product, introduction to vector fields, operations with vector-valued functions, limits and continuity of vector functions, differentiation of vector valued function, gradient, divergence and curl. Curves and their parameterization, line integration of vector functions, circulation. Surface and volume integration.

Unit-4

Gauss's theorem, Green's theorem, Stoke's theorem and their simple applications.

| Class | Topic | TEACHER |
|-------|-------|---------|
|-------|-------|---------|

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|--------------------|--|--------|----|---|
| Lecture 1 | Functions of several variables | Unit-1 | RS | August-6 Classes, July-6 Classes |
| Lecture 2 | limit of functions of two or more variables | | RS | |
| Lecture 3 | continuity of functions of two or more variables | | RS | |
| Lecture 4 | directional derivative and partial differentiation, | | RS | |
| Lecture 5 | Schwartz's theorem for homogenous function of two variables | | RS | |
| Lecture 6 | Young's theorem and Euler's theorem for homogenous function of two variables | | RS | |
| Lecture 7 | Application of Schwartz's & Young's theorem and Euler's theorem for function of several variables | | RS | |
| Lecture 8 | total differentiability and Jacobian | | RS | |
| Lecture 9 | sufficient condition for differentiability, Mean value theorem | | RS | |
| Lecture 10 | Taylor's theorem, Implicit function theorem(statement only), ∇ , the gradient, tangent planes | | RS | |
| Lecture 11 | Chain rule for one and two independent parameters. | | RS | |
| Lecture 12 | Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems | | RS | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 12 and Assignment-1 | | RS | |
| Lecture 13 | Double integration over rectangular region | Unit-2 | PK | September -6 Classes, August-5 Classes |
| Lecture 14 | double integration over non-rectangular region | | PK | |
| Lecture 15 | changing the order of integration. | | PK | |
| Lecture 16 | Triple integrals | | PK | |
| Lecture 17 | Triple integral over a parallelepiped and solid regions-1 | | PK | |
| Lecture 18 | Triple integral over a parallelepiped and solid regions-2 | | PK | |

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| Lecture 19 | Volume by triple integrals-1 | | PK | |
| Lecture 20 | Volume by triple integrals-2 | | PK | |
| Lecture 21 | cylindrical and spherical co-ordinates | | PK | |
| Lecture 22 | Change of variables in double integrals and triple integrals | | PK | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 22 and Assignment-2 | | PK | |
| Lecture 23 | Scalar and Vector triple product | Unit-3 | RS | November-10 Classes, October -2 Classes |
| Lecture 24 | introduction to vector fields | | RS | |
| Lecture 25 | operations with vector-valued functions | | RS | |
| Lecture 26 | limits and continuity of vector functions | | RS | |
| Lecture 27 | differentiation of vector valued function | | RS | |
| Lecture 27 | Gradient of scalar function, divergence of a vector field | | RS | |
| Lecture 28 | Curl of a vector field | | RS | |
| Lecture 29 | Curves and their parameterization | | RS | |
| Lecture 30 | line integration of vector functions | | RS | |
| Lecture 31 | circulation on a vector field | | RS | |
| Lecture 32 | Surface integration | | RS | |
| Lecture 33 | volume integration | | RS | |
| Lecture 34 | Miscellaneous examples on line, surface and volume integration | | RS | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 23 to Lecturer 34 and Assignment-3 | | RS | |

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|--------------------|---|--------|----|---|
| Lecture 35 | Gauss's theorem | Unit-4 | RS | January -3 Classes, December -8 Classes |
| Lecture 36 | Application of Gauss's theorem | | RS | |
| Lecture 37 | Application of Gauss's theorem | | RS | |
| Lecture 38 | Green's theorem | | RS | |
| Lecture 39 | Application of Green's theorem | Unit-4 | RS | |
| Lecture 40 | Application of Green's theorem | | RS | |
| Lecture 41 | Stoke's theorem | | RS | |
| Lecture 42 | Application of Stoke's theorem | | RS | |
| Lecture 43 | Application of Stoke's theorem | | RS | |
| Lecture 44 | Miscellaneous examples on Gauss's theorem, Green's theorem, Stoke's theorem-1 | | RS | |
| Lecture 45 | Miscellaneous examples on Gauss's theorem, Green's theorem, Stoke's theorem-2 | | RS | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 45 and Assignment-4 | | RS | |

Reference Books

- 18.G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson,2005.
- 19.M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Pearson,2007.
- 20.E.Marsden,A.J.TrombaandA.Weinstein,BasicMultivariableCalculus,Springer,2005.
- 21.J. Stewart, Multivariable Calculus, Concepts and Contexts, 4nd Ed., Cengage Learning, 2009.
- 22.T.M. Apostol, Mathematical Analysis, Narosa,2002.
- 23.S.R. Ghorpade and B.V. Limaye, A Course in Multivariable Calculus and Analysis, Springer,2010.

- 24.R. Courant and F. John, Introduction to Calculus and Analysis (Vol. II), Springer,1999.
- 25.W. Rudin, Principles of Mathematical Analysis, McGraw Hill,2017.
- 26.J.E. Marsden, and A. Tromba, Vector Calculus, W.H. Freeman,1996.
27. T. Tao, Analysis II, Hindustan Book Agency,2006
28. M.R. Spiegel, Schaum's outline: Vector Analysis, McGraw Hill,2017.
29. C.E. Weatherburn, Elementary Vector Analysis: With Application to Geometry and Physics, CBS Ltd.,1926.

PROGRAM NAME: B.Sc. (Honours)

COURSE:MATHEMATICS(Hons) 4th Semester

PAPER NAME: **Differential Equations** **PAPER CODE:** DC08**NAME OF TEACHER(S):** **POLY**
KARMAKAR(P.K.), Dr. TILAK KUMAR PAUL(T.K.P.)

Unit-1

Exact, linear and Bernoulli's equations. Equations not of first degree, Clairaut's equations, singular solution. Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian and its properties. Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters, Eigenvalue problem.

Unit-2

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, 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.

Unit-3

Power series solution of a differential equation about an ordinary point, solution about a regular singular point. Legendre polynomials, Bessel functions of the first kind and their properties.

Unit-4

Partial differential equations, basic concepts and definitions. First-Order Equations: classification, construction and geometrical interpretation. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first-order linear equations. Solution by Lagrange's and Charpit's method.

| Class | Topic | TEACHER | | |
|------------------|--|---------|----|----------------|
| Lecture 1 | Exact equations | Unit-1 | PK | July-7 Classes |
| Lecture 2 | Linear and Bernoulli's equations. | | PK | |
| Lecture 3 | Equations solving not of first degree | | PK | |
| Lecture 4 | Clairaut's equations | | PK | |
| Lecture 5 | Singular solution | | PK | |
| Lecture 6 | Lipschitz condition | | PK | |
| Lecture 7 | Picard's Theorem | | PK | |
| Lecture 8 | General solution of homogeneous equation of second order | Unit-1 | PK | Aug |

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| Lecture 9 | Principle of super position for homogeneous equation | | PK | |
| Lecture 10 | Wronskian and its properties. | | PK | |
| Lecture 11 | Linear homogeneous equations of higher order with constant coefficients | | PK | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | | PK | |
| Lecture 12 | Linear non-homogeneous equations of higher order with constant coefficients | Unit-2 | PK | September-4 Classes, August-9 Classes |
| Lecture 13 | Euler's equation | | PK | |
| Lecture 14 | Method of undetermined coefficients | | PK | |
| Lecture 15 | Method of variation of parameters | | PK | |
| Lecture 16 | Eigenvalueproblem | | PK | |
| Lecture 17 | Systems of linear differential equations, types of linear systems | | PK | |
| Lecture 18 | Differential operators, an operator method for linear systems with constant coefficients | | PK | |
| Lecture 19 | Basic Theory of linear systems in normal form | | PK | |
| Lecture 20 | Homogeneous linear systems with constant coefficients | | PK | |
| Lecture 21 | Two Equations in two unknown functions | | PK | |
| Lecture 22 | Equilibrium points, | | PK | |
| Lecture 23 | Interpretation of the phase plane | | PK | |
| Lecture 24 | Discussion | | PK | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 24 and Assignment-2 | | PK | |

