

**STATE MODEL SYLLABUS FOR UNDER
GRADUATE
COURSE IN MATHEMATICS
(Bachelor of Science Examination)**

**UNDER
CHOICE BASED CREDIT SYSTEM**

Preamble

Mathematics is an indispensable tool for much of science and engineering. It provides the basic language for understanding the world and lends precision to scientific thought. The mathematics program at Universities of Odisha aims to provide a foundation for pursuing research in Mathematics as well as to provide essential quantitative skills to those interested in related fields. With the maturing of the Indian industry, there is a large demand for people with strong analytical skills and broad-based background in the mathematical sciences.

COURSE STRUCTURE FOR MATHEMATICS HONORS

Semester	Course	Course Name	Credits
I	AECC-I	AECC-I	04
	C-I	Calculus	04
	C-I	Practical	02
	C-II	Discrete Mathematics	05
	C-II	Tutorial	01
	GE-I	GE-I	05
	GE-I	Tutorial	01
			22
II	AECC-II	AECC-II	04
	C-III	Real Analysis	05
	C-III	Tutorial	01
	C-IV	Differential equations	04
	C-IV	Practical	02
	GE-II	GE-II	05
	GE-II	Tutorial	01
			22
III	C-V	Theory of Real functions	05
	C-V	Tutorial	01
	C-VI	Group Theory-I	05
	C-VI	Tutorial	01
	C-VII	Partial differential equations and system of ODEs	04
	C-VII	Practical	02
	GE-III	GE-III	05
	GE-III	Tutorial	01
SECC-I	SECC-I	04	

			28
IV	C-VIII	Numerical Methods and Scientific Computing	04
	C-VIII	Practical	02
	C-IX	Topology of Metric spaces	05
	C-IX	Tutorial	01
	C-X	Ring Theory	05
	C-X	Tutorial	01
	GE-IV	GE-IV (Theory)	05
	GE-IV	Tutorial	01
	SECC-II	SECC-II	04
			28
Semester	Course	Course Name	Credits
V	C-XI	Multivariable Calculus	05
	C-XI	Tutorial	01
	C-XII	Linear Algebra	05
	C-XII	Tutorial	01
	DSE-I	Linear Programming	05
	DSE-I	Tutorial	01
	DSE-II	Probability and Statistics	05
	DSE-II	Tutorial	01
			24
VI	C-XIII	Complex analysis	05
	C-XIII	Tutorial	01
	C-XIV	Group Theory-II	05
	C-XIV	Tutorial	01
	DSE-III	Differential Geometry	05
	DSE-III	Tutorial	01
	DSE-IV	Number Theory/Project	06
			24
		TOTAL	148

B.A./B.SC.(HONOURS)-MATHEMATICS

HONOURS PAPERS:

Core course – 14 papers

Discipline Specific Elective – 4 papers (out of the 5 papers suggested)

Generic Elective for non Mathematics students – 4 papers. In case University offers 2 subjects as GE, then papers 1 and 2 will be the GE paper.

Marks per paper –

For practical paper: Mid term : 15 marks, End term : 60 marks, Practical- 25 marks

For non practical paper: Mid term : 20 marks, End term : 80 marks

Total – 100 marks Credit per paper – 6

Teaching hours per paper –

Practical paper-40 hours theory classes + 20 hours Practical classes

Non Practical paper-50 hours theory classes + 10 hours tutorial

CORE PAPER-1

CALCULUS

Objective: The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of mathematical nature as well as practical problems. More precisely, main target of this course is to explore the different tools for higher order derivatives, to plot the various curves and to solve the problems associated with differentiation and integration of vector functions.

Expected Outcomes: After completing the course, students are expected to be able to use Leibnitz's rule to evaluate derivatives of higher order, able to study the geometry of various types of functions, evaluate the area, volume using the techniques of integrations, able to identify the difference between scalar and vector, acquired knowledge on some the basic properties of vector functions.

UNIT-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the 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' Hospitals rule, Application in business ,economics and life sciences.

UNIT-II

Riemann integration as a limit of sum, integration by parts, Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x dx, \int \cos^n x dx, \int \tan^n x dx, \int \sec^n x dx, \int (\log x)^n dx, \int \sin^n x \cos^n x dx,$ definite integral, integration by substitution.

UNIT-III

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, 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.

UNIT-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.

LIST OF PRACTICALS

(Using any software/ MATLAB to be performed on a Computer.)

1. Plotting the graphs of the functions e^{ax+b} , $\log(ax+b)$, $1/ax+b$, $\sin(ax+b)$, $\cos(ax+b)$ and $|ax+b|$ to illustrate the effect of a and b on the graph.
2. Plotting the graphs of the polynomial of degree 4 and 5.
3. Sketching parametric curves (E.g. Trochoid, cycloid, 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 (using Cartesian co-ordinates).

BOOKS RECOMMENDED:

1. H. Anton, I. Bivens and S. Davis, *Calculus*, 10thEd., John Wiley and Sons (Asia)P. Ltd., Singapore, 2002.
2. Shanti Narayan, P. K. Mittal, *Differential Calculus*, S. Chand, 2014.
3. Shanti Narayan, P. K. Mittal, *Integral Calculus*, S. Chand, 2014.

BOOKS FOR REFERENCE:

1. James Stewart, Single Variable Calculus, Early Transcendentals, Cengage Learning, 2016.
2. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

CORE PAPER-II

DISCRETE MATHEMATICS

Objective: This is a preliminary course for the basic courses in mathematics and all its applications. The objective is to acquaint students with basic counting principles, set theory and logic, matrix theory and graph theory.

Expected Outcomes: The acquired knowledge will help students in simple mathematical modeling. They can study advance courses in mathematical modeling, computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, axiom of choice, Zorn's lemma, Functions, cardinals and ordinals, countable and uncountable sets, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, modular arithmetic, Chinese remainder theorem, Fermat's little theorem.

UNIT-II

Principles of Mathematical Induction, pigeonhole principle, principle of inclusion and exclusion Fundamental Theorem of Arithmetic, permutation combination circular permutations binomial and multinomial theorem, Recurrence relations, generating functions, generating function from recurrence relations.

UNIT-III

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix,

Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems, Eigen values, Eigen vectors of a matrix.

UNIT-IV

Graph terminology, types of graphs, sub-graphs, isomorphic graphs, Adjacency and incidence matrices, Paths, Cycles and connectivity, Eulerian and Hamiltonian paths, Planar graphs.

BOOKS RECOMMENDED:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
2. Kenneth Rosen Discrete mathematics and its applications Mc Graw Hill Education 7th edition.
3. V Krishna Murthy, V. P. Mainra, J. L. Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd.

BOOKS FOR REFERENCE:

1. J. L. Mott, A. Kendel and T.P. Baker: Discrete mathematics for Computer Scientists and Mathematicians, Prentice Hall of India Pvt Ltd, 2008.

CORE PAPER-III

REAL ANALYSIS

Objective: The objective of the course is to have the knowledge on basic properties of the field of real numbers, studying Bolzano-Weierstrass Theorem, sequences and convergence of sequences, series of real numbers and its convergence etc. This is one of the core courses essential to start doing mathematics.

Expected Outcome: On successful completion of this course, students will be able to handle fundamental properties of the real numbers that lead to the formal development of real analysis and understand limits and their use in sequences, series, differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of R , ε -neighborhood of a point in 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, Interior point, , Open Sets, Closed sets, , Limit points of a set , Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set.

UNIT-II

Sequences and Subsequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Divergence Criteria, Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion. 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, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT-III

Limits of functions (epsilon-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 & discontinuity. Algebra of continuous functions, Continuous functions on an interval, Boundedness Theorem, Maximum Minimum Theorem, Bolzano's Intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem, Monotone and Inverse Functions.

UNIT-IV

Differentiability of a function at a point & in an interval, Caratheodory's theorem, chain Rule, algebra of differentiable functions, Mean value theorem, interior extremum theorem. Rolle's theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities.

BOOKS RECOMMENDED:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley

and Sons (Asia) Pvt. Ltd., Singapore, 2002.

2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.

BOOKS FOR REFERENCE:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
2. A.Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014.
3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.
4. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, Jones & Bartlett, Second Edition, 2010.

CORE PAPER-IV

DIFFERENTIAL EQUATIONS

Objective: Differential Equations introduced by Leibnitz in 1676 models almost all Physical, Biological, Chemical systems in nature. The objective of this course is to familiarize the students with various methods of solving differential equations and to have a qualitative applications through models. The students have to solve problems to understand the methods.

Expected Outcomes: A student completing the course is able to solve differential equations and is able to model problems in nature using Ordinary Differential Equations. This is also prerequisite for studying the course in Partial Differential Equations and models dealing with Partial Differential Equations.

UNIT-I

Differential equations and mathematical models, General, Particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations and Bernoulli's equation, special integrating factors and transformations.

UNIT-II

Introduction to compartmental models, Exponential decay radioactivity (case study of detecting art forgeries), lake pollution model (with case study of Lake Burley Griffin), drug assimilation

into the blood (case study of dull, dizzy and dead), exponential growth of population, Density dependent growth, Limited growth with harvesting.

UNIT-III

General solution of homogeneous equation of second order, principle of superposition, Wronskian, its properties and applications, method of undetermined coefficients, Method of variation of parameters, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation.

UNIT-IV

Equilibrium points, Interpretation of the phase plane, predatory-pray model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Practical / Lab work to be performed on a computer:

Modeling of the following problems using *Matlab / Mathematica / Maple* etc.

1. Plotting of second & third order solution family of differential equations.
2. Growth & Decay model (exponential case only).
3. (a) Lake pollution model (with constant/seasonal flow and pollution concentration)/
(b) Case of single cold pill and a course of cold pills.
(c) Limited growth of population (with and without harvesting).
4. (a) Predatory- prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
(b) Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
(c) Battle model (basic battle model, jungle warfare, long range weapons).
5. Plotting of recursive sequences.

BOOKS RECOMMENDED:

1. J. Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers, New Delhi.

2. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab*, 2ndEd., Taylor and Francis group, London and New York,2009.

