BINOD BIHARI KOYALANCHAL UNIVERSITY DHANBAD
Class ROUTINE OF – MATHEMATICS
B.S.K. College, Maithon (Dhanbad)

DAY	Time / class	8:00 AM – 8:50 AM 1st period	8:50 AM – 9:40 AM 2nd period	9:40 AM – 10:30 AM 3rd period	10:30 AM – 11:20 AM 4th period	11:20 AM – 12:10 PM 5th Period	Remarks
MONDAY	Ist / IInd Sem		Core 1 / Core 3				Core 1, Core 2 Sem I
	IIIrd / IVth Sem			Core 5 / Core 8			Core 3, Core 4 Sem II
	Vth / VIth Sem	Core 11 / Core 13					GE – 1 Sem I GE – 2 Sem II
TUESDAY	Ist / IInd Sem				Core 1 / Core 3		GE – 3 Sem III
	III / IVth Sem		Core 9 / Core 8				GE – 4 Sem IV
	Vth / VIth Sem	Core 12 / Core 14		DSE 1 / DSE – 3			Core – 5, Core 6 – Core 7 – Sem III
WEDNESDAY	1st / 2nd Sem			Core 2 / Core 4	Math GE 1/2		Core 8, Core – 9, Core – 10 – Sem IV
	3rd / 4th Sem	DSE-1 / DSE 3	Core 6 / Core 9				
	5th / 6th Sem	DSE-1 / DSE-3					Core 11, Core 12 – Sem V
THURSDAY	1st / 2nd Sem			Core 2 / Core 4	Math GE 1/2		Core 13, Core 14 – Sem VI
	3rd / 4th Sem		Core 7 / Core 10				DSE – 1, 2 Sem V
	5th / 6th Sem	DSE - 2 / DSE 4					DSE – 3, 4 Sem VI
FRIDAY	1st / 2nd Sem				DSE (Gen)		
	3rd / 4th Sem			Core 6 / Core - 9		Math GE - 3/4	
	5th / 6th Sem	DSE - 1 / DSE 3	Core 12 / Core 14				
SATURDAY	1st / 2nd Sem		Core 2 / Core 4				
	3rd / 4th Sem			Core 7 / Core 10	G.E (Math) 3/4		
	5th / 6th Sem	Core 11 / Core 13		~~DSE (Gen)~~			

H.O.D. Mathematics

(Signature)

B. S. K. COLLEGE, MAITHON (DHANBAD), JHARKHAND

Department: - Mathematics

Lesson Plan : 201[illegible]– [illegible]

Faculty: Dr. R. G. Mondal

Semester – I

Internal Full Marks : 20 Semester Full Marks : 80 Total Full Marks : 100

Question no.1 is compulsory consists of ten short answer type questions each of two marks covering entire syllabus uniformly. Another four questions out of eight are required to answer.

Paper	Unit	Topic (Definition, Examples, Properties, Theorems & Numericals)	No. of Classes
CC 1.1 Calculus	I	Hyperbolic functions, higher order derivatives, Leibniz rule 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, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves. L'Hospital's rule.	12
	II	Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\, dx$, $\int \cos^n x\, dx$, $\int \tan^n x\, dx$, $\int \sin^n x \cos^m x\, dx$, $\int \sin nx\, dx$, $\int \cos nx\, dx$, $\int (\log x)^n\, dx$, parametric equations,parameterizing a curve, arc length, arc length of parametric curves, volume and area of surface of revolution.	12
	III	Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.	06
	IV	Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.	12
CC1.2 Algebra	I	Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications, logarithmic of complex numbers.	12
	II	Equivalence relations, 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.	12
	III	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. Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.	18
GE 1.3 Calculus	I	Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.	12
	II	Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.	12
	III	Reduction formulae, length of curves, volume and area of surface of revolution. Vector differentiation, curl, divergence and gradient.	18

Semester – II

Internal Full Marks : 20 | Semester Full Marks : 80 | Total Full Marks : 100

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Paper	Unit	Topic (Definition, Examples, Properties, Theorems & Numericals)	No. of Classes
CC 2.1 Real Analysis	I	Review of Algebraic and Order Properties of R, δ-neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points. Illustrations of Bolzano Weierstrass theorem for sets.	12
	II	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.	12
	III	Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test,. Raabe,s test, DeMorgan's and Bertrand's test, Alternating series, Leibniz test, Absolute and Conditional convergence, Kummer's test, logarithmic ratio test.	18
CC2.2 Differential Equations	I	First order exact differential equations. Integrating factors, rules to find an integrating factor. First order and higher degree equations solvable for x, y, p. Clairaut's form, singular solutions, general solution. Second order linear differential equation with constant coefficient.	12
	II	General solution of second order linear homogeneous and non-homogeneous equations, linear homogeneous and non-homogeneous equations of higher order with constant coefficients, The Cauchy-Euler equation. Second order linear differential equations with variable coefficients.	12
	III	Power series solution of a differential equation about an ordinary point, solution about a regular Singular point, Bessel's equation and Legendre's equation, recurrence formulae, orthogonal properties, generating function.	12
	IV	Laplace transform and inverse transform, properties, application to initial value problem up to second order ODE.	06
GE 2.3 Differential equations	I	First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.	12
	II	Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.	18
	III	Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.	12