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|--------------------|---|--------|-----|---|
| Lecture 25 | Power series solution of a differential equation | Unit-3 | TKP | September-8 Classes |
| Lecture 26 | Problem solve | | TKP | |
| Lecture 27 | Power series solution of a differential equation about an ordinary point | | TKP | |
| Lecture 27 | Problem solve | | TKP | |
| Lecture 28 | Power series solution of a differential equation about a regular singular point | | TKP | |
| Lecture 29 | Problem solve | | TKP | |
| Lecture 30 | Legendre polynomials | | TKP | |
| Lecture 31 | Problem solve | | TKP | |
| Lecture 32 | Bessel functions of the first kind | Unit-3 | TKP | November-4 Classes |
| Lecture 33 | properties of Bessel functions of the first kind | | TKP | |
| Lecture 34 | Problem solve | | TKP | |
| Lecture 35 | Discussion | | TKP | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 25 to Lecturer 35 and Assignment-3 | | TKP | |
| Lecture 36 | Partial differential equations | Unit-4 | TKP | December-8 Classes, November-3 Classes |
| Lecture 37 | Basic concepts about partial differential equations | | TKP | |
| Lecture 38 | Problem solve | | TKP | |
| Lecture 39 | First- Order partial differential equations | | TKP | |
| Lecture 40 | First- Order Equations: classification | | TKP | |

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| Lecture 41 | First- Order Equations: construction. | TKP |
| Lecture 42 | First- Order Equations: geometrical interpretation. | TKP |
| Lecture 43 | Method of characteristics for obtaining general solution of quasi linear equations | TKP |
| Lecture 44 | Canonical forms of first-order linear equations | TKP |
| Lecture 45 | Solution by Lagrange's method. | TKP |
| Lecture 46 | Solution by Charpit's method. | TKP |
| Lecture 47 | Discussion | TKP |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 47 and Assignment-4 | TKP |

Graphical Demonstration (Teaching Aid)

1. Plotting of family of curves which are solutions of second order differential equation.
2. Plotting of family of curves which are solutions of third order differential equation.

Reference Books

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill, 2017.
2. S.L. Ross, Differential Equations, 3rd Ed., Wiley, 2007.
3. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value Problems Computing and Modeling, Pearson, 2005.
4. M.L. Abel and J.P. Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier, 2004.
5. D. Murray, Introductory Course in Differential Equations, Orient Longman, 2003.
6. W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley, 2009.
7. E.A. Coddington, An Introduction to Ordinary Differential Equations, Dover Publications Inc., 1989.

PROGRAM NAME: B.Sc. (Honours)
COURSE: MATHEMATICS (Hons) 4th Semester

PAPER NAME: Mechanics **PAPER CODE:** DC 09

NAME OF TEACHER(S): MD SAHID ALAM (S.A.)

Mechanics

Unit-1

Coplanar forces in general: Resultant force and resultant couple, Special cases, Varignon's theorem, Necessary and sufficient conditions of equilibrium. Equilibrium equations of the first, second and third kind.

An arbitrary force system in space: Moment of a force about an axis, Varignon's theorem. Resultant force and resultant couple, necessary and sufficient conditions of equilibrium. Equilibrium equations, Reduction to a wrench, Poinot's central axis, intensity and pitch of a wrench, Invariants of a system of forces. Statically determinate and indeterminate problems.

Equilibrium in the presence of sliding Friction force: Contact force between bodies, Coulomb's laws of static Friction and dynamic friction. The angle and cone of friction, the equilibrium region.

Unit-2

Virtual work: Workless constraints- examples, virtual displacements and virtual work. The principle of virtual work, Deductions of the necessary and sufficient conditions of equilibrium of an arbitrary force system in plane and space, acting on a rigid body.

Stability of equilibrium: Conservative force field, energy test of stability, condition of stability of a perfectly rough heavy body lying on a fixed body. Rocking stones.

Unit-3

Kinematics of a particle: Velocity, acceleration, angular velocity, linear and angular momentum. Relative velocity and acceleration. Expressions for velocity and acceleration in case of rectilinear motion and planar motion in Cartesian and polar coordinates, tangential and normal components. Uniform circular motion.

Newton laws of motion and law of gravitation: Space, time, mass, force, inertial reference frame, principle of equivalence and g . Vector equation of motion. Work, power, kinetic energy, conservative forces-potential energy. Existence of potential energy function.

Energy conservation in a conservative field. Stable equilibrium and small oscillations: Approximate equation of motion for small oscillation. Impulsive forces

Unit-4

Problems in particle dynamics: Rectilinear motion in a given force field - vertical motion under uniform gravity, inverse square field, constrained rectilinear motion, vertical motion under gravity in a resisting medium, simple harmonic motion, Damped and forced oscillations, resonance of an oscillating system, motion of elastic strings and springs.

Planar motion of a particle: Motion of a projectile in a resisting medium under gravity, orbits in a central force field, Stability of nearly circular orbits. Motion under the attractive inverse square law, Kepler's laws on planetary motion. Slightly disturbed orbits, motion of artificial satellites. Constrained motion of a particle on smooth and rough curves. Equations of motion referred to a set of rotating axes.

| Class | Topic | TEACHER | | |
|--------------------|---|---------|----|--|
| Lecture 1 | Coplanar forces in general: Resultant force and resultant couple, Special cases. | Unit-1 | RS | August-3 Classes, July-9 Classes |
| Lecture 2 | Coplanar forces, Varignon's theorem. | | SA | |
| Lecture 3 | Necessary and sufficient conditions of equilibrium. | | SA | |
| Lecture 4 | Equilibrium equations of the first, second and third kind. | | SA | |
| Lecture 5 | An arbitrary force system in space: Moment of a force about an axis,. | | SA | |
| Lecture 6 | Varignon's theorem. | | SA | |
| Lecture 7 | Resultant force and resultant couple, necessary and sufficient conditions of equilibrium. | | SA | |
| Lecture 8 | Equilibrium equations. | | SA | |
| Lecture 9 | Reduction to a wrench, Poinsot's central axis, intensity and pitch of a wrench. | | SA | |
| Lecture 10 | Invariants of a system of forces. | | SA | |
| Lecture 11 | Statically determinate and indeterminate problems. | | SA | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | SA | | |
| Lecture 12 | Equilibrium in the presence of sliding Friction force. | Unit-2 | SA | September-3 Classes, August-8 Classes |
| Lecture 13 | Friction force: Contact force between bodies. | | SA | |
| Lecture 14 | Coulomb's laws of static Friction and dynamic friction. | | SA | |
| Lecture 15 | The angle and cone of friction, the equilibrium region. | | SA | |
| Lecture 16 | Virtual work: Workless constraint examples, virtual displacements and virtual work. | | SA | |

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| Lecture 17 | The principle of virtual work. | | SA | |
| Lecture 18 | Deductions of the necessary and sufficient conditions of equilibrium of an arbitrary force system in plane and space, acting on a rigid body. | | SA | |
| Lecture 19 | Virtual work problems. | | SA | |
| Lecture 20 | Virtual work problems. | | SA | |
| Lecture 21 | Stability of equilibrium: Conservative force field. | | SA | |
| Lecture 22 | Energy test of stability. | | SA | |
| Lecture 23 | Condition of stability of a perfectly rough heavy body lying on a fixed body | | SA | |
| Lecture 24 | Rocking stones. | | SA | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 24 and Assignment-2 | | SA | |
| Lecture 25 | Kinematics of a particle: Velocity, acceleration, angular velocity, linear and angular momentum. | Unit-3 | SA | November-4 Classes, September-7 Classes |
| Lecture 26 | Relative velocity and acceleration. | | SA | |
| Lecture 27 | Expressions for velocity and acceleration in case of rectilinear motion and planar motion in Cartesian and polar coordinates, . | | SA | |
| Lecture 27 | Expressions for velocity and acceleration in case of rectilinear motion and planar motion in tangential and normal components. | | SA | |
| Lecture 28 | Uniform circular motion. | | SA | |
| Lecture 29 | Newton laws of motion and law of gravitation: Space, time, mass, force, inertial reference frame, principle of equivalence and g. | | SA | |
| Lecture 30 | Vector equation of motion. Work, power | | SA | |
| Lecture 31 | Kinetic energy. | | SA | |