BOOKS FOR REFERENCE:

1. Simmons G F, *Differential equation*, Tata Mc Graw Hill, 1991.
2. Martin Braun, *Differential Equations and their Applications*, Springer International, Student Ed.
3. S. L. Ross, *Differential Equations*, 3rd Edition, John Wiley and Sons, India.
4. C.Y. Lin, *Theory and Examples of Ordinary Differential Equations*, World Scientific, 2011.

CORE PAPER-V

THEORY OF REAL FUNCTIONS

Objective: The objective of the course is to have knowledge on limit theorems on functions, limits of functions, continuity of functions and its properties, uniform continuity, differentiability of functions, algebra of functions and Taylor's theorem and, its applications. The student how to deal with real functions and understands uniform continuity, mean value theorems.

Expected Outcome: On the completion of the course, students will have working knowledge on the concepts and theorems of the elementary calculus of functions of one real variable. They will work out problems involving derivatives of function and their applications. They can use derivatives to analyze and sketch the graph of a function of one variable, can also obtain absolute value and relative extrema of functions. This knowledge is basic and students can take all other analysis courses after learning this course.

UNIT-I

L' Hospital's Rules, other Intermediate forms, 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 extreme, Taylor's

series and Maclaurin's series, expansions of exponential and trigonometric functions.

UNIT-II

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.

UNIT-III

Improper integrals: Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions, uniform convergence, Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

UNIT-IV

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 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.

BOOKS RECOMMENDED:

1. R.G. Bartle & D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons.
2. G. Das and S. Pattanayak, *Fundamentals of mathematics analysis*, TMH Publishing Co.
3. S. C. Mallik and S. Arora, *Mathematical analysis*, New Age International Ltd., New Delhi.

BOOK FOR REFERENCES:

1. A. Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014
2. K. A. Ross, *Elementary analysis: the theory of calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004A. Mattuck, Introduction to Analysis, Prentice Hall

3. Charles G. Denlinger, *Elements of real analysis*, Jones and Bartlett (Student Edition), 2011.

CORE PAPER-VI

GROUP THEORY-I

Objective: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of group theory and examples of groups and their properties. This course will lead to future basic courses in advanced mathematics, such as Group theory-II and ring theory.

Expected Outcomes: A student learning this course gets idea on concept and examples of groups and their properties . He understands cyclic groups, permutation groups, normal subgroups and related results. After this course he can opt for courses in ring theory, field theory, commutative algebras, linear classical groups etc. and can be apply this knowledge to problems in physics, computer science, economics and engineering.

UNIT-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 of subgroups, centralizer, normalizer, center of a group,

UNIT-II

Product of two subgroups, Properties of cyclic groups, classification of subgroups of cyclic groups, Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group,

UNIT-III

Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups.

UNIT-IV

Cauchy's theorem for finite abelian groups, group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third

isomorphism theorems.

BOOKS RECOMMENDED:

1. Joseph A. Gallian, *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi
2. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.

BOOK FOR REFERENCES:

1. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
2. Joseph I. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
3. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

CORE PAPER-VII

PARTIAL DIFFERENTIAL EQUATIONS AND SYSTEM OF ODEs

Objective: The objective of this course is to understand basic methods for solving Partial Differential Equations of first order and second order. In the process, students will be exposed to Charpit's Method, Jacobi Method and solve wave equation, heat equation, Laplace Equation etc. They will also learn classification of Partial Differential Equations and system of ordinary differential equations.

Expected Outcomes: After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non linear evolution equations etc. All these courses are important in engineering and industrial applications for solving boundary value problem.

UNIT-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. Method of Separation of Variables for solving first order partial differential equations.

UNIT-II

Derivation 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.

UNIT-III

The Cauchy problem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end. Equations with non-homogeneous boundary conditions, Non- Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem

UNIT-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, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations.

LIST OF PRACTICALS (USING ANY SOFTWARE)

- (i) Solution of Cauchy problem for first order PDE.
- (ii) Finding the characteristics for the first order PDE.
- (iii) Plot the integral surfaces of a given first order PDE with initial data.

(iv) Solution of wave equation $\frac{\partial^2 u}{\partial t^2} - c \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

- (a) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), x \in R, t > 0$
- (b) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u(0, t) = 0, x \in (0, \infty), t > 0$
- (c) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u_x(0, t) = 0, x \in (0, \infty), t > 0$
- (d) $u(x, 0) = \phi(x), u_t(x, 0) = \psi(x), u(0, t) = 0, u(l, t) = 0, 0 < x < l, t > 0$

(v) Solution of wave equation $\frac{\partial u}{\partial t} - \kappa \frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

- (a) $u(x, 0) = \phi(x), u(0, t) = a, u(l, t) = b, 0 < x < l, t > 0$
- (b) $u(x, 0) = \phi(x), x \in R, 0 < t < T$
- (c) $u(x, 0) = \phi(x), u(0, t) = a, x \in (0, \infty), t \geq 0$

BOOKS RECOMMENDED :

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Birkhauser, Indian reprint, 2014.
2. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India,

BOOK FOR REFERENCES:

1. J Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers, New Delhi,
2. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.
3. Robert C. Mc Owen: Partial Differential Equations, Pearson Education Inc.
4. T Amarnath: An Elementary Course in Partial Differential Equations, Narosa Publications.

CORE PAPER-VIII

NUMERICAL METHODS AND SCIENTIFIC COMPUTING

Use of Scientific Calculator is allowed.

Objective: Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration.

Expected Outcome: Students can handle physical problems to find an approximate solution. After getting trained a student can opt for advance courses in numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Rate of convergence, Algorithms, Errors: Relative, Absolute, Round off, Truncation.

Approximations in Scientific computing, Error propagation and amplification, conditioning, stability and accuracy, computer arithmetic mathematical software and libraries, visualisation,

Numerical solution of non-linear equations: Bisection method, Regula- Falsi method, Secant method, Newton- Raphson method, Fixed-point Iteration method.

UNIT-II

Rate of convergence of the above methods. System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Computing eigen-values and eigenvectors

UNIT-III

Polynomial interpolation: Existence uniqueness of interpolating polynomials. Lagrange and Newtons divided difference interpolation, Error in interpolation, Central difference & averaging operators, Gauss-forward and backward difference interpolation. Hermite and Spline interpolation, piecewise polynomial interpolation.

UNIT-IV

Numerical Integration: Some simple quadrature rules, Newton-Cotes rules, Trapezoidal rule, Simpsons rule, Simpsons *3/8th* rule, Numerical differentiation and integration, Chebyshev differentiation and FFT, Richardson extrapolation.

PRACTICAL/LAB WORK TO BE PERFORMED ON A COMPUTER:

Use of computer aided software (CAS), for example *Matlab / Mathematica / Maple / Maxima* etc., for developing the following Numerical programs:

- (i) Calculate the sum $1/1 + 1/2 + 1/3 + 1/4 + \dots + 1/N$.
- (ii) To find the absolute value of an integer.
- (iii) Enter- 100 integers into an array and sort them in an ascending' order.
- (iv) Any two of the following
 - (a) Bisection Method
 - (b) Newton Raphson Method
 - (c) Secant Method
 - (d) Regular Falsi Method
 - (v) Gauss-Jacobi Method
 - (vi) SOR Method or Gauss-Siedel Method
 - (vii) Lagrange Interpolation or Newton Interpolation

(viii) Simpson's rule.

Note: For any of the CAS *Matlab / Mathematica / Maple / Maxima* etc., Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expression, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

BOOKS RECOMMENDED:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New age International Publisher, India,
2. Michael Heath: *Scientific Computing : An introductory Survey*.

BOOK FOR REFERENCES:

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. Kendall E. Atkinson: *An Introduction to Numerical Analysis*
3. C. F. Gerald and P. O. Wheatley, *App.ied Numerical Analysis*, Pearson Education, India, 7th Edition, 2008
4. S. D. Conte & S. de Boor: *Elementary Numerical Analysis: An Algorithmic Approach*.

CORE PAPER-IX

TOPOLOGY OF METRIC SPACES

Objective: This is an introductory course in topology of metric spaces. The objective of this course is to impart knowledge on open sets, closed sets, continuous functions, connectedness and compactness in metric spaces.

Expected Outcomes: On successful completion of the course students will learn to work with abstract topological spaces. This is a foundation course for all analysis courses in future.

UNIT-I

Metric spaces, sequences in metric spaces, Cauchy sequences, complete metric spaces, open and closed balls, neighborhood, open set, interior of a set, limit point of a set, closed set, diameter of

a set, Cantor's theorem,

UNIT-II

Subspaces, Countability Axioms and Separability, Baire's Category theorem

UNIT-III

Continuity: Continuous mappings, Extension theorems, Real and Complex valued Continuous functions, Uniform continuity, Homeomorphism, Equivalent metrics and isometry, uniform convergence of sequences of functions.

UNIT-IV

Contraction mappings and applications, connectedness, Local connectedness, Bounded sets and compactness, other characterization of compactness, continuous functions on compact spaces,

BOOKS RECOMMENDED:

1. Satish Shirali & Harikishan L. Vasudeva, *Metric Spaces*, Springer Verlag London (2006)
(First Indian Reprint 2009)

BOOK FOR REFERENCES:

1. S. Kumaresan, *Topology of Metric Spaces*, Narosa Publishing House, Second Edition 2011.

CORE PAPER-X

RING THEORY

Objective: This is a second course in modern algebra which deals with ring theory. Some basics of ring theory like rings, subrings, ideals, ring homomorphisms and their properties and. This course is an integral part of any course on Modern algebra the others being Group theory and Field Theory.

Expected Outcomes: After completing this course, this will help students to continue more courses in advanced Ring theory modules, Galois groups.

UNIT-I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring, Ideals, ideal generated by a subset of a ring, factor rings, operations on

ideals.

UNIT-II

Prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

UNIT-III

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, Unique factorization in $Z[x]$.

UNIT-IV

Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

BOOKS RECOMMENDED:

1. Joseph A. Gallian, *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi.
2. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.

BOOK FOR REFERENCES:

1. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
2. Joseph I. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
3. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

CORE PAPER - XI **MULTIVARIATE CALCULUS**

Objective: The objective of this course is to introduce functions of several variables to a student after he has taken a course in one variable calculus. The course will introduce partial derivatives and several of its consequences and will introduce double and triple integrals along with line integrals which are fundamental to all streams where calculus can be used.