Semester – III

Internal Full Marks : 20 Semester Full Marks : 80 Total Full Marks : 100

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Paper	Unit	Topic (Definition, Examples, Properties, Theorems & Numericals)	No. of Classes
CC 3.1 Theory of Real Functions	I	Limits of functions ($\varepsilon - \delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. 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. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.	18
	II	Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities.	12
	III	Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1 + x)$, $1/ax+b$ and $(1 + x)^n$.	12
CC 3.2 Group Theory I	I	Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups. Subgroups and examples and theorems on subgroups, normal subgroup, centralizer, normalizer, center of a group.	18
	II	Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group. Properties of cosets, Lagrange's theorem and consequences including. Fermat's Little theorem.	12
	III	External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups. Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.	12
CC 3.3 PDE and Systems of ODE	I	Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. 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, Lagrange's equation, Method of Separation of Variables for solving first order partial differential equations.	12
	II	Introduction of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.	12
	III	Nonlinear partial differential equation, standard forms I, II,III and IV. Charpit's method. Monge's method to solve equation of the form (i) $Rr + Ss + Tt = V$ and (ii) $Rr + Ss + Tt + U(rt = s^2) = V$	12
	IV	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.	06
GE 3.3 Real analysis	I	Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.	12
	II	Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof.	12
	III	Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.	18

Semester – IV

Internal Full Marks : 20 Semester Full Marks : 80 Total Full Marks : 100

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Paper	Unit	Topic (Definition, Examples, Properties, Theorems & Numericals)	No. of Classes
CC 4.1 Numerical Methods	I	Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.	06
	II	System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton's Gregory forward and backward difference interpolation.	18
	III	Numerical differentiation, Numerical Integration: Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule. Ordinary Differential Equations: Euler's method. Runge-Kutta methods of orders two and four.	18
CC 4.2 Riemann Integration and Series of Functions	I	Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.	18
	II	Improper integrals and their convergence, Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.	18
	III	Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.	06
CC 4.3 Ring Theory and Linear lgebra - I	I	Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.	12
	II	Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients. Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces, theorems.	18
	III	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.	12
GE 4.3 Algebra	I	Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (n,R).	12
	II	Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.	18
	IV	Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C.	12

<u>Semester – V</u>

Internal Full Marks : 20 Semester Full Marks : 80 Total Full Marks : 100

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Paper	Unit	Topic (Definition, Examples, Properties, Theorems & Numericals)	No. of Classes
CC 5.1 Multivariate Calculus	I	Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, Extrema of functions of two variables, method of Lagrange multipliers.	12
	II	Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, 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.	12
	III	The gradient, maximal and normal property of the gradient, tangent planes Definition of vector field, divergence and curl Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, onservative vector fields, independence of path, Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem.	18
CC 5.2 Group Theory - II	I	Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic roups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.	12
	II	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.	12
		Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.	12
	IV	Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for n ≥ 5, non-simplicity tests.	06
DSE 1.1 Linear Programing	I	Introduction to linear programming problem, convex sets and their properties, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.	12
	II	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.	18
	III	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.	12
DSE 1.3 Analytical Geometry	I	Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola.	24
	II	Spheres, cone, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.	18

Semester – VI

Internal Full Marks : 20 | Semester Full Marks : 80 | Total Full Marks : 100

Question no.1 is compulsory consists of ten short answer type questions each of two marks covering entire syllabus uniformly. Another four questions out of eight are required to answer.

Paper	Unit	Topic (Definition, Examples, Properties, Theorems & Numericals)	No. of Classes
CC 6.1 Metric Space & Complex Analysis	I	Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable spaces.	12
	II	Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem.	06
	III	Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.	12
	IV	Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, bilinear transformation, cross ratio, conformal mapping	12
CC 6.2 Ring Theory & Linear Algebra II	I	Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.	18
	II	Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.	12
	III	Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, minimal solutions to systems of linear equations, normal and self-adjoint operators, Orthogonal projections and Spectral theorem.	12
DSE 2.2 Boolean Algebra & Automata Theory	I	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, Definition, examples and properties of modular and distributive lattices,	18
	II	Boolean algebras,Boolean polynomials, minimal forms of Boolean polynomials Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.	12
	III	Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages. Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties. Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.	12
DSE 2.3 Probability & Statistics	II	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.	18
	III	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.	12