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|--------------------|---|--------|--------|--------------------|
| Lecture 32 | Conservative forces-potential energy. | | SA | |
| Lecture 33 | Existence of potential energy function. | | SA | |
| Lecture 34 | Energy conservation in a conservative field. | | SA | |
| Lecture 35 | Energy conservation in a conservative field. | | SA | |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 25 to 35 and Assignment-3 | | SA | |
| Lecture 36 | Stable equilibrium and small oscillations: Approximate equation of motion for small oscillation. | Unit-4 | SA | November-9 Classes |
| Lecture 37 | Impulsive forces | | SA | |
| Lecture 38 | Problems in particle dynamics: Rectilinear motion in a given force field - vertical motion under uniform gravity. | | SA | |
| Lecture 39 | Inverse square field, constrained rectilinear motion. | | SA | |
| Lecture 40 | vertical motion under gravity in a resisting medium, | | SA | |
| Lecture 41 | simple harmonic motion. | | SA | |
| Lecture 42 | Damped and forced oscillations | | SA | |
| Lecture 43 | Resonance of an oscillating system, motion of elastic strings and springs. | | SA | |
| Lecture 44 | Planar motion of a particle: Motion of a projectile in a resisting medium under gravity, | | SA | |
| Lecture 45 | orbits in a central force field | | Unit-4 | |
| Lecture 46 | Stability of nearly circular orbits. | SA | | |
| Lecture 47 | Motion under the attractive inverse square law, Kepler's laws on planetary motion.. | SA | | |
| Lecture 48 | Slightly disturbed orbits, motion of artificial satellites. | SA | | |

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| Lecture 49 | Constrained motion of a particle on smooth and rough curves. | | SA |
| Lecture 50 | Equations of motion referred to a set of rotating axes | | SA |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 50 and Assignment-4 | | SA |

Reference Books

1. R.D. Gregory, Classical mechanics, Cambridge University Press,2006.
2. K.R. Symon, Mechanics, Addison Wesley,1971.
3. M.Lunn,AFirstCourseinMechanics,OxfordUniversityPress,1991.
4. J.L.SyngandB.A.Griffith,PrinciplesofMechanics,McgrawHill,1949.
5. T.W.B.Kibble,F.H.Berkshire,ClassicalMechanics,ImperialCollegePress,2004.
6. D.T. Greenwood, Principle of Dynamics, Prentice Hall,1987.
7. F. Chorlton, Textbook of Dynamics, E. Horwood,1983.
8. D. Kleppner and R. Kolenkow, Introduction to Mechanics, Mcgraw Hill,2017.
9. A.P. French, Newtonian Mechanics, Viva Books,2011.
10. S.P. Timoshenko and D.H. Young, Engineering Mechanics, Schaum Outline Series, 4th Ed.,1964.
11. D. Chernilevski, E. Lavrovaand V. Romanov, Mechanics for Engineers, MIRPublishers
12. I.H. Shames and G.K.M. Rao, Engineering Mechanics: Statics and Dynamics, 4th Ed., Pearson,2009.
13. R.C. Hibbeler and A. Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed.,Pearson,Delhi.

14. S.L. Loney, An Elementary Treatise on the Dynamics of Particle and of Rigid Bodies, Loney Press,2007.
15. S.L. Loney, An Elementary Treatise on Statics, Cambridge University Press,2016.
16. R.S. Verma, A Textbook on Statics, Pothishala,1962.
17. A.S. Ramsey, Dynamics (Part I & II), Cambridge University Press,1952.

PROGRAM NAME: B.Sc. (Honours)
COURSE: MATHEMATICS(Hons) 4th Semester

PAPER NAME: Probability & Statistics PAPER CODE: DC10

NAME OF TEACHER(S): RAKESH SARKAR(R.S.)

Unit-1

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, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

Unit-2

Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.

Unit-3

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.

Unit-4

Random Samples, Sampling Distributions. Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample problems of normal populations, confidence intervals for proportions, problems. Testing of hypothesis: Null and alternative hypotheses, the critical and acceptance regions, two types of error, Neyman-Pearson Fundamental Lemma, tests for one sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications.

| Class | Topic | TEACHER | |
|------------|---|---------|------------------|
| Lecture 1 | Sample space | Unit-1 | July-7 Classes |
| Lecture 2 | probability axioms | | |
| Lecture 3 | real random variables (discrete and continuous) | | |
| Lecture 4 | cumulative distribution function | | |
| Lecture 5 | probability mass/density functions | | |
| Lecture 6 | mathematical expectation | | |
| Lecture 7 | moments | | |
| Lecture 8 | moment generating function | Unit-1 | August-5 Classes |
| Lecture 9 | characteristic function | | |
| Lecture 10 | Discrete distributions & continuous distributions | | |
| Lecture 11 | Discrete distributions: uniform distributions | | |

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| Lecture 12 | Discrete distributions: binomial | | RS | |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 12 and Assignment-1 | | RS | |
| Lecture 13 | Discrete distributions: Poisson | Unit-2 | RS | September-3 Classes, August-8 Classes |
| Lecture 14 | Discrete distributions: geometric | | RS | |
| Lecture 15 | Discrete distributions: negativebinomial | | RS | |
| Lecture 16 | Continuousdistributions:uniform | | RS | |
| Lecture 17 | Continuousdistributions:normal | | RS | |
| Lecture 18 | Continuousdistributions:exponential | | RS | |
| Lecture 19 | Joint cumulative distribution function and its properties | | RS | |
| Lecture 20 | Joint probability density functions | | RS | |
| Lecture 21 | Marginal distributions | | RS | |
| Lecture 22 | Conditional distributions | | RS | |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 13 to Lecturer 22 and Assignment-2 | | RS | |
| Lecture 23 | Expectation of function of two random variables | Unit-3 | RS | November-4 Classes, September-7 Classes |
| Lecture 24 | Conditional expectations | | RS | |
| Lecture 25 | Independent random variables | | RS | |
| Lecture 26 | Bivariate normal distribution | | RS | |
| Lecture 27 | Correlation coefficient | | RS | |
| Lecture 27 | Jointmomentgeneratingfunction(jmgf) | | RS | |

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| Lecture 28 | Calculation of covariance (from jmgf), | | RS | |
| Lecture 29 | Linear regression for two variables | | RS | |
| Lecture 30 | Chebyshev's inequality statement | | RS | |
| Lecture 31 | Chebyshev's inequality interpretation of (weak) law of large numbers and strong law of large numbers. | | RS | |
| Lecture 32 | Central Limit theorem for independent identically distributed random variables with finite variance. | | RS | |
| Lecture 33 | Central Limit theorem for identically distributed random variables with finite variance. | | RS | |
| Examination | Class Test-3 (Tutorial Exam) on Lecturer 23 to Lecturer 33 and Assignment-3 | | RS | |
| Lecture 34 | Random Samples, Sampling Distributions | Unit-4 | | December-5 Classes, November-8 Classes |
| Lecture 35 | Estimation: Unbiasedness, consistency | | RS | |
| Lecture 36 | The method of moments and the method of maximum likelihood estimation, | | RS | |
| Lecture 37 | Confidence intervals for parameters in one sample problems of normal populations, | | RS | |
| Lecture 38 | Confidence intervals for proportions, problems. | | RS | |
| Lecture 39 | Testing of hypothesis: Null and alternative hypotheses tests for one sample problems for normal populations, tests for proportions, | | RS | |
| Lecture 40 | The critical and acceptance regions, | | RS | |
| Lecture 41 | Two types of error, Neyman-Pearson Fundamental Lemma, | | RS | |
| Lecture 42 | Tests for one sample problems for normal populations | | RS | |
| Lecture 43 | Tests for proportions | | RS | |
| Lecture 44 | Chi-square goodness of fit test | | RS | |

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| Lecture 45 | Applications of Chi-square goodness of fit test | | RS |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 45 and Assignment-4 | | RS |

Reference Books

1. Miller and M. Miller, John E. Freund's Mathematical Statistics with Applications, 7th Ed., Pearson, 2006.
2. S. Ross, Introduction to Probability Models, 9th Ed., Academic Press, 2007.
3. R.B. Ash, Basic Probability Theory, Dover Publications, 2008.
4. R.V. Hogg, J.W. McKean and A.T. Craig, Introduction to Mathematical Statistics, Pearson, 2007.
5. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, 3rd Ed., McGraw Hill, 2007.
6. Gupta, Groundwork of Mathematical Probability and Statistics, Academic Publisher, 2015.
7. W. Feller, An Introduction to Probability Theory and its Applications, Wiley, 1968.
8. A.P. Baisnab and M. Jas, Elements of Probability and Statistics, McGraw Hill, 1993.
9. V.K. Rohatgi, A.K. Md. E. Saleh, An Introduction to Probability and Statistics, Wiley, 2008.

PROGRAM NAME: B.Sc. (Honours)
COURSE: MATHEMATICS(Hons) 5th Semester

PAPER NAME: **Advanced Analysis on \mathbb{R} & \mathbb{C}** **PAPER CODE:** DC11

NAME OF TEACHER(S): **POLY KARMAKAR(P.K.)**

Unit-1

Metric spaces: Definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, Closed set, closure, subspaces, dense sets, separable spaces.