Expected Outcomes: After reading this course a student will be able to calculate partial derivatives, directional derivatives, extreme values and can calculate double, triple and line integrals. He will have an idea of basic vector calculus including Green's theorem, divergence theorem and Stokes theorem. He can take courses in calculus on manifolds, Differential geometry and can help in numerical computations involving several variables.

UNIT-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, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT-II

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Definition of vector field, divergence and curl, Double integration over rectangular region, double integration over nonrectangular region. Double integrals in polar co-ordinates,

UNIT-III

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-IV

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, The Divergence theorem.

BOOKS RECOMMENDED:

1. M. J. Strauss, G. L. Bradley and K. J. Smith, *Calculus* (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. S C Mallik and S Arora: *Mathematical Analysis*, New Age International Publications

BOOK FOR REFERENCES:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer(SIE). Indian reprint, 2005.
3. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks/Cole, Thomson Learning, USA, 2001.
4. S Ghorpade, B V Limaye, *Multivariable calculus*, Springer international edition

CORE PAPER –XII

LINEAR ALGEBRA

Objective: Linear algebra is a basic course in almost all branches of science. A full course in undergraduate program will help students in finding real life applications later.. The objective of this course is to introduce a student the basics of linear algebra and some of its application

Expected Outcomes: The student will use this knowledge wherever he/She goes after undergraduate program. It has applications in computer science, finance mathematics, industrial mathematics, bio mathematics and what not.

UNIT-I

Vector spaces, subspaces, examples, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

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

UNIT-II

Matrix representation of a linear transformation, Algebra of linear transformations, Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix, Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Basics of Fields.

UNIT-III

Eigenspaces of a linear operator, diagonalizability. Invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, Inner product spaces and norms, Gram-Schmidt orthogonalization process,

UNIT-IV

Orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

BOOKS RECOMMENDED:

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra* (4th Edition), Pearson, 2018.

BOOKS FOR REFERENCE:

1. Rao A R and Bhim Sankaram Linear Algebra Hindustan Publishing house.
2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

CORE PAPER-XIII COMPLEX ANALYSIS

Objectives: The objective of the course is aimed to provide an introduction to the theories for functions of a complex variable. The concepts of analyticity and complex integration are presented. The Cauchy's theorem and its applications, the calculus of residues and its applications are discussed in detail.

Expected Outcomes: Students will be able to handle certain integrals not evaluated earlier and will know a technique for counting the zeros of polynomials. This course is prerequisite to many other advance analysis courses.

UNIT-I

Complex Numbers and Complex plane: Basic properties, convergence, Sets in the Complex plane, Functions on the Complex plane: Continuous functions, holomorphic functions, power series, Integration along curves.

UNIT-II

Cauchy's Theorem and Its Applications: Goursat's theorem, Local existence of primitives and Cauchy's theorem in a disc, Evaluation of some integrals, Cauchy's integral formulas.

UNIT-III

Morera's theorem, Sequences of holomorphic functions, Holomorphic functions defined in terms of integrals, Schwarz reflection principle, Zeros and poles.

UNIT-IV

Meromorphic Functions and the Logarithm: The residue formula, Examples, Singularities and meromorphic functions, The argument principle and applications, The complex logarithm.

BOOKS RECOMMENDED:

1. Elias M. Stein & Rami Shakarchi, *Complex Analysis*, Princeton University press, Princeton and Oxford, 2003.

BOOKS FOR REFERENCE:

1. James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications* (Eighth Edition), McGraw - Hill International Edition, 2009.
2. G. F. Simmons, *Introduction to Topology and Modern Analysis*, Mcgraw-Hill, Edition 2004.
3. Joseph Bak and Donald 1. Newman, *Complex analysis* (2ndEdition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

CORE PAPER-XIV
GROUP-THEORY-II

Objective: The objective of this course is to be exposed to more advanced results in group theory after completing a basic course. The course introduces results on automorphism, commutator subgroup, group action Sylow theorems etc.

Expected Outcomes: The knowledge of automorphism helps to study more on field theory. Students learn on direct products, group actions, class equations and their applications with proof of all results. This course helps to opt for more advanced courses in algebra and linear classical groups.

UNIT-I

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. characteristic subgroups.

UNIT-II

Commutator subgroup and its properties, 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.

UNIT-III

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

UNIT-IV

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.

BOOKS RECOMMENDED:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, Narosa Publishing House, New Delhi.
2. Joseph A. Gallian *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi.

BOOK FOR REFERENCES:

1. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
2. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
3. J.R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000.

Discipline Specific Elective Paper-1

LINEAR PROGRAMMING

Objective: The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications. Also, students will know the application of linear Programming method in Game Theory.

Expected Outcomes: More knowledge on this topic in higher studies will help students to deal industrial models. This is also prerequisite for studying advanced courses in Nonlinear Programming Problems, Inventory Control Problem and Queuing Theory etc.

UNIT-I

Introduction to linear Programming problem, 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.

UNIT-II

Duality, formulation of the dual problem, primal-dual relationships, Fundamental Theorem of Duality, economic interpretation of the dual.

UNIT-III

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-IV

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.

BOOKS RECOMMENDED:

1. Kanti Swarup, Operations Research, Sultan Chand & Sons, New Delhi. Books.

BOOKS FOR REFERENCE:

1. S. Hillier and G.J. Lieberman, *Introduction to Operations Research- Concepts and Cases* (9th Edition), TataMcGraw Hill, 2010.
2. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows* (2nd edition), John Wiley and Sons, India, 2004.
3. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.
4. Hamdy A. Taha, *Operations Research: An Introduction* (10th edition), Pearson, 2017.

Discipline Specific Elective Paper-II

Probability and Statistics

Objective: The objective of the course is to expertise the student to the extensive role of statistics in everyday life and computation, which has made this course a core course in all branches of mathematical and engineering sciences.

Expected Outcome: The students shall learn probability and statistics for various random variables, multivariate distributions, correlations and relations. He shall learn law of large numbers and shall be able to do basic numerical calculations.

UNIT-I

Probability: Introduction, Sample spaces, Events, probability of events, rules of probability, conditional probability, independent events, Bayes's theorem,

Probability distributions and probability densities: random variables, probability distributions, continuous random variables, probability density functions, Multivariate distributions, joint distribution function, joint probability density function, marginal distributions, conditional distributions, conditional density, The theory in practice, data analysis, frequency distribution, class limits, class frequencies, class boundary, class interval, class mark, skewed data, multimodality, graphical representation of the data, measures of location and variability. Population, sample, parameters

UNIT-II

Mathematical Expectation: Introduction, expected value of random variable, moments, Chebyshev's theorem, moment generating functions, product moments, moments of linear combinations of random variables, conditional expectations, the theory in practice, measures of location, dispersion

UNIT-III

Special probability distributions: Discrete Uniform distribution, binomial distribution, Negative binomial, geometric, hypergeometric, poisson, multinomial distribution, multinomial. Special probability densities; Uniform distribution, gamma, exponential, gamma, chi-square, beta distribution, normal, normal approximation to binomial, bivariate normal, Functions of random variables, distribution function technique, transformation technique-one variable, several

variables, moment generating function technique,

UNIT-IV

Sampling distributions: population distribution, random sample, sampling distribution of mean, Central Limit theorem, Sampling distribution of the mean: finite populations, chi-square, t, F distributions, regression and correlation: Bivariate regression, regression equation, Linear regression, method of least squares.

BOOKS RECOMMENDED:

1. Irwin Miller and Marylees Miller, *John E. Freund's Mathematical Statistics with Applications* (8th Edition), Pearson, Asia, 2014.

BOOK FOR REFERENCES:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
2. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, (3rd Edition), Tata McGraw- Hill, Reprint 2007.
3. Sheldon Ross, *Introduction to Probability Models* (9th Edition), Academic Press, Indian Reprint, 2007.

Discipline Specific Elective Paper-III

DIFFERENTIAL GEOMETRY

Objective: After learning methods on curve tracing and Analytic Geometry, the objective of this course is to teach Differential geometry of curves and surfaces which trains a student using tools in calculus to derive intrinsic properties of plain curves and space curves.

Expected Outcome: After completing this course a student will learn on Serret-Frenet formulae, relation between tangent, normal and binormals, first and second fundamental forms and ideas on various curvatures. He has scope to take more advanced courses in surface theory and geometry.

UNIT-I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves.

UNIT-II

Evolutes and involutes of curves. Theory of Surfaces: Parametric curves on surfaces, surfaces of revolution, helicoids, Direction coefficients. First and second Fundamental forms.

UNIT-III

Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula,

Conjugate and Asymptotic lines. Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

UNIT-IV

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem. Surfaces of constant curvature.

BOOKS RECOMMENDED:

1. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, 2012.

BOOK FOR REFERENCES:

1. A. Pressley, *Elementary Differential Geometry*, Springer International Edition, 2014.
2. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press 2003.
4. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.

Discipline Specific Elective Paper-IV NUMBER THEORY

Objective: The main objective of this course is to build up the basic theory of the integers, prime numbers and their primitive roots, the theory of congruence, quadratic reciprocity law and number theoretic functions, Fermat's last theorem, to acquire knowledge in cryptography specially in RSA encryption and decryption.

Expected Outcomes: Upon successful completion of this course students will be able to know the basic definitions and theorems in number theory, to identify order of an integer, primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, to understand modular arithmetic number-theoretic functions and apply them to cryptography.

UNIT- I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

UNIT-II

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

UNIT-III

Order of an integer modulo n , primitive roots for primes, composite numbers having

primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, quadratic reciprocity, quadratic congruences with composite moduli.

UNIT-IV

Affine ciphers, Hill ciphers, p vgh v g gv ublic key cryptography, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last Theorem.