Unit-2

Sequences and their convergence in metric spaces, Cauchy sequences. Complete Metric Spaces, Cantor's theorem. Continuous mappings, sequential criterion and other characterizations of continuity, uniform continuity. Connectedness and compactness of a metric space.

Unit-3

Limits and continuity of the complex functions. Complex differentiation and the Cauchy-Riemann equations, analytic functions, examples of analytic functions, elementary properties of analytic functions, harmonic function, evaluation of the harmonic conjugate. Complex power series and radius of convergence, complex exponential function, trigonometric functions, hyperbolic functions, complex logarithm and analytic branch of logarithm. Introduction to conformal mapping.

Unit-4

Complex valued function defined on real intervals, curves and paths in the complex plane, parameterization of curves, contour and its elementary properties. Complex line integrals,

Cauchy-Goursat theorem, Cauchy's theorem and its simple application, Cauchy's integral formula. Power series representation of complex functions, Taylor series representation, Laurent series representation.

| Class | Topic | TEACHER |
|-------------|--|---------|
| Lecture 1 | Metrics spaces: Definition and examples | PK |
| Lecture 2 | Open balls | PK |
| Lecture 3 | closed balls | PK |
| Lecture 4 | Neighbourhood, open set | PK |
| Lecture 5 | interior of a set | PK |
| Lecture 6 | Limit point of a set | PK |
| Lecture 7 | Closed set | PK |
| Lecture 8 | closure | PK |
| Lecture 9 | subspaces | PK |
| Lecture 10 | dense sets | PK |
| Lecture 11 | separable spaces | PK |
| Examination | Class Test-1 (Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | PK |
| Lecture 12 | Sequences and their convergence in metric spaces | PK |
| Lecture 13 | Cauchy sequences | PK |

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| Lecture 14 | Complete Metric Spaces | PK |
| Lecture 15 | Cantor's theorem | PK |
| Lecture 16 | Continuous mappings | PK |
| Lecture 17 | sequential criterion of continuity | PK |
| Lecture 18 | other characterizations of continuity | PK |
| Lecture 19 | uniform continuity | PK |
| Lecture 20 | Connectedness of a metric space | PK |
| Lecture 21 | compactness of a metric space. | PK |
| Lecture 22 | Discussion | PK |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 22 and Assignment-2 | PK |
| Lecture 23 | Limits and continuity of the complex functions | PK |
| Lecture 24 | Complex differentiation | PK |
| Lecture 25 | the Cauchy- Riemann equations | PK |
| Lecture 26 | analytic functions, examples of analytic functions | PK |
| Lecture 27 | , elementary properties of analytic functions | PK |
| Lecture 27 | harmonic function | PK |
| Lecture 28 | evaluation of the harmonic conjugate | PK |
| Lecture 29 | Complex power series and radius of convergence | PK |
| Lecture 30 | complex exponential function | PK |

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| Lecture 31 | Complex trigonometric functions | PK |
| Lecture 32 | ,hyper- bolic functions | PK |
| Lecture 33 | complex logarithm | PK |
| Lecture 34 | analytic branch of logarithm | PK |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 23 to Lecturer 34 and Assignment-3 | PK |
| Lecture 35 | Introduction to conformal mapping | PK |
| Lecture 36 | Complex valued function defined on real intervals in the complex plane | PK |
| Lecture 37 | Complex valued function defined on curves in the complex plane | PK |
| Lecture 38 | Complex valued function defined on paths in the complex plane | PK |
| Lecture 39 | Parameterization of curves and its elementary properties. | PK |
| Lecture 40 | Parameterization of contour and its elementary properties. | PK |
| Lecture 41 | Complex line integrals | PK |
| Lecture 42 | Cauchy-Goursat theorem | PK |
| Lecture 43 | Cauchy's theorem and its simple application | PK |
| Lecture 44 | Cauchy's integral formula | PK |
| Lecture 45 | Power series representation of complex functions | PK |
| Lecture 46 | Taylor series representation | PK |
| Lecture 47 | Laurent series representation. | PK |

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| Lecture 48 | Discussion | PK |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 48 and Assignment-4 | PK |

Reference Books

1. S. Shirali and H.L. Vasudeva, Metric Spaces, Springer Verlag, London,2006.
2. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House,2011.

LESSON PLAN 2023-24

3. M.O Searcoid, Metric Spaces, Springer, 2007.
4. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 2004.
5. J.E. Marsden and M.J. Hoffman, Basic Complex Analysis, W.H. Freeman, 1998.
6. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill, 2009.
7. J. Bak and D.J. Newman, Complex Analysis (Undergraduate Texts in Mathematics), 2nd Ed., Springer, 1997.
8. S. Ponnusamy, Foundations of Complex Analysis, Narosa, 2011.
9. E.M. Stein and R. Shakrachi, Complex Analysis, Princeton University Press, 2003.
10. J.B. Conway, Functions of one Complex variable, Narosa, 1996.
11. D. Sarason, Complex Function Theory, Hindustan Book Agency, 2008.
12. V. Karunakaran, Complex Analysis, Alpha Science, 2005.
13. T.W. Gamelin, Complex Analysis, Springer, 2001.
14. A. Kumar and S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
15. K.A. Ross, Elementary Analysis: The Theory of Calculus (Undergraduate Texts in Mathematics), Springer, 2013.
16. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., Wiley, 2002.
17. C.G. Denlinger, Elements of Real Analysis, Jones & Bartlett, 2011.

18. S. Goldberg, Calculus and Mathematical Analysis.

19. T.M. Apostol, Calculus (Vol. I & II), Wiley, 2007

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS (Hons) 5th Semester

PAPER NAME: Numerical Methods & C Programming Language **PAPER CODE:** DC12

NAME OF TEACHER(S): Dr. TILAK KUMAR, RAKESH SARKAR (R.S.)

Unit-1

Errors: Relative, Absolute, Round off, Truncation, Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Convergence of these methods.

Unit-2

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU Decomposition. Finite difference operators. Interpolation: Newton's and Lagrange methods. Error bounds. Central difference interpolation. Numerical differentiation.

Unit-3

Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 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. Approximation: Least square polynomial approximation.

Ordinary Differential Equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

Unit-4

Overview of the C-Programming Languages, Data Type, Constants and Variables, Input and Output, Operators and Expressions, if-else Statement, switch Statement, for Loop, while Loop, do-while Loop, break and continue, functions, array and simple problems.

| Class | Topic | TEACHER |
|-----------|--|---------|
| Lecture 1 | Errors Calculation, Relative, Absolute, | TKP |
| Lecture 2 | Round off, Truncation | TKP |
| Lecture 3 | Transcendental and Polynomial equations | TKP |
| Lecture 4 | Bisection method | TKP |
| Lecture 5 | Solution of Transcendental and Polynomial equations using Bisection method | TKP |
| Lecture 6 | Newton's method and Solution of Transcendental and Polynomial equations | TKP |
| Lecture 7 | Secant method, Regula-falsi method | TKP |
| Lecture 8 | fixed point iteration, Newton-Raphson method | TKP |
| Lecture 9 | Convergence of these methods | TKP |

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| Lecture 10 | Solution of Transcendental and Polynomial equations using Secant method, Regula-falsi method | TKP |
| Lecture 11 | Solution of Transcendental and Polynomial equations using fixed point iteration, Newton-Raphson method | TKP |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | TKP |
| Lecture 12 | System of linear algebraic equations | TKP |
| Lecture 13 | Gaussian Elimination | TKP |
| Lecture 14 | Gauss Jordan methods | TKP |
| Lecture 15 | Solution of System of linear algebraic equations by Gaussian Elimination and Gauss Jordan methods | TKP |
| Lecture 16 | Gauss Jacobi method, Gauss Seidel method | TKP |
| Lecture 17 | Convergence Analysis of Gauss Jacobi method, Gauss Seidel method | TKP |
| Lecture 18 | Solution of System of linear algebraic equations by Gauss Jacobi method, Gauss Seidel method | TKP |
| Lecture 19 | LU Decomposition | TKP |
| Lecture 20 | Finite difference operators | TKP |
| Lecture 21 | . Interpolation: Newton's and Lagrange methods and Error bounds | TKP |
| Lecture 22 | Central difference interpolation. Numerical differentiation | TKP |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 22 and Assignment-2 | TKP |
| Lecture 23 | Numerical Integration: Newton Cotes formula | RS |
| Lecture 24 | Numerical Integration: Trapezoidal rule, Composite Trapezoidal rule | RS |
| Lecture 25 | Numerical Integration: Simpson's 1/3rd rule, Composite Simpson's 1/3rd rule and Simpsons 3/8th rule | RS |
| Lecture 26 | Weddle's rule | RS |
| Lecture 27 | Boole's Rule | RS |
| Lecture 27 | Midpoint rule | RS |
| Lecture 28 | Gauss quadrature formula | RS |
| Lecture 29 | The algebraic eigenvalue problem: Power method | RS |
| Lecture 30 | Approximation: Least square polynomial approximation | RS |
| Lecture 31 | Ordinary Differential Equations: The method of successive approximations | RS |
| Lecture 32 | Euler's method, the modified Euler method | RS |
| Lecture 33 | Runge-Kutta methods of orders two and four | RS |
| Lecture 34 | Numerical solutions of some special types of Ordinary Differential Equations | RS |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 23 to Lecturer 34 and Assignment-3 | RS |
| Lecture 35 | Overview of the C-Programming Languages | RS |

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| Lecture 36 | Data Type | RS |
| Lecture 37 | Constants and Variables | RS |
| Lecture 38 | Input and Output | RS |
| Lecture 39 | Operators and Expressions | RS |
| Lecture 40 | if-else Statement, nested if-else Statement | RS |
| Lecture 41 | Some applications of if-else Statement and nested if-else Statement | RS |
| Lecture 42 | switch Statement | RS |
| Lecture 43 | for Loop | RS |
| Lecture 44 | while Loop, do-while Loop | RS |
| Lecture 45 | break and continue | RS |
| Lecture 46 | functions | RS |
| Lecture 47 | array and simple problems | |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 46 and Assignment-4 | RS |

Reference Books

1. K.E. Atkinson, An Introduction to Numerical Analysis, John Wiley and Sons, 1978.
2. B.W. Kernighan and D. Ritchie, The C Programming Language, Prentice Hall, 1988.
3. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, 2007.
5. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
6. U.M. Ascher and C. Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
7. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.
8. J.B. Scarborough, Numerical Mathematical Analysis, Oxford and IBH, 2005.
9. H. Schildt, The Complete Reference: C, McGraw Hill, 2017.
10. G. David, Head First C, Shroff, 2012.
11. S. Prata, C Primer Plus, Sams, 2004.
12. C. Xavier, C Language and Numerical Methods, New Age International, 2007.
13. B. Gottfried, Programming with C, McGraw Hill, 2017.
14. E. Balaguruswamy, Programming in ANSI C, McGraw Hill, 2017.
15. F.J. Scheid, Computers and Programming, McGraw-Hill, 1982.

16. T. Jeyapoovan, A First Course in Programming With C, Vikas Publication House, 2004.

17. Y. Kanetkar, Let Us C, BPB Publications, 2016.

PAPER NAME: Advanced Algebra PAPER CODE: MATH-H-DSE1(1)

NAME OF TEACHER(S): MD SAHID ALAM(S.A)

Advanced Algebra

Unit-1

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.

Unit-2

Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions. Generalized Cayley's theorem. Index theorem.

Unit-3

Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n , p -groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.

Unit-4

Polynomial ring over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, and unique factorization in $\mathbb{Z}[x]$. Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains.

| Class | Topic | TEACHER |
|-----------|--|---------|
| Lecture 1 | Automorphism | RS |
| Lecture 2 | Automorphism, inner automorphism | RS |
| Lecture 3 | automorphism groups | RS |
| Lecture 4 | automorphism groups of finite | SA |
| Lecture 5 | automorphism groups of infinite | SA |
| Lecture 6 | applications of factor groups to automorphism groups | SA |
| Lecture 7 | Characteristic subgroups. | SA |
| Lecture 8 | Commutator subgroup and its properties. | SA |

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| Lecture 9 | Commutator subgroup and its properties. REVISION | SA |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 09 and Assignment-1 | SA |
| Lecture 10 | External direct products | SA |
| Lecture 11 | Properties of external direct products. | SA |
| Lecture 12 | The group of units modulo n as an external direct product. | SA |
| Lecture 13 | Internal direct products. | SA |
| Lecture 14 | Fundamental Theorem of finite abelian groups. | SA |
| Lecture 15 | Group actions. | SA |
| Lecture 16 | Stabilizers and kernels. | SA |
| Lecture 17 | Permutation representation associated with a given group action. | SA |
| Lecture 18 | Applications of group actions. | SA |
| Lecture 19 | Generalized Cayleys theorem. | SA |
| Lecture 20 | Index theorem. | SA |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 20 and Assignment-2 | SA |
| Lecture 21 | Groups acting on themselves by conjugation. | SA |
| Lecture 22 | Class equation and consequences. | SA |
| Lecture 23 | Conjugacy in S_n . | SA |
| Lecture 24 | P-groups. | SA |
| Lecture 25 | Sylow's theorems and consequences. | SA |
| Lecture 26 | Cauchys theorem. | SA |
| Lecture 27 | Simplicity of A_n for $n \geq 5$. | SA |
| Lecture 27 | Simplicity of A_n for $n \geq 5$, non-simplicity tests. | SA |
| Lecture 28 | Polynomial rings over commutative rings. | SA |
| Lecture 29 | Division algorithm and consequences. | SA |
| Lecture 30 | Principal ideal domains. | SA |
| Lecture 31 | Factorization of polynomials. | SA |
| Lecture 32 | Principal ideal domains, factorization of polynomials . | SA |
| Lecture 33 | Reducibility tests, irreducibility tests. | SA |
| Lecture 34 | Eisenstein criterion. | SA |

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| Lecture 35 | Unique factorization in $\mathbb{Z}[x]$. | SA |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 21 to Lecturer 35 and Assignment-3 | SA |
| Lecture 36 | Divisibility in integral domains. | SA |
| Lecture 37 | Irreducible. | SA |
| Lecture 38 | Primes. | |
| Lecture 39 | Unique factorization domains. | SA |
| Lecture 40 | Euclidean domains. | SA |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 40 and Assignment-4 | SA |

Reference Books

1. J.B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. J.A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.
4. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
5. G. Strang, Linear Algebra and its Applications, Thomson, 2007.
6. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
7. K. Hoffman and R.A. Kunze, Linear Algebra, 2nd Ed., Prentice Hall of India, 1971.
8. S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India, 2004
9. D.S. Dummit and R.M. Foote, Abstract Algebra, 3rd Ed., Wiley & Sons, 2004.
10. J.R. Durbin, Modern Algebra, Wiley & Sons, 2000.
11. D. A. R. Wallace, Groups, Rings and Fields, Springer, 1998
12. D.S. Malik, John M. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill, 1996.
13. I.N. Herstein, Topics in Algebra, Wiley, India, 1975.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 5th Semester

PAPER NAME: Fluid Mechanics **PAPER CODE:** DSE-02

NAME OF TEACHER(S): DR. TILAK KUMAR PAL(TKP)

Unit-1

Perfect fluid. Pressure at a point. Pressure of heavy fluid. Pressure at any point of a fluid at rest is the same in every directions. Conditions of equilibrium for homogeneous,

heterogeneous, and elastic fluid. Lines of force. Surfaces of equal pressure and density. Pressure gradient, pressure function and equation of equilibrium. Homogeneous fluid at rest under gravity.

Unit-2

Definition of center of pressure. Formula for the depth of the center of pressure of a plane area. Position of center of pressure. Thrusts on plane and curved surfaces. Rotating fluid. Pressure at any point and surfaces of equipressure when a mass of homogeneous fluid contained in a vessel revolves uniformly about a vertical axis. Floating bodies. Stability of equilibrium of floating bodies.

Unit-3

Kinematics of Fluid: Scalar and Vector Field, flow field, Description of Fluid Motion. Lagrangian method, Eulerian method, Relation between Eulerian and Lagrangian method, Variation of flow parameters in time and space. Steady and unsteady flow, uniform and non-uniform flow. Material derivative and acceleration: temporal derivative, convective derivative.