BOOKS RECOMMENDED:

1. David M.Burton, *Elementary Number Theory* (6thEdition), TataMcGraw-Hill Edition, Indian reprint, 2007.

BOOK FOR REFERENCES:

1. Thomas Koshy, *Elementary Number Theory with Applications* (2nd Edition), Academic Press, 2007.

2. Neville Robinns, *Beginning Number Theory* (2ndEdition), Narosa Publishing House Pvt. Limited, Delhi,2007.

OR

Discipline Specific Elective Paper-IV

PROJECT

Guidelines for +3 (CBCS) Under Graduate(B.A./B.Sc.) Mathematics (Honours) Project

1. Any student registering for doing project is required to inform the HOD, Mathematics the name of his/her project supervisor(s) at the time of pre-registration.
2. By the last date of add and drop, the student must submit the “Project Registration Form”, appended as Annexure-I to this document, to the HOD, Mathematics. This form requires a project title, the signature of the student, signature(s) of the supervisor(s) and the signature of the HOD, Mathematics of the college/university.
3. The project supervisor(s) should normally be a faculty member(s) of the Department of Mathematics and the topic of the project should be relevant to Mathematical Sciences. If a student desires to have a Project Supervisor from another department of the institute, the prior approval for the same should be sought from the HOD, Mathematics.
4. A student may have at the most two Project Supervisors. If a student desires to have two supervisors, at least one of these should be from the Department of Mathematics.
5. The student(s) will be required to submit one progress report and a final report of the Project to the HOD, Mathematics. The progress report is to be submitted in the sixth

week of the semester in which the project is undertaken. The hard copy and an electronic version of the final report of the project should be submitted two weeks before the end semester examination of the sixth semester. In addition the student will be required to make an oral presentation in front of a committee (Under Graduate (B.A./ B.Sc.) Mathematics (Honours) Project committee of the college in which supervisor is one of the members) constituted for this purpose by the Department of Mathematics of the college.

6. The student is expected to devote about 100 hours. The project will be evaluated by a committee of faculty members at the end of the sixth semester. The committee will be constituted by the Under Graduate (B.A./B.Sc.) Mathematics (Honours) Project committee of the college keeping in mind the areas of project they will cover.
7. In each semester the grade of a student will be awarded by the committee in consultation with his/her project supervisor(s). The project is evaluated on the basis of the following components: First Progress Reports: 20%; second/Final Report: 30%; Presentation: 30%; Viva: 20%.
8. Project progress reports should normally be no longer than 250 words and final report should not be longer than 40 A4 size pages in double spacing. Each final project report need to contain the following: (i) Abstract (ii) Table of contents (iii) Review of literature (iv) Main text(v) List of references. It may be desirable to arrange the main text as an introduction, the main body and conclusions.

GUIDELINES FOR STRUCTURING CONTENTS

Sequence of Contents:

The following sequence for the thesis organization should be followed:

- | | |
|-------------------|------------------------------------|
| (i) Preliminaries | Title Page |
| | Certificate |
| | Abstract/Synopsis |
| | Acknowledgement and/ or Dedication |
| | Table of Contents |

List of Figures, Tables, Illustrations,
Symbols, etc (wherever applicable)

(ii) Text of Thesis

Introduction

The body of the thesis, summary and conclusions

(iii) Reference Material

List of References, Bibliography

(iv) Appendices

NOTE:

1. *Synopsis/Abstract* should be self-complete and contain no citations for which the thesis has to be referred.

2. The Text of the Thesis

(a) *Introduction:*

Introduction may be the first chapter or its first major division. In either case, it should contain a brief statement of the problem investigated. It should outline the scope, aim, general character of the research and the reasons for the student's interest in the problem.

(b) *The body of Thesis*

This is the substance of the dissertation inclusive of all divisions, subdivisions, tables, figures, etc.

(c) *Summary and conclusions*

If required, these are given as the last major division (chapter) of the text. A further and final subdivision titled "*Scope for Further Work*" may follow.

(d) *Reference material*

The list of references should appear as a consolidated list with references listed either alphabetically or sequentially as they appear in the text of the thesis.

For referencing an article in a scientific journal the suggested format should contain the following information: authors, title, name of journal, volume number, page numbers and year. For referencing an article published in a book, the suggested format should contain, authors, the title of the book, editors, publisher, year, page number of the article in the book being referred to. For referencing a thesis the suggested format should contain, author, the title of thesis, where thesis was submitted or awarded, year.

ANNEXURE-I
Department of Mathematics
Project Registration Form

Name of the college/university:

Name of the student:

Roll No. :

e-mail :

Name of the supervisor(s):

Department(s):

e-mail(s):

Title of the Project:

Signature of the Student:

Signature of supervisor(s): (i)

(ii)

Signature of HOD, Mathematics:

GENERIC ELECTIVES (TWO PAPER CHOICE)

Generic Elective Paper I

CALCULUS AND DIFFERENTIAL EQUATIONS

Objective: Calculus invented by Newton and Leibnitz is a powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Expected Outcomes: After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Review of limits, continuity and differentiability of functions of one variable and their properties, Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's theorem and Cauchy's form of remainder, Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(1+x)$, $(1+x)^m$, L' Hospital's Rule, other Intermediate forms.

UNIT-III

Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylor's theorem and Maclaurin's theorem for functions of two variables (statements & applications), Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers (Formulae & its applications), Concepts of Multiple integrals & its applications.

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree. Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

BOOKS RECOMMENDED:

1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.
3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.

BOOK FOR REFERENCES:

1. H.Anton,I.Bivens and S.Davis,*Calculus*,10th Ed.,John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
2. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
4. B. P.Acharya and D. C.Sahu: Analytical Geometry of Quadratic Surfaces, Kalyani Publishers.

Generic Elective Paper II

ALGEBRA

Objective: This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural

numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Expected Outcomes: The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments

UNIT-II

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-III

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems,.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, matrix representation of a linear transformation, Eigen values, Eigen vectors of a matrix.

BOOKS RECOMMENDED:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
2. V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra ,

Affiliated East-West Press Pvt. Ltd

BOOKS FOR REFERENCE:

1. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
2. B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition 2010.
3. Ward Cheney, David Kincaid. Linear algebra theory and applications, Jones and Bartlett, 2010.

OR

GENERIC ELECTIVES (FOUR PAPERS CHOICE)

Generic Elective Paper I

CALCULUS AND DIFFERENTIAL EQUATIONS

Objective: Calculus invented by Newton and Leibnitz is powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Expected Outcomes: After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Review of limits, continuity and differentiability of functions of one variable and their properties, Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's theorem and Cauchy's form of remainder, Taylor's series, Maclaurin's series of $\sin x$, $\cos x$, e^x , $\log(1+x)$, $(1+x)^m$, L' Hospital's Rule, other Intermediate forms.

UNIT-III

Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylor's theorem and Maclaurin's theorem for functions of two variables (statements & applications), Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers (Formulae & its applications), Concepts of Multiple integrals & its applications.

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree. Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

BOOKS RECOMMENDED:

1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.
3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.

BOOKS FOR REFERENCE:

1. H. Anton, I. Bivens and S. Davis, *Calculus*, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

2. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
4. B. P.Acharya and D. C. Sahu: Analytical Geometry of Quadratic Surfaces, Kalyani Publishers.

Generic Elective Paper II

ALGEBRA

Objective: This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Expected Outcomes: The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets ,relations, Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments

UNIT-II

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-III

Matrices, algebra of matrices , determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix,

Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems,.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, matrix representation of a linear transformation, Eigen values, Eigen vectors of a matrix.

BOOKS RECOMMENDED:

- 1 Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
- 2 V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd

BOOKS FOR REFERENCE:

1. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
2. B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition 2010.
3. Ward Cheney, David Kincaid. Linear algebra theory and applications, Jones and Bartlett, 2010

Generic Elective Paper III

REAL ANALYSIS

Objective: The objective of the course is to have the knowledge on basic properties of the field of real numbers, studying Bolzano-Weiersstrass Theorem, sequences and convergence of sequences, series of real numbers and its convergence etc. This is one of the core courses essential to start doing mathematics.

Expected Outcome: On successful completion of this course, students will be able to handle fundamental properties of the real numbers that lead to the formal development of real

analysis and understand limits and their use in sequences, series, differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of R , ε -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 .

UNIT-II

Intervals, Interior point, Open Sets, Closed sets, Limit points of a set, Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set. 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.

UNIT-III

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n th root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT-IV

Sequence and Series of functions, pointwise and uniform convergences, M_n test, M test, statement of results about uniform convergence, differentiability and integrability of function, power series and radius of convergence.

BOOKS RECOMMENDED:

1. S.C. Mallik and S. Arora- Mathematical Analysis, New Age International Publications.
2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.

BOOKS FOR REFERENCE:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and

- Sons (Asia) Pvt. Ltd., Singapore,2002.
2. A. Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014.
 3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall,2001.
 4. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, Jones & Bartlett, Second Edition, 2010.

Generic Elective Paper IV

NUMERICAL METHODS

Objective: Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of nonlinear equations, systems of linear equations, differential equations, Interpolation, differentiation, evaluating integration.

Expected Outcome: Students can handle physical problems to find an approximated solution. After getting trained a student can opt for advance courses in Numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method.

Gauss Elimination and Gauss Jordan methods, LU decomposition, Gauss-Jacobi, Gauss-Siedel.

UNIT-II

Lagrange and Newton interpolation: linear and higher order, finite difference operators.

UNIT-III

Numerical differentiation: forward difference, backward difference and central Difference.

UNIT-IV

Integration: trapezoidal rule, Simpson's rule, Euler's method, Runge-Kutta methods of orders two and four.

BOOKS RECOMMENDED:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

BOOKS FOR REFERENCE:

1. S. S. Sastry, *Introductory method for Numerical Analysis*, PHI New Delhi, 2012.
2. S. D. Conte and Carl De Boor, *Elementary Numerical Analysis*, Mc Graw Hill, 1980.

**PROPOSED STRUCTURE OF THE +3 UNDER GRADUATE (B.A/B.SC)
MATHEMATICS (PASS) SYLLABUS
BASED ON CHOICE BASED CREDIT SYSTEM (CBCS)**

Semester	Course Number	Title of the Course	Number of credits assigned to the course		Total Credits
			Theory	Practical(P)/ Tutorial((T)	
DSC 4 PAPERS					
	MATH- DSC-1	Calculus and Differential equations	5	1	6
	MATH-DSC2	Algebra	5	1	6
	MATH-DSC-3	Real Analysis	5	1	6
	MATH-DSC-4	Numerical Methods	5	1	6
DSE 2 PAPERS					
	MATH- DSE-1	Group Theory	5	1	6
	MATH-DSE-2	Linear Programming	5	1	6
TOTAL					36

**B.A./B.SC.(PASS)-MATHEMATICS
MATHEMATICS PAPERS FOR PASS STUDENTS**

Discipline Specific Core – 4 papers

Discipline Specific Elective – 2 papers

Marks per paper –Mid term : 20 marks, End term : 80 marks

Total – 100 marks Credit per paper – 6

Teaching hours per paper – 50 hours Theory classes + 10 hours tutorial

Discipline Specific Core Paper I
CALCULUS AND DIFFERENTIAL EQUATIONS

Objective: Calculus invented by Newton and Leibnitz is powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Excepted Outcomes: After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Review of limits, continuity and differentiability of functions of one variable and their properties, Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's theorem and Cauchy's form of remainder, Taylor's series, Maclaurin's series of $\sin x, \cos x, e^x, \log(1+x), (1+x)^m$, L' Hospital's Rule, other Intermediate forms.