Unit-4

Conservation Equation: Control mass system, control volume system, Isolated system. Conservation of Mass-The Continuity equation: Differential form and vector form, integral form. Conservation of Momentum: Momentum theorem, Reynolds transport theorem. Conservation of energy.

| Class | Topic | TEACHER |
|-------------|--|---------|
| Lecture 1 | Perfect fluid. | TKP |
| Lecture 2 | Pressure at a point. | TKP |
| Lecture 3 | Pressure of heavy fluid. | TKP |
| Lecture 4 | Pressure at any point of a fluid at rest is the same in every directions. | TKP |
| Lecture 5 | Conditions of equilibrium for homogeneous, heterogeneous, and elastic fluid. | TKP |
| Lecture 6 | Lines of force. Surfaces of equal pressure and density. | TKP |
| Lecture 7 | Pressure gradient, pressure function and equation of equilibrium | TKP |
| Lecture 8 | Homogeneous fluid at rest under gravity. | TKP |
| Examination | Class Test-1 (Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | TKP |
| Lecture 9 | Definition of center of pressure. | TKP |
| Lecture 10 | Formula for the depth of the center of pressure of a plane area. | TKP |

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| Lecture 11 | Position of center of pressure. | TKP |
| Lecture 12 | Thrusts on plane and curved surfaces. | TKP |
| Lecture 13 | Rotating fluid. | TKP |
| Lecture 14 | Pressure at any point and surfaces of equipressure when a mass of homogeneous fluid contained in a vessel revolves uniformly about a vertical axis. | TKP |
| Lecture 15 | Floating bodies. | TKP |
| Lecture 16 | Stability of equilibrium of floating bodies. | TKP |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 9 to Lecturer 16 and Assignment-2 | TKP |
| Lecture 17 | Kinematics of Fluid | TKP |
| Lecture 18 | Scalar and Vector Field, flow field, | TKP |
| Lecture 19 | Description of Fluid Motion. | TKP |
| Lecture 20 | Lagrangian method, | TKP |
| Lecture 21 | Eulerian method, | TKP |
| Lecture 22 | Relation between Eulerian and Lagrangian method, | TKP |
| Lecture 23 | Steady and unsteady flow, | TKP |
| Lecture 24 | uniform and non-uniform flow. | TKP |
| Lecture 25 | Material derivative and acceleration: | TKP |
| Lecture 26 | temporal derivative, | TKP |
| Lecture 27 | convective derivative. | TKP |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 17 to Lecturer 27 and Assignment-3 | TKP |
| Lecture 28 | Conservation Equation: | TKP |
| Lecture 29 | Control mass system, | TKP |
| Lecture 30 | control volume system, | TKP |
| Lecture 31 | Isolated system | TKP |
| Lecture 32 | Conservation of Mass-The Continuity equation: | TKP |
| Lecture 33 | Differential form and vector form, integral form. | TKP |
| Lecture 34 | Conservation of Momentum: | TKP |
| Lecture 35 | Momentum theorem, | TKP |
| Lecture 36 | Reynolds transport theorem. | TKP |

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| Lecture 37 | Conservation of energy. | TKP |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 37 and Assignment-4 | TKP |

Reference Books

1. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, 1967.
2. F. Chorlton, Textbook of Fluid Dynamics, Van Nostrand Co., 1967.
3. F.M. White, Fluid Mechanics, McGraw Hill, 2003.
4. P.K. Kundu and I.M. Cohen, Fluid Mechanics, 4th Rev. Ed., Academic Press, 2008.
5. G. Falkovich, Fluid Mechanics: A short course for physicists, Cambridge University Press,
6. I.G. Currie, Fundamental Mechanics of Fluids, McGraw Hill, 1974.
7. B. Massey and J.W. Smith, Mechanics of Fluids, 8th Ed., Taylor & Francis, 2005.

PAPER NAME: Discrete Mathematics

PAPER CODE: SEC-1

NAME OF TEACHER(S): RAKESH SARKAR(R.S.)

Unit-1

Definition of undirected graphs, Using of graphs to solve different puzzles and problems. Multi- graphs. Walks, Trails, Paths, Circuits and cycles, Eulerian circuits and paths. Eulerian graphs, example of Eulerian graphs. Hamiltonian cycles and Hamiltonian graphs. Weighted graphs and Travelling salespersons Problem. Dijkstra's algorithm to find shortest path. Definition of Trees and their elementary properties. Definition of Planar graphs, Kuratowski's graphs. Partial Order relations and lattices, Chains and antichains. Pigeon hole Principle.

Unit-2

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Unit-3

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set. Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation. Partial ordering relations, n-ary relations.

Unit-4

Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Logic gates, switching circuits and applications of switching circuits.

| Class | Topic | TEACHER |
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| Lecture 1 | Definition of undirected graphs, Multi- graphs | RS |
| Lecture 2 | Using of graphs to solve different puzzles and problems | RS |
| Lecture 3 | Walks, Trails, Paths, Circuits and cycles | RS |
| Lecture 4 | Eulerian circuits and paths | RS |
| Lecture 5 | Eulerian graphs, example of Eulerian graphs | RS |
| Lecture 6 | Hamiltonian cycles and Hamiltonian graphs | RS |
| Lecture 7 | Weighted graphs and Travelling salespersons Problem | RS |
| Lecture 8 | Dijkstra's algorithm to find shortest path | RS |
| Lecture 9 | Definition of Trees and their elementary properties | RS |
| Lecture 10 | Definition of Planar graphs, Kuratowski's graphs | RS |
| Lecture 11 | Partial Order relations and lattices | RS |
| Lecture 12 | Chains and antichains. Pigeon hole Principle | RS |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 12 and Assignment-1 | RS |
| Lecture 13 | Introduction, propositions, truth table, negation | RS |
| Lecture 14 | Introduction, propositions, truth table, negation | RS |
| Lecture 15 | conjunction and disjunction | RS |
| Lecture 16 | Implications, biconditional propositions | RS |
| Lecture 17 | converse, contra positive and inverse propositions of logical operators | RS |
| Lecture 18 | precedence of logical operators | RS |
| Lecture 19 | Propositional equivalence | RS |
| Lecture 20 | Logical equivalences | RS |
| Lecture 21 | Predicates and quantifiers | RS |
| Lecture 22 | Introduction, Quantifiers, Binding variables and Negations | RS |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 13 to Lecturer 22 and Assignment-2 | RS |
| Lecture 23 | Sets, subsets, Set operations and the laws of set theory and Venn diagrams | RS |
| Lecture 24 | Examples of finite and infinite sets | RS |
| Lecture 25 | Finite sets and counting principle | RS |
| Lecture 26 | Empty set, properties of empty set | RS |
| Lecture 27 | Standard set operations, Classes of sets | RS |

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| Lecture 27 | Power set of a set. Difference and Symmetric difference of two sets | RS |
| Lecture 28 | Set identities, Generalized union and intersections | RS |
| Lecture 29 | Relation: Product set | RS |
| Lecture 30 | Composition of relations, Types of relations, Partitions | RS |
| Lecture 31 | Equivalence Relations with example of congruence modulo relation | RS |
| Lecture 32 | Partial ordering relations | RS |
| Lecture 33 | Partial ordering relations and n -ary relations | RS |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 23 to Lecturer 33 and Assignment-3 | RS |
| Lecture 34 | Definition, examples lattices | |
| Lecture 35 | Definition, examples and properties of modular lattices | RS |
| Lecture 36 | Definition, examples and properties of modular and distributive lattices | RS |
| Lecture 37 | Boolean algebras | RS |
| Lecture 38 | Examples of Boolean algebras | RS |
| Lecture 39 | Boolean polynomials | RS |
| Lecture 40 | Minimal and Maximal forms of Boolean polynomials | RS |
| Lecture 41 | Quinn-McCluskey method | RS |
| Lecture 42 | Karnaugh diagrams | RS |
| Lecture 43 | Logic Gates | RS |
| Lecture 44 | Diagrams on Logic Gates | RS |
| Lecture 45 | Switching Circuits | RS |
| Lecture 46 | Applications of Switching Circuits | RS |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 46 and Assignment-4 | RS |

Reference Books

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.
4. K.A. Ross and C.R. Wright, Discrete Mathematics, Prentice Hall, 2002.

PROGRAM NAME: B.Sc. (Honours)

Unit-1

Linear programming modeling, Optimal solutions and graphical interpretation of optimality. Notion of convex set, convex function, their properties and applications in context of LPP. Pre-liminary definitions (like convex combination, extreme point etc.). Optimal hyper-plane and existence of optimal solution of LPP. Basic feasible solutions: algebraic interpretation of extreme point. Relationship between extreme points and corresponding BFS. Adjacent extreme points and corresponding BFS along with examples. Fundamental theorem of LPP and its illustration through examples.

Unit-2

LPP in canonical form to get the initial BFS and method of improving current BFS. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison.

Unit-3

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, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

Unit-4

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

| Class | Topic | TEACHER |
|------------------|---|---------|
| Lecture 1 | Linear programming modelling with example | TKP |
| Lecture 2 | Optimal solutions and graphical interpretation of optimality. | TKP |
| Lecture 3 | Notion of convex set, convex function, their properties | TKP |
| Lecture 4 | and applications in context of LPP. Pre-liminary definitions (like convex combination, extreme point etc.). | TKP |
| Lecture 5 | Optimal hyper-plane and existence of optimal solution of LPP. | TKP |
| Lecture 6 | Basic feasible solutions: algebraic interpretation of extreme point | TKP |

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| Lecture 7 | Relationship between extreme points and corresponding BFS | TKP |
| Lecture 8 | Adjacent extremepoints and corresponding BFS along with examples. | TKP |
| Lecture 9 | Fundamental theorem of LPP and its illustration through examples. | TKP |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 9 and Assignment-1 | TKP |
| Lecture 10 | LPP in canonical form to get the initial BFS | TKP |
| Lecture 11 | Method of improving current BFS. | TKP |
| Lecture 12 | Theory of simplex method, | TKP |
| Lecture 14 | Graphical solution, | TKP |
| Lecture 15 | Convex sets, optimality and unboundedness, | TKP |
| Lecture 16 | The simplex algorithm, | TKP |
| Lecture 17 | Simplex method in tableau format, | TKP |
| Lecture 18 | Introduction to artificial variables, | TKP |
| Lecture 19 | Two-phase method. | TKP |
| Lecture 20 | Big-M method and their comparison. | TKP |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 10 to Lecturer 20 and Assignment-2 | TKP |
| Lecture 21 | Duality, formulation of the dual problem, | RS |
| Lecture 22 | primal-dual relationships, | RS |
| Lecture 23 | economic interpretation of the dual. | RS |
| Lecture 24 | northwest-corner method, | RS |
| Lecture 25 | least cost method | RS |
| Lecture 26 | Vogel approximation method for determination of starting basic solution, | RS |
| Lecture 27 | algorithm for solving transportation problem, | RS |
| Lecture 28 | assignment problem and its mathematical formulation, | RS |
| Lecture 29 | Hungarian method for solving assignment problem. | RS |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 21 to Lecturer 29 and Assignment-3 | RS |
| Lecture 30 | Game theory: formulation of two person zero sum games, | |
| Lecture 31 | solving two person zero sum games, | RS |

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| Lecture 32 | games with mixed strategies, | RS |
| Lecture 33 | graphical solution procedure, | RS |
| Lecture 34 | linear programming solution of games. | RS |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 34 and Assignment-4 | RS |

Reference Books

1. M.S. Bazaraa, J.J. Jarvis and H.D. Sherali, Linear Programming and Network Flows, 2nd Ed., Wiley, 2004.
2. P.K. Dutta, Strategies and Games: Theory and Practice, MIT Press, 1999.
3. L.F. Fernandez and H.S. Bierman, Game Theory with Economic Applications, Addison Wesley, 1998.
4. R.D. Gibbons, Game Theory for Applied Economists, Princeton University Press, 1992.
5. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., McGraw Hill, 2009.
6. H.A. Taha, Operations Research: An Introduction, 8th Ed., Prentice Hall India, 2006.
7. G. Hadley, Linear Programming, Narosa, 2002.

PROGRAM NAME: B.Sc. (Honours)

COURSE: MATHEMATICS(Hons) 6th Semester

PAPER NAME: **Computer aided Laboratory(Practical Paper)**

PAPER CODE: DC14

NAME OF TEACHER(S): **RAKESH SARKAR (R.S.), DR. TILAK KR. PAUL(T.K.P.),**

MD SAHID ALAM(S.A.), POLY KARMAKAR(P.K.)

List of practical (By using C in LINUX)

1. Solution of transcendental and algebraic equations by

- Bisection method
- Newton Raphson method.
- Fixed point method.
- Regula Falsi method.

2. Solution of system of linear equations

- LU decomposition method
- Gaussian elimination method
- Gauss-Jacob method
- Gauss-Seidel method

3. Interpolation

- Lagrange Interpolation
- Newton Interpolation

4. Numerical Integration

- Trapezoidal Rule
- Simpson's one third rule
- Weddle's Rule
- Gauss Quadrature

5. Method of finding Eigenvalue by Power method

6. Fitting a Polynomial Function

7. Solution of ordinary differential equations

- Euler method
- Modified Euler method
- Runge-Kutta method

8. Programming in probability and statistics

- Probability by using Empirical Definition
- Mean
- Median
- Mode
- Standard deviation
- Coefficient of correlation

9. Matrices

- Determinants
- Transpose
- Product
- Addition/Subtraction
- Rank
- Inverse

| Class | Topic | TEACHER |
|-------------------|------------------------------|---------|
| Lecture 1 | Bisection method | SA |
| Lecture 2 | Newton Raphson method. | SA |
| Lecture 3 | Fixed point method. | SA |
| Lecture 4 | Regula Falsi method | SA |
| Lecture 5 | LU decomposition method | PK |
| Lecture 6 | Gaussian elimination method. | PK |
| Lecture 7 | Gauss-Jacobi method | PK |
| Lecture 8 | Gauss-Seidel method | PK |
| Lecture 9 | Lagrange Interpolation | SA |
| Lecture 10 | Newton Interpolation | SA |

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| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 10 and Assignment-1 | |
| Lecture 11 | Trapezoidal Rule | TKP |
| Lecture 12 | Simpson's one third rule | TKP |
| Lecture 13 | Weddle's Rule | TKP |
| Lecture 14 | Gauss Quadrature | TKP |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 11 to Lecturer 14 and Assignment-2 | |
| Lecture 15 | Method of finding Eigenvalue by Power method | SA |
| Lecture 16 | Fitting a Polynomial Function | SA |
| Lecture 17 | Euler method | PK |
| Lecture 18 | Modified Euler method | PK |
| Lecture 19 | RungeKutta method | PK |
| Lecture 20 | Probability by using Empirical Definition | RS |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 15 to Lecturer 20 and Assignment-3 | |
| Lecture 21 | Mean | RS |
| Lecture 22 | Median | RS |
| Lecture 23 | Mode | RS |
| Lecture 24 | Standard deviation | RS |
| Lecture 25 | Coefficient of correlation | RS |
| Lecture 26 | Determinants | RS |
| Lecture 27 | Transpose of matrices | RS |
| Lecture 27 | Product of matrices | RS |
| Lecture 28 | Addition/Subtraction of matrices | RS |
| Lecture 29 | Rank of matrices | PK |
| Lecture 30 | Inverse of matrices | PK |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 21 to Lecturer 30 and Assignment-4 | |

PROGRAM NAME: B.Sc. (Honours)

COURSE:MATHEMATICS(Hons) 6th Semester

PAPER NAME: **Point Set Topology**

PAPER CODE: MATH-H-DSE-3(1)

NAME OF TEACHER(S): **MD SAHID ALAM(S.A.), POLY KARMAKAR(P.K.)**

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Unit-1

Countable and Uncountable Sets, Schroeder-Bernstein Theorem, Cantors Theorem. Cardinal Numbers and Cardinal Arithmetic. Continuum Hypothesis, Zorns Lemma, Axiom of Choice. Well-Ordered Sets, Hausdorffs Maximal Principle. Ordinal Numbers.

Unit-2

Topological spaces, Basis and Subbasis for a topology, subspace Topology, Interior Points, Limit Points, Derived Set, Boundary of a set, Closed Sets, Closure and Interior of a set.

Unit-3

Continuous Functions, Open maps, Closed maps and Homeomorphisms. Product Topology, Quotient Topology, Metric Topology, Baire Category Theorem.