UNIT-III

Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of

higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylor's theorem and Maclaurin's theorem for functions of two variables (statements & applications), Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers (Formulae & its applications), Concepts of Multiple integrals & its applications.

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree. Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

BOOKS RECOMMENDED:

1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.
3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.

BOOKS FOR REFERENCE:

1. H. Anton, I. Bivens and S. Davis, *Calculus*, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
2. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
4. B. P. Acharya and D. C. Sahu: Analytical Geometry of Quadratic Surfaces, Kalyani Publisher

ALGEBRA

Objective: This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Expected Outcomes: The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments

UNIT-II

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-III

Matrices, algebra of matrices , determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems,.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, matrix representation of a linear transformation, Eigen values, Eigen vectors of a matrix.

BOOKS RECOMMENDED:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
2. V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd

BOOKS FOR REFERENCE:

1. David C. Lay, Linear Algebra and its Applications, 3rdEd., Pearson Education Asia, Indian Reprint, 2007.
2. B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition, 2010.
3. Ward Cheney, David Kincaid. Linear algebra theory and applications, Jones and Bartlett, 2010.

Discipline Specific Core Paper III

REAL ANALYSIS

Objective: The objective of the course is to have the knowledge on basic properties of the field of real numbers, studying Bolzano- Weierstrass Theorem, sequences and convergence of sequences, series of real numbers and its convergence etc. This is one of the core courses essential to start doing mathematics.

Expected Outcome: On successful completion of this course, students will be able to handle fundamental properties of the real numbers that lead to the formal development of real analysis and understand limits and their use in sequences, series, differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of R , ε -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 .

UNIT-II

Intervals, Interior point, Open Sets, Closed sets, Limit points of a set , Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set. 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.

UNIT-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, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT-IV

Sequence and Series of functions, pointwise and uniform convergences, M_n test, M test, statement of results about uniform convergence, differentiability and integrability of function, power series and radius of convergence.

BOOKS RECOMMENDED:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.

BOOKS FOR REFERENCE:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.
2. A.Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014.
3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall,2001.
4. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, Jones & Bartlett, Second Edition, 2010.

Discipline Specific Core Paper IV

NUMERICAL METHODS

Objective: Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of nonlinear equations, systems of linear equations, differential equations, Interpolation, differentiation, evaluating integration.

Expected Outcome: Students can handle physical problems to find an approximated solution. After getting trained a student can opt for advance courses in numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method.

Gauss Elimination and Gauss Jordan methods, LU decomposition, Gauss-Jacobi, Gauss-Siedel.

UNIT-II

Lagrange and Newton interpolation: linear and higher order, finite difference operators.

UNIT-III

Numerical differentiation: forward difference, backward difference and central Difference.

UNIT-IV

Integration: trapezoidal rule, Simpson's rule, Euler's method, Runge-Kutta methods of orders two and four.

BOOKS RECOMMENDED:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

BOOKS FOR REFERENCE:

1. S. S. Sastry, *Introductory method for Numerical Analysis*, PHI New Delhi, 2012.

2. S. D. Conte and Carl De Boor, Elementary Numerical Analysis, Mc Graw Hill, 1980.

Discipline Specific Elective Paper –I

GROUP THEORY

Objective: Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of group theory and examples of groups and their properties. This course will lead to future basic courses in advanced mathematics, such as Group theory-II and ring theory.

Expected Outcomes: A student learning this course gets idea on concept and examples of groups and their properties. He understands cyclic groups, permutation groups, normal subgroups and related results. After this course he can opt for courses in ring theory, field theory, commutative algebras, linear classical groups etc. and can be apply this knowledge to problems in physics, computer science, economics and engineering.

UNIT-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 of subgroups, centralizer, normalizer, center of a group,

UNIT-II

Product of two subgroups, Properties of cyclic groups, classification of subgroups of cyclic groups, Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group,

UNIT-III

Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups.

UNIT-IV

Cauchy's theorem for finite abelian groups, group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third isomorphism theorems.

BOOKS RECOMMENDED:

1. Joseph A. Gallian, *Contemporary Abstract Algebra* (4th Edition), Narosa Publishing House, New Delhi,
2. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.

BOOK FOR REFERENCES:

1. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
2. Joseph I. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
3. I. N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

Discipline Specific Elective Paper –II

LINEAR PROGRAMMING

Objective: The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications. Also, students will know the application of linear Programming method in Game Theory.

Expected Outcomes: More knowledge on this topic in higher studies will help students to deal industrial models. This is also prerequisite for studying advanced courses in Nonlinear Programming Problems, Inventory Control Problem and Queuing Theory etc.

UNIT-I

Introduction to linear Programming problem, 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.

UNIT-II

Duality, formulation of the dual problem, primal-dual relationships, Fundamental Theorem of Duality, economic interpretation of the dual.

UNIT-III

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-IV

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.

BOOKS RECOMMENDED:

1. Kanti Swarup, Operations Research, Sultan Chand & Sons, New Delhi. Books.

BOOKS FOR REFERENCE:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows* (2nd edition), John Wiley and Sons, India, 2004.
2. Hillier and G.J. Lieberman, *Introduction to Operations Research- Concepts and Cases* (9th Edition), TataMcGraw Hill, 2010.
3. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.
4. Hamdy A. Taha, *Operations Research: An Introduction* (10th edition), Pearson, 2017

SKILL ENHANCEMENT COMPULSORY COURSES (SECC)

Optional for SECC II paper

Skill Enhancement Compulsory Courses (Option1)

COMPUTER GRAPHICS

Development of computer Graphics: Raster Scan and Random Scan graphics storages, displays processors and character generators, colour display techniques, interactive input/output devices. Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti aliasing. Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended:

1. D. Hearn and M.P. Baker-Computer Graphics, 2nd Ed., PrenticeHall of India, 2004.
2. J. D. Foley, A van Dam, S.K. Feiner and J.F. Hughes-Computer Graphics: Principals and Practices, 2nd Ed., Addison-Wesley, MA, 1990.
3. D. F. Rogers-Procedural Elements in Computer Graphics, 2nd Ed., McGraw Hill Book Company, 2001.
4. D. F. Rogers and A. J. Admas-Mathematical Elements in Computer Graphics, 2nd Ed., McGraw Hill Book Company, 1990.

SKILL ENHANCEMENT COURSES (Option2)-

INFORMATION SECURITY

Overview of Security: Protection versus security; aspects of security data integrity, data availability, privacy; security problems, user authentication, Orange Book. Security Threats: Program threats, worms, viruses, Trojan horse, trap door, stack and buffer over flow; system threats- intruders; communication threats- tapping and piracy. Security Mechanisms: Intrusion detection, auditing and logging, tripwire, system-call monitoring.

Books Recommended:

1. C. Pfleeger and S. L. Pfleeger-Security in Computing, 3rd Ed., Prentice-Hall of India, 2007.
2. D. Gollmann-Computer Security, John Wiley and Sons, NY, 2002.
3. J. Piwprzyk, T. Hardjono and J. Seberry-Fundamentals of Computer Security, Springer-Verlag Berlin, 2003. 335
4. J.M. Kizza-Computer Network Security, Springer, 2007.
5. M. Merkow and J. Breithaupt-Information Security: Principles and Practices, Pearson Education, 2006.

Training Programmes to be Imparted

1. There should be training programs in MATLAB/ PYTHON/ R/ MATHEMATICA software for all college teachers to acquaint the teachers on state of the art. Experts from Indian Statistical Institute Kolkata and nearby IIT's should be invited for the programs to add to quality.
2. The faculty members in colleges/universities should be trained in the following courses at University or any Institute of Higher Learning.
 - a) Advanced Group Theory
 - b) Advanced Ring Theory
 - c) Differential Equations & Mathematical Modeling
 - d) Mathematical Finance
 - e) Object Oriented Programming in C++
 - f) Computer Graphics
 - g) Information Security
3. Emphasis may be given for implementation of the programs as listed in the courses with Practical.
4. College/universities should be provided with the recommended set of books in adequate numbers.
5. There should be frequent visits to colleges/universities offering crash courses to initiate some of the new courses.

Required Equipment/Technical Experts

The following equipments/software shall be provided to colleges/universities for smooth running of practical/project:

1. There should be funding to Computer Lab with minimum of 15 computer systems for 30 students with licensed MATLAB/PYTHON/R/MATHEMATICA software.
2. At least one computer programmer must be assigned in computer labs during practical sessions.