Unit-4

Connected and Path Connected Spaces, Connected Sets in \mathbb{R} , Components and Path Components, Local Connectedness. Compact Spaces, Compact Sets in \mathbb{R} . Compactness in Metric Spaces. Totally Bounded Spaces, Ascoli-Arzelà Theorem, The Lebesgue Number Lemma. Local Compactness.

| Class | Topic | TEACHER |
|-------------------|---|---------|
| Lecture 1 | Countable and Uncountable Sets, | SA |
| Lecture 2 | Schroeder-Bernstein Theorem, | SA |
| Lecture 3 | Cantors Theorem. | SA |
| Lecture 4 | Cardinal Numbers and Cardinal Arithmetic | SA |
| Lecture 5 | Continuum Hypothesis, | SA |
| Lecture 6 | Zorns Lemma. | |
| Lecture 7 | Axiom of Choice. | |
| Lecture 8 | Well-Ordered Sets, | SA |
| Lecture 9 | Hausdorffs Maximal Principle. | SA |
| Lecture 10 | Ordinal Numbers. | SA |
| Lecture 11 | Topological spaces, | SA |
| Lecture 12 | Basis and for a topology, | SA |
| Lecture 13 | Subbasis for a topology | SA |
| Lecture 14 | Subspace Topology, | |
| | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | SA |
| Lecture 15 | Interior Points, Limit Points, | SA |

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| Lecture 16 | Derived Set, Boundary of a set, Closed Sets, | SA |
| Lecture 17 | Closure and Interior of a set. | SA |
| Lecture 18 | Continuous Functions | SA |
| Lecture 19 | Open maps, Closed maps. | SA |
| Lecture 20 | Homeomorphisms. | SA |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 17 and Assignment-2 | SA |
| Lecture 21 | Product Topology | PK |
| Lecture 22 | Quotient Topology | PK |
| Lecture 23 | Metric Topology | PK |
| Lecture 24 | Baire Category Theorem | PK |
| Lecture 25 | Connected Spaces | PK |
| Lecture 26 | Path Connected Spaces. | PK |
| Lecture 27 | Connected Sets in \mathbb{R} , | PK |
| Lecture 27 | Components | PK |
| Lecture 28 | Path Components. | PK |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 18 to Lecturer 26 and Assignment-3 | PK |
| Lecture 29 | Local Connectedness | PK |
| Lecture 30 | Compact Spaces, | PK |
| Lecture 31 | Compact Sets in \mathbb{R} . | PK |
| Lecture 32 | Compactness in Metric Spaces. | PK |
| Lecture 33 | Totally Bounded Spaces, | PK |
| Lecture 34 | Ascoli-Arzela Theorem, | PK |
| Lecture 35 | The Lebesgue Number Lemma. | PK |
| Lecture 36 | Local Compactness | PK |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 27 to Lecturer 36 and Assignment-4 | PK |

Text/Reference Books:

1. J.R. Munkres, Topology: A First Course, Prentice Hall of India,2000.
2. J. Dugundji, Topology, Allyn and Bacon,1966.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill,1963.
4. K.D. Joshi, Introduction to General Topology,NewAge International Private Limited,2017.
5. J.L. Kelley, General Topology, Springer,1975.
6. J. Hocking and G. Young, Topology, Dover Publications,1988.
7. L.A. Steen and J.A. Seebach, Counter Examples in Topology, Dover Publications,1995.

PROGRAM NAME: B.Sc. (Honours)

COURSE:MATHEMATICS(Hons) 6th Semester

PAPER NAME: **Problem Solving Techniques in Probability & Statistics**

PAPER CODE: SEC-2

NAME OF TEACHER(S): **RAKESH SARKAR(R.S.), Dr. TILAK KUMAR PAUL(T.K.P.)**

Unit-1

1. Application problems based on Classical Definition of Probability.
2. Application problems based on Bayes' Theorem.
3. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$.
4. Fitting of binomial distributions for given n and p .
5. Fitting of binomial distributions after computing mean and variance.
6. Fitting of Poisson distributions for given value of lambda.
7. Fitting of Poisson distributions after computing mean.

Unit-2

1. Fitting of negative binomial distribution.
2. Fitting of suitable distribution.
3. Application problems based on binomial distribution.
4. Application problems based on Poisson distribution.

5. Application problems based on negative binomial distribution.

Unit-3

1. Graphical representation of data
2. Problems based on measures of central tendency
3. Problems based on measures of dispersion
4. Problems based on combined mean and variance and coefficient of variation
5. Problems based on moments, skewness and kurtosis

Unit-4

1. Fitting of polynomials, exponential curves
2. Karl Pearson correlation coefficient
3. Partial and multiple correlations
4. Spearman rank correlation with and without ties.
5. Correlation coefficient for a bivariate frequency distribution
6. Lines of regression, angle between lines and estimated values of variables.
7. Checking consistency of data and finding association among attributes

| Class | Topic | TEACHER |
|--------------------|---|---------|
| Lecture 1 | Application problems based on Classical Definition of Probability | TKP |
| Lecture 2 | Application problems based on Bayes' Theorem | TKP |
| Lecture 3 | binomial distributions | TKP |
| Lecture 4 | Fitting of binomial distributions for n and $p = q = 1/2$ | TKP |
| Lecture 5 | Fitting of binomial distributions for given n and p . | TKP |
| Lecture 6 | Fitting of binomial distributions after computing mean and variance-1 | TKP |
| Lecture 7 | Fitting of binomial distributions after computing mean and variance-2 | TKP |
| Lecture 8 | Poisson distributions | TKP |
| Lecture 9 | Fitting of Poisson distributions for given value of λ | TKP |
| Lecture 10 | Fitting of Poisson distributions after computing mean-1 | TKP |
| Lecture 11 | Fitting of Poisson distributions after computing mean-2 | TKP |
| Examination | Class Test-1(Tutorial Exam) on Lecturer 1 to Lecturer 11 and Assignment-1 | TKP |
| Lecture 12 | Fitting of negative binomial distribution-1 | TKP |
| Lecture 13 | Fitting of negative binomial distribution-2 | TKP |
| Lecture 14 | Fitting of suitable distribution-1 | TKP |

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| Lecture 15 | Fitting of suitable distribution-2 | TKP |
| Lecture 16 | Fitting of suitable distribution-3 | TKP |
| Lecture 17 | Application problems based on binomial distribution-1 | TKP |
| Lecture 18 | Application problems based on binomial distribution-2 | TKP |
| Lecture 19 | Application problems based on Poisson distribution-1 | TKP |
| Lecture 20 | Application problems based on Poisson distribution-2 | TKP |
| Lecture 21 | Application problems based on negative binomial distribution-1 | TKP |
| Lecture 22 | Application problems based on negative binomial distribution-2 | TKP |
| Examination | Class Test-2(Tutorial Exam) on Lecturer 12 to Lecturer 22 and Assignment-2 | TKP |
| Lecture 23 | Graphical representation of data-1 | RS |
| Lecture 24 | Graphical representation of data-2 | RS |
| Lecture 25 | Problems based on measures of central tendency-1 | RS |
| Lecture 26 | Problems based on measures of central tendency-1 | RS |
| Lecture 27 | Problems based on measures of dispersion-1 | RS |
| Lecture 27 | Problems based on measures of dispersion-2 | RS |
| Lecture 28 | Problems based on measures of dispersion-3 | RS |
| Lecture 29 | Problems based on combined mean and variance and coefficient of variation-1 | RS |
| Lecture 30 | Problems based on combined mean and variance and coefficient of variation-2 | RS |
| Lecture 31 | Problems based on combined mean and variance and coefficient of variation-3 | RS |
| Lecture 32 | Problems based on moments, skewness and kurtosis-1 | RS |
| Lecture 33 | Problems based on moments, skewness and kurtosis-2 | RS |
| Lecture 34 | Problems based on moments, skewness and kurtosis-3 | RS |
| Examination | Class Test-3(Tutorial Exam) on Lecturer 23 to Lecturer 34 and Assignment-3 | RS |
| Lecture 35 | Fitting of polynomials, exponential curves-1 | RS |
| Lecture 36 | Fitting of polynomials, exponential curves-2 | RS |
| Lecture 37 | Karl Pearson correlation coefficient-1 | RS |
| Lecture 38 | Karl Pearson correlation coefficient-2 | RS |
| Lecture 39 | Partial and multiple correlations-1 | RS |
| Lecture 40 | Partial and multiple correlations-2 | RS |
| Lecture 41 | Spearman rank correlation with and without ties-1 | RS |

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| Lecture 42 | Spearman rank correlation with and without ties-2 | RS |
| Lecture 43 | Correlation coefficient for a bivariate frequency distribution-1 | RS |
| Lecture 44 | Correlation coefficient for a bivariate frequency distribution-2 | RS |
| Lecture 45 | Lines of regression, angle between lines and estimated values of variables-1 | RS |
| Lecture 46 | Lines of regression, angle between lines and estimated values of variables-2 | RS |
| Lecture 47 | Checking consistency of data and finding association among attributes-1 | RS |
| Lecture 48 | Checking consistency of data and finding association among attributes-2 | RS |
| Examination | Class Test-4(Tutorial Exam) on Lecturer 1 to Lecturer 48 and Assignment-4 | RS |

LESSON PLAN 2023-24