ଦକ୍ଷତାବର୍ଦ୍ଧକ ବାଧ୍ୟତାମୂଳକ ପାଠ୍ୟକ୍ରମ
Ability Enhancement Compulsory Course (AECC)
ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା – ଓଡ଼ିଆ
(2019-20)

MIL (Communications) – Odia

ଦ୍ୱିତୀୟ ପର୍ଯ୍ୟାୟ (**2nd Semester**) କଳା, ବିଜ୍ଞାନ ଓ ବାଣିଜ୍ୟ ସାଧାରଣ (**Pass**) / ସମ୍ମାନ (**Hons**)
ଶ୍ରେଣୀ ପାଇଁ ଉଦ୍ଦିଷ୍ଟ

ମୋଟ୍ କ୍ରେଡିଟ୍ସ-୪, ମୋଟ୍ ଶ୍ରେଣୀ ପାଠଦାନ ନିର୍ଦ୍ଦିଷ୍ଟ-୪୦, ଗୋଟିଏ ଶ୍ରେଣୀ ପାଠଦାନର (ପିରିୟଡ୍) ସମୟ ଅବଧି
-୪୫ ମିନିଟ୍, ପାଠ୍ୟକ୍ରମ - ୨, ପୂର୍ଣ୍ଣସଂଖ୍ୟା - ୧୦୦

(Credits – 4) Total Classes - 40, One Period - 45 Minutes, Course - II, Full Marks - 100

ପାଠ୍ୟକ୍ରମର ଭୂମିକା :

ଏହି ପାଠ୍ୟକ୍ରମଟି ପସନ୍ଦ ଓ ଆସ୍ଥାଭିତ୍ତିକ (CBCS / ସିବିସିଏସ୍) ପାଠ୍ୟ ପ୍ରଣାଳୀ ଅନୁସାରେ ପ୍ରସ୍ତୁତ ହୋଇଛି । ବିଭିନ୍ନ ସ୍ତରରେ ଆବଶ୍ୟକ ଅନୁସାରେ ସମସାମୟିକ ପରିସ୍ଥିତିକୁ ନେଇ ଭାବବିନିମୟ ଓ ପାରସ୍ପରିକ ଯୋଗାଯୋଗ ସ୍ଥାପନ କିପରି ଓଡ଼ିଆ ଭାଷାରେ ସହଜରେ, ସରଳରେ ହୋଇପାରିବ – ଏ ଦିଗ ପ୍ରତି ଏଥିରେ ଧ୍ୟାନ ଦିଆଯାଇଛି । ଓଡ଼ିଆ ଭାଷା ଓ ସାହିତ୍ୟର ପ୍ରାୟୋଗିକ ଜ୍ଞାନର ବିକାଶ ନିମିତ୍ତ +୩ ସରୀୟ ବିଦ୍ୟାର୍ଥୀଙ୍କୁ ଏହି ପାଠ୍ୟକ୍ରମର ଖସଡ଼ାଟି ସାହାଯ୍ୟ କରିବ । ସେଥିପାଇଁ ପ୍ରଚଳିତ ଭାଷାର ବୈୟାକରଣିକ, ବ୍ୟାବହାରିକ ଓ ପ୍ରାୟୋଗିକ ଦିଗ ପ୍ରତି ଏଥିରେ ଧ୍ୟାନ ଦିଆଯାଇଛି । ଏଥିରେ ସଂଯୋଗ ପ୍ରକ୍ରିୟାର ଅନୁବିଧି, ଯୋଗାଯୋଗର ତଥ୍ୟ ଓ ତତ୍ତ୍ୱ ପ୍ରତି ଗୁରୁତ୍ୱ ଦିଆଯାଇଛି । ସରକାରୀ କାର୍ଯ୍ୟାଳୟରେ ଓଡ଼ିଆ ଭାଷାର ବ୍ୟବହାରରେ ଏହା ଦକ୍ଷତା ବୃଦ୍ଧି କରିବ । ଓଡ଼ିଆ ଭାଷାର ପ୍ରୟୋଗରେ ସେମାନେ ଶୁଦ୍ଧ ଓ ପରିଚ୍ଛନ୍ନ ଭାବରେ ଯେକୌଣସି ପ୍ରକାର ଜ୍ଞାନର ସୂଚନା ତଥ୍ୟ ଓ ସିଦ୍ଧାନ୍ତକୁ ମୌଖିକ ଓ ଲିଖିତ ସ୍ତରରେ ସହଜରେ ପ୍ରକାଶ କରିପାରିବେ ଏବଂ ସେମାନଙ୍କ ମାତୃଭାଷା ପ୍ରୟୋଗର ବିକାଶ ଘଟିପାରିବ ।

ମୂଲ୍ୟ ବିଭାଜନ ପଦ୍ଧତି : (ସବୁଥିରୁ ବିକଳ୍ପ ପଡ଼ିବ)

- କ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକ (ୟୁନିଟ୍) ରୁ ବିକଳ୍ପସହ ଦୁଇଟି ଲେଖାଏଁ ମୋଟ ୮ଟି ୧୫ନମ୍ବର ବିଶିଷ୍ଟ ଦୀର୍ଘପ୍ରଶ୍ନ ପଡ଼ିବ । ବିଦ୍ୟାର୍ଥୀଙ୍କୁ ୪ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ । (୧୫ x ୪ = ୬୦)
- ଖ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକରୁ ୧୨ଟି ଅତିସଂକ୍ଷିପ୍ତ ପ୍ରଶ୍ନ ପଡ଼ିବ । ସେଥିରୁ ୧୦ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ । (୧୦ x ୨ = ୨୦)
- ଗ) ମହାବିଦ୍ୟାଳୟସ୍ତରୀୟ ଅନ୍ତଃ ପରୀକ୍ଷା (୨୦)
- ମୋଟ୍ ମୂଲ୍ୟାଙ୍କ - ୧୦୦

ସବିଶେଷ ପାଠ୍ୟ

ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା – ଓଡ଼ିଆ (AECC)

ପାଠ୍ୟ-୧ / Course – 1: ଯୋଗାଯୋଗ ଅନୁବିଧି, ରୀତି ଓ ମାଧ୍ୟମ

୧ମ ଏକକ : ଯୋଗାଯୋଗର ପରିଭାଷା, ଅନୁବିଧି, ପରିସର ଓ ପ୍ରକାରଭେଦ

୨ୟ ଏକକ : ସାକ୍ଷାତକାର, ଭାଷଣ କଳା

୩ୟ ଏକକ : ସମ୍ବାଦର ପରିଭାଷା, ପରିସର ଓ ସମ୍ବାଦ ପ୍ରସ୍ତୁତି

୪ର୍ଥ ଏକକ : ଓଡ଼ିଆ ଭାଷାର ବର୍ଣ୍ଣମାଳା, ବର୍ଣ୍ଣାଶୁଦ୍ଧିର ନିରୀକରଣ । (ବନାନ ତୁଟି - ସାଦୃଶ୍ୟଜନିତ ଅଶୁଦ୍ଧି, ଲିଙ୍ଗଗତ ଅଶୁଦ୍ଧି, ସନ୍ଧିଗତ ଅଶୁଦ୍ଧି, ସମାସଗତ ଅଶୁଦ୍ଧି, ବଚନ ଓ ବିଭକ୍ତିଗତ ଅଶୁଦ୍ଧି, ବାକ୍ୟ ବିଧିଜନିତ ଅଶୁଦ୍ଧି, ସମାର୍ଥବୋଧକ ଶବ୍ଦାଶୁଦ୍ଧି, ପ୍ରତ୍ୟୟ ଜନିତ ଅଶୁଦ୍ଧି, ଶବ୍ଦ ସଂଯୋଗାତ୍ମକ ଓ ସ୍ଵରସଙ୍ଗତି ଜନିତ ଅଶୁଦ୍ଧି)

ସହାୟକ ଗ୍ରନ୍ଥସୂଚୀ (ପାଠ୍ୟ-୧ / Course – 1)

୧. ଯୋଗାଯୋଗ ମୂଳକ ମାତୃଭାଷା (ଓଡ଼ିଆ) ସାମଲ ବିରଞ୍ଚି ନାରାୟଣ, ସତ୍ୟନାରାୟଣ ବୁକ୍ ଷ୍ଟୋର, କଟକ ।
୨. ସଂଯୋଗ ଅନୁବିଧି, ସନ୍ତୋଷ କୁମାର ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ
୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ - କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ, ସତ୍ୟନାରାୟଣ ବୁକ୍ ଷ୍ଟୋର, କଟକ
୪. ପ୍ରାୟୋଗିକ ଓଡ଼ିଆ ଭାଷା – ଓଡ଼ିଶା ରାଜ୍ୟପାଠ୍ୟ ପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ଵର
୫. ସମ୍ବାଦ ଓ ସାମ୍ବାଦିକତା – ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡ଼ିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ଵର
୬. ନିର୍ଭୁଲ ଲେଖାର ମୂଳସୂତ୍ର, ନୀଳାଦିଭୂଷଣ ହରିଚନ୍ଦନ, ପି.ସି.ଆର ପବ୍ଲିକେସନ, ଭୁବନେଶ୍ଵର
୭. ସର୍ବସାର ବ୍ୟାକରଣ - ନାରାୟଣ ମହାପାତ୍ର ଓ ଶ୍ରୀଧର ଦାସ, ନିୟୁ ଷ୍ଟୁଡେଣ୍ଟସ୍ ଷ୍ଟୋର, କଟକ

**ENVIRONMENTAL STUDIES
&
DISASTER MANAGEMENT
(AECC I)
SEMESTER-1**

FOR UNDER-GRADUATE COURSES ARTS, SCIENCE AND COMMERCE (2021-22)

Course Objectives:

The following objectives have been framed for the proposed curriculum to: -

1. Find out solutions for a sustainable Earth for future generation
2. Make the stakeholders aware of their rights, responsibilities, consequences of their conduct towards nature and build resilience
3. Develop a sense of equitable use of resources and their preservation for the future generation
4. Sensitize the stakeholders on Disaster and Pandemic preparedness

Learning Outcome:

On successful completion of the course students will be able to:

1. Identify the historical origins of destructive attitudes and practices toward the natural environment;
2. Know the compatibility of human and environmental/ecological values
3. Know the natural resources available on earth and how to conserve and manage them
4. Understand the disasters and pandemic they are facing and empower the new generation to face the new challenges

Pedagogy/ Teaching Transaction

1. Classroom teaching
2. Self- Study
3. E-Learning
4. Guest Lectures
5. Case Study Analysis and Discussion
6. Field Trip/Visit
7. Seminars
8. Audio, Video, Film Based Discussion/Analysis
9. Group Exercises
10. Group Discussions

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**ENVIRONMENTAL STUDIES
&
DISASTER MANAGEMENT**

(AECC I)

SEMESTER-1

FOR UNDER-GRADUATE COURSES ARTS, SCIENCE AND COMMERCE (2021-22)
FULL MARK-100 (Credit-4)

Unit-I (Environment)

(13 periods x 45 min)

The Environment: The Atmosphere, Lithosphere, Hydrosphere, Biosphere (01 period)

Ecosystem: Energy flow in the ecosystem (01 period)

Biogeochemical Cycle: Water Cycle, Carbon Cycle, Nitrogen Cycle (02 periods)

Pollution: Water Pollution, Air Pollution, Soil Pollution, Radiation Pollution, Industrial Pollution, Light Pollution, Sound Pollution (05 periods)

Environmental Laws (Water Act 1974, Air Act 1981, The Wildlife Protection Act 1972, The Environment Protection Act 1986), The Forest Conservation Act 1980 (04 periods)

Unit-II (Climate Change & Sustainable Development) (13 periods x 45 min)

Population Ecology: Individuals, Species, Population, Community (01 period)

Human Population Growth, Population Control Methods (01 period)

Urbanization and its effect on society (01 period)

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Climate Change: Causes, effect, Global Warming, Carbon footprint and environmental protection (05 periods)

Steps taken towards sustainable development: Ban of single-use plastics, Automobile Scrapping Policy, Promotion of Electrical Vehicles (03 periods)

Brief idea on Sustainable Development Goals (SDGs), Agenda 21 of Rio Earth Summit (02 periods)

Unit-III (Disaster Management)

(13 periods x 45 min)

Disaster Management: Types of disasters (Natural and Man-made) and their causes and effect) (02 periods)

Vulnerability Assessment and Risk Analysis: Vulnerability to various disasters (Flood, Cyclone, Earthquake, Heat waves and Lightning) (02 periods)

Institutional Framework: Institutional arrangements for disaster management (National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), National Disaster Response Force (NDRF) and Odisha Disaster Rapid Action Force (ODRAF) (02 periods)

Preparedness Measures: Disaster Management Cycle, Early Warning System, Pre-Disaster and Post-Disaster Preparedness, Strengthening of SDMA and DDMA, Community Preparedness, Stakeholder participation, Corporate Social Responsibility (CSR) (05 periods)

Survival Skills: Survival skills adopted during and after disaster (Flood,

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Unit-IV (Public Health Management)

(13 periods x 45min)

Brief idea on Epidemics and Pandemics (01 period)

Non-communicable diseases with special reference to Cardiovascular diseases, Cancer, Diabetes, Hypertension and Obesity and their prevention (02 periods)

Communicable diseases with special reference to Covid-19, Flu, Hepatitis, AIDS and Tuberculosis and their transmission (02 periods)

Dynamics of Disease Transmission: Mode of transmission (Direct/Indirect), Events after infection: Immunity (Active vrs Passive, Innate vrs Acquired, Herd Immunity), Incubation Period (02 periods)

Prevention of Epidemics/Pandemics Diseases: Preventing Measures (Quarantine, Sanitization, Personal Protective measures such as Hand washing and use of protective devices, Vaccination); Control Measures (Surveillance, Isolation, Contact Tracing) (03 Periods)

Life Style management (Diet, Physical Exercise, Yoga and sleeping habit) (02 periods)

Role of Different Sectors in Managing Health Disaster: Role of Government (Centre and State), Community, Civil Society, Student mass, NGOs (01 period)

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Books Recommended:

1. Asthana DK and Asthana M: A Text Book of Environmental Studies, S. Chand, New Delhi
2. Bharucha E: A Text Book of Environmental Studies, New Delhi: UGC
3. Dash MC and Mishra PC: Man and Environment, McMillan, London
4. Disaster Management and Mitigation Plan, 2013 of Dept. of Health & Family Welfare, Govt. of Odisha*
5. Mishra DD: *Fundamental Concepts in Environmental Studies*, S. Chand, New Delhi
6. National Policy on Disaster Management, 2009*
7. National Disaster Management Plan, 2019*
8. Odum EP: *Fundamentals of Ecology*, Natraj Publications
9. State Disaster Management Plan, 2019 of Government of Odisha*
10. Standard Operating Procedure (SOP) issued by Govt. of India and Govt. Of Odisha on Public Health Managements in the websites: www.mohfw.gov.in and health.odisha.gov.in*
11. The Disaster Management Act, 2005 of Government of India*

[Note: Star (*) marked References, published by the State as well as Central Government are available in the open sources]

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SKILL ENHANCEMENT COURSES (SEC)

As per the CBCS regulation, the student registered under Honours course in any subject has to opt for two SEC courses and a student registered under Pass stream has to opt for four SEC courses. In this context, Some options are provided here. Syllabus of individual subjects also have listed additional skill based papers at the end. In addition, the combined board and Project OHEPEE has also formulated two skill papers in great detail keeping requirements of spoken English and quantitative as well as logical thinking abilities in mind. These two Special SEC papers are available as separate Model Syllabi.

Optional for SEC paper

Total Marks- 100

Skill Enhancement Courses (SEC Option-I)

ENGLISH COMMUNICATION

Introduction: This paper intends to build up the four primary skills in students in the academic as well as in the wider domains of use like public offices. The books recommended only provide guidelines for what to teach, and the list is in no way exhaustive. Teachers must be free and resourceful enough to collect teaching materials on their own, and even use newspaper clippings as teaching materials.

This is an activity-based, goal-oriented, functional course in English Communication, which aims to make the students able and efficient communicators by helping them to be self-reflexive about English. This course has a pre-defined context of being supportive and complementary to the core courses in various disciplines. Therefore, unlike most other courses in English Communication on offer, it does not seek to build facile fluency that passes off as communicative competence. Rather, it intends to equip the students with the relevant skills of presentation and expression needed in the academic as well as in the professional domains of communicative use. While reading skills exercises are meant to promote the acquisition of analytical and comprehension skills, writing skills exercises are centered on sentence construction, paragraph development and précis writing. Teachers must be free and flexible enough in relation to teaching materials, using newspaper clippings, non-conventional and multi-media resources in the classroom. There is ample scope to build the speaking and listening skills of students in the way the course is planned with an emphasis on interactive learning and articulation.

UNIT 1: Introduction

- (i) What is communication?
- (ii) Types of communication (Horizontal, Vertical, Interpersonal, Grapevine),
- (iii) Uses of Communication, Inter-cultural communication, Communication today:
- (iv) Distinct features of Indianisation, alternative texts of language learning, global English and English in the print and electronic media in India.

UNIT 2: The Four Skills and Prospect of new material in language learning

- (i) Listening-Passive and active, Speaking effective, intelligibility and clarity
- (ii) Methods and techniques of reading such as skimming, scanning and searching for information; Reading to understand the literal, metaphorical and suggested meaning of a passage,
- (iii) Identifying the tone (admiring, accusatory, ironical, sympathetic, evasive, indecisive, ambiguous, neutral etc.) of the writer and view-points.
- (iv) Cohesive and Coherent writing

UNIT 3: Grammatical and Composition Skills

- (i) Doing exercises like filling in the blanks, correcting errors, choosing correct forms out of alternative choices, joining clauses, rewriting sentences as directed, and replacing indicated sections with single words / opposites / synonyms, choosing to use correct punctuation marks, getting to understand and use formal and informal styles, learning to understand the usages of officialese, sexism, racism, jargon.
- (ii) Learning to understand information structure of the sentence such as topic-focus relationship; strategies of thematization, postponement, emphasis, structural compression (deletion of redundant parts, nominalization, cleft and pseudo-cleft sentences, elliptical structures etc.), Logical Connectors between sentences, Methods of developing a paragraph, structure of an essay and methods of developing an essay

UNIT 4: Exercises in Written Communication

- (i) Précis writing
- (ii) Note-taking skills
- (iii) Writing reports
- (iv) Guidelines and essentials of official correspondence for making enquiries, complaints and replies
- (v) Making representations; writing letters of application for jobs; writing CV, writing letters to the editor and social appeals in the form of letters/pamphlets.

Reference Books:

- *Ways of Reading: Advanced reading Skills for Students of English Literature.* Martin Montgomery et al. London: Routledge, 2007.

- *Applying Communication Theory for Professional Life: A Practical Introduction.* Dainton and Zelle, <http://tsime.uz.ac.zw/claroline/backends/download.php?url=L0ludHJvX3RvX2NvbW11bmljYXRpb25fVGh3J5LnBkZg%3D%3D&cidReset=true&cidReq=MBA563>
- *Literature and the art of Communication*, Cambridge University Press.
- *Vistas and Visions*. Orient Black Swan (writing and grammar exercises at the end of lessons are recommended) From *Remapping An Anthology for Degree Classes*, ('Writing Skills'), Orient Black Swan.
- *Indian English through Newspapers* (Chapter 4,5 and 6), Concept, New Delhi,2008.
- *Contemporary Communicative English*, S Chand
- *Technical Communication: A Reader Centred Approach*. P.V. Anderson. Wadsworth, Cengage.

SEC- II (Quantitative and Logical Thinking)

QUANTITATIVE APTITUDE & DATA INTERPRETATION

Unit-1: Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and Cube roots, Surds and Indices, Problems on Numbers, Divisibility, Steps of Long Division Method for Finding Square Roots

Unit -2: Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture.

Unit-3: Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them.

Unit-4: Concept of Angles, Different Polygons like triangles, rectangle, square, right angled triangle, Pythagorean Theorem, Perimeter and Area of Triangles, Rectangles, Circles.

Unit -5: Raw and Grouped Data, Bar Graphs, Pie charts. Mean, Median and Mode, Events and Sample Space, Probability

LOGICAL REASONING

Unit-1: Analogy basing on kinds of relationships, Simple Analogy, Pattern and Series of Numbers, Letters, Figures. Coding-Decoding of Numbers, Letters, Symbols (Figures), Blood relations.

UNIT-2 Logical Statements-Two premise argument, More than two premise argument using connectives.

UNIT -3: Venn Diagrams, Mirror Images, Problems on Cubes and Dices.



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BERHAMPUR UNIVERSITY,

BHANJA BIHAR, BERHAMPUR -760007(GANJAM) ODISHA.

No. 7738 /Acad-I/BU/2021

Date 5/11/2021

NOTIFICATION

It is for information of all concerned that basing on the recommendation of the Board of Studies in Home Science, the Vice-Chancellor has been pleased to approve the model Syllabus on "Ethics and Values" for Under Graduate level to be effective from the Academic Session 2021-22 onwards. The syllabus shall be applicable to all affiliated and autonomous colleges and will be available in the Berhampur University website.

By order

Signature
DEPUTY REGISTRAR 5/11/2021

Memo No. 7739 (157) /Acad-I/BU/2021

Date 5/11/2021

Copy to

1. The Member Secretary // Vice Chairperson, Odisha State Higher Education Council, Dept. of Higher Education, Govt. of Odisha, Bhubaneswar for information.
2. The Principal, all the Affiliated // Autonomous College, Under Berhampur University, for information and necessary action.
3. The Controller of Examinations, Berhampur University for information and necessary action.
4. The Section Officer, Question Setting Unit, Berhampur University, for information and necessary action.
5. The Section Officer, Examination General / Confidential UG Section, Berhampur University for information and necessary action.
6. The Web Administrator along with soft copy of the Syllabus, Berhampur University, with a request to upload the same in the University website.

Signature
DEPUTY REGISTRAR 5.11.2021

SUGGESTED CURRICULUM FOR THE PROPOSED COURSE

Ethics and Values

(Consisting of six modules of 1 credit each; 15 lectures per credit)

ODISHA STATE HIGHER EDUCATION COUNCIL

A-11, 2nd Floor, PUSTAK BHAVAN
SUKA BIHAR, BHOI NAGAR-751022
BHUBANESWAR, ODISHA

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OBJECTIVES/LEARNING GOALS OF THE COURSE

- Development of a good human being and a responsible citizen.
- Developing a sense of right and wrong leading to ethically correct behavior.
- Inculcating a positive attitude and a healthy work culture.

SEMESTER-I

Unit-1

Title: - Issues Relating to Women

Total no. of Periods-15

Full mark-25

Credit point -1

1.0 Aims of the Unit:

- *The module aims to generate a sensitivity among the students towards women*
- *Enable them to value the contributions of women, from family to the larger society*
- *To generate among them a distinct urge to respect women*
- *To appreciate that women should have equal status and equal entitlements as member of the society*

Learning Objectives:

After going through the contents of the module and the classroom transactions on the contents, the students are expected to

- Have changes in their perceptions and practices towards women
- Develop proper attitude towards women and value their work and contribution
- Come forward to challenge unethical treatments against women
- End gender based hierarchy and hegemony, remove the feeling that women are counter to men and bring about a complementarity among the hitherto existing gender binary
- Allow women to realize their self worth and contribute their best for betterment of the society
- Pioneer in creating a gender equal society where the well being, happiness and security of the women will be well protected ; contributing towards a better and happier society

Teaching Hours

1.1 Introduction:

General introduction on Ethics and Values, Gender equality as an essential precursor to social progress, the present scenario, Desirable gender related values.

1-2-3

1.2 Women and Family

Pre-natal sex selection, Gendered practices in the family, Gender based division of labour in the family, Marriage and women, Marriage and women's consent, Child marriage, Practice of dowry, Women and family violence.

4-5-6-7

1.3 Women and Work

Women's work: The Invisible hands, Exploitation of women at work, Gender Stereotyping at work, Glass ceiling, Women and pay gap, Sexual Harassment of women at work, Working women and role conflict.

8-9-10-11

1.4 Women, Community and Society

Violence against women in public spaces, Gender sensitive language and communication, Gendered language, Sexist Language, Gender neutral language, Women and property Rights, Women's property Rights in Indian Laws, The functionality of Women's Property Rights:

12-13-14-15

Signature

SEMESTER-II

Unit-2

Title: - Values and Good Citizenship

Total no. of Periods-15

Full mark-25

Credit point -1

2.0 Aim of the Unit:

- Introducing the Salient features of Indian Constitution to students and to inculcate the sense of patriotism in them
- Encouraging them to Volunteer for social work
- Instilling appropriate work ethics in them

Learning Objectives:

- Understanding Basic Values of Indian Constitution
- Inculcating Volunteerism for Social change
- Helping students to become good human being and citizen

Teaching Hours

2.1 Indian Constitution

Salient Values of Preamble: Sovereign, Socialist, Secular, Democratic, Republic, Justice, Liberty, Equality and Fraternity.

1-2-3

2.2 Patriotism

Patriotic Value and ingredients of nation building, Concept of Good citizenship, Emotional connection with the country, Duties of citizens and Qualities of good citizens

4-5-6-7

2.3 Volunteerism

Concept and facets of Volunteerism and Leadership, Building a better society through Volunteerism, Blood Donation, Social Work, Helping the Aged, Environmental Protection

8-9-10-11

2.4 Work Ethics

Punctuality, Cleanliness, Law abidingness, Rational Thinking and Scientific Temper

12-13-14-15

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SEMESTER-III

Unit-3

Title: - Issues of Drug, Tobacco and Alcohol Addiction

Total no. of Periods-15

Full mark-25

Credit point -1

3.0 Aims of the Unit:

- Creating awareness about health and Societal hazards of drugs, tobacco and alcohol addiction
- Sensitizing students about professional support system for treatment and rehabilitation

Learning Objectives:

- The students become aware of the grave danger of consuming alcohol, tobacco and drugs
- Students would encourage their friends to remain away from tobacco ,alcohol , drugs and seek professional help when needed

3.1 Extent of the Problem

Extent of Drug and Tobacco addiction and alcoholism in India, Myths associated with them, Health hazards associated with them and how they have become silent killers

3.2 Socio- economic impact

Socio- economic impact of Drug and Tobacco addiction and alcoholism:

Loss of physical and mental strength, Loss of character, Loss of family ties and relationship, Loss of earning and livelihood potentials, Loss of societal respect and dignity etc

3.3 Laws to Address this Problem

Silent features of social legislation such as NDPS Act, 1985 and COTPA Act , 2003 , Mechanism and Government Schemes for prevention , de-addiction and rehabilitation

3.4 Role of Stake - holders

Provision of Tobacco free campus and role of students, Role of students in their family and immediate surroundings, Role of NGOs and other agencies

Teaching Hours

1-2-3-4

5-6-7-8

9-10-11-12

13-14-15

SEMESTER-IV

Unit-4

Title: - Ethical Values for Student Life

Total no. of Periods-15

Full mark-25

Credit point -1

4.0 Aims of the Unit:

- To familiarize the students with core values of Academics and Goals of Education
- To create an awareness about Unethical practices in the academics

Learning Objectives:

- The students will learn to behave ethically in the campus
- Exhibit respectful treatment to others in an organizational context
- Contribute to develop a positive social environment through active participation and cooperation with others

Teaching Hours

4.1 Meaning and Objective of Education:

Knowledge is power and quest for knowledge is the real meaning of education, not quest for Degree and qualifications; Real education builds character: Difference between Academic Qualification and Ability, Academic failure could be failure within the classroom, but not outside (i.e. Failed in exam, passed in life!)

1-2-3

4.2 Challenges for Ethical Practices in Institutions of Higher Education:

Ragging, Suicide and Need for Educational Counseling, Violence vs. Peaceful Protest, Conflict resolution, Plagiarism and Violation of Intellectual property Rights, Cheating in Examination and other Fraudulent Practices

4-5-6-7

4.3 Inter personal Relation and Community Life in HEI:

Green Preacher and conservation of Energy, Community Life in Campus including Hostels, Local Common area, Inter personal relations (Students-Teacher, Students-Student and Man-Woman, Positive Friendship).

8-9-10-11

4.4 Ethical Leadership in Academic Institution:

Concept and Traits of Leadership to provide solution, everyone has Leadership Role (not limited to position), Concept of Ethical leadership, Scope of Leadership in college and Universities for Students, Teachers and Administrators, Importance of co-curricular and extra – curricular activities.

12-13-14-15

2023

SEMESTER-V

Unit-5

Title: -Vulnerable Sections of Society: Understanding their Issues

Total no. of Periods-15

Full mark-25

Credit point -1

5.0 Aims of the Unit:

To create an awareness amongst students about the need for ensuring dignity and equality for the vulnerable sections of the society.

Learning Objectives:

- Students would be able to appreciate values and ethics relating to vulnerable sections of the society.
- Students would learn to practice equality, diversity and social justice.
- Students would become more empathetic and compassionate towards vulnerable sections of the society.

5.1 Issues Relating to Children:

Nutrition and health, Child Exploitation: Child labour, trafficking, Sexual exploitation

5.2 Issues Relating to Elderly Persons:

Abuse of Elders, Financial Insecurity, Loneliness and Social Insecurity, Health Care Issues, Needs for a Happy and Dignified Ageing

5.3 Issues Relating to Persons with disability:

Rights of PWD, affirmative action, Prevention of discrimination, providing equal opportunity, various scheme for empowering PWD and social justice for PWD

5.4 Issues Relating to Third Gender:

Understanding the Third Gender, Social justice for them, Removal of discrimination, Affirmative action and Acceptance of diversity of gender.

Teaching Hours

1-2-3-4

5-6-7-8

9-10-11-12

13-14-15

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SEMESTER-VI

Unit-6

Title: - Environmental & Techno Ethics

Total no. of Periods-15

Full mark-25

Credit point -1

Aims of the Unit:

- To develop awareness and sensitize students about the importance of environment for a sustainable earth and to bring Green Technology into action
- To focus their attention towards cleanliness, preservation of biodiversity and practice of conservation of natural resources
- To make them understand the judicious use of modern technology strictly on need basis
- To use science and technology for preservation of environment and its sustainable development but not for destruction.

Learning Objectives:

- Develop an understanding of environmental ethics and work towards sustainable development
- Commitment to Green Technology for sustainable future
- Understand ethical issues relating to use of digital medium

Teaching Hours

6.1 Environmental Ethics:

Types of Ecological Values, Environmental Values & Valuing Nature, Equitable use of Resources, Role of Individual in the conservation of resources for future generation, Bio-Ethics-Genetic manipulation in plants and animals for benefit of society and cruelty against animal.

1-2-3

6.2 Promotion of Green Technology:

Goal of Green Technology: Reduce recycling, Renew (removal of chemicals), Refuse and Responsibility.

Green Technology in relation to: -Energy and Construction.

4-5-6-7

6.3 Ethics and Technology with reference to Science, gadget, machine etc. and interaction with each other;

Agricultural, Industrial, Digital, Globalized Age etc

8-9-10-11

6.4 Judicious Use of Technology:

Judicious use of Mobile Phones, Electrical machines, Plastics, Television, Computers and their harmful effects

Ethics and Use of Digital Technology: Cyber ethics- Crimes and Ethical hacking,

Ethics of social media: WhatsApp, Facebook, Twitter and others.

12-13-14-15

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