COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

DEPARTMENT OF MATHEMATICS

MODEL SYLLABUS-2019--- AS PER DHE (GOVT.OF ODISHA)

First & Second Semester Examination –2023-24

Third & Fourth Semester Examination- 2024-25

Fifth & Sixth Semester Examination – 2025-26

GOVERNMENT AUTONOMOUS COLLEGE,
PHULBANI, KANDHAMAL

Program Outcome for B.Sc. (Hons) Mathematics

The Bachelor's Degree in B.Sc. (Hons) Mathematics is awarded to the students on the basis of knowledge, understanding, skills, attitudes, values and academic achievements sought to be acquired by learners at the end of this program. Hence, the learning outcomes of mathematics for this course are aimed at facilitating the learners to acquire these attributes, keeping in view of their preferences and aspirations for knowledge of mathematics. Mathematics is the study of quantity, structure, space and change. It has very broad scope in science, engineering and social sciences. The key areas of study in mathematics are Calculus, Algebra, Geometry, Analysis, Differential Equations and Mechanics.

Program Specific Outcome of B.Sc. (Hons)- Mathematics

PSO-1: Think in a critical manner.

PSO-2: Familiarize the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.

PSO-3: Acquire good knowledge and understanding to solve specific theoretical and applied problems in advanced areas of mathematics and statistics.

PSO-4: Provide students/learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.

PSO-5: Encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

DISTRIBUTION OF MARKS

Paper with Practical	
Mid Sem (15 Marks)	
Two questions to be answered carrying 1 mark each	2X1 mark = 2 marks
Two questions to be answered carrying 1.5 marks each	2X1.5 marks = 3 marks
Two questions to be answered carrying 2 marks each	2X2 marks = 4 marks
One question to be answered carrying 6 marks each	1X6 marks = 6 marks
End Sem (60 Marks)	
Eight questions to be answered carrying 1 mark each	8X1 mark = 8 marks
Eight questions to be answered carrying 1.5 marks each	8X1.5 marks = 12 marks
Eight questions to be answered carrying 2 marks each	8X2 marks = 16 marks
Four questions to be answered carrying 6 marks each	4X6 marks = 24 marks

Paper without Practical	
Mid Sem (20 Marks)	
Three questions to be answered carrying 1 mark each	3X1 mark = 3 marks
Two questions to be answered carrying 2 marks each	2X2 marks = 4 marks
Two questions to be answered carrying 3 marks each	2X3 marks = 6 marks
One question to be answered carrying 7 marks each	1X7 marks = 7 marks
End Sem (80 Marks)	
Twelve questions to be answered carrying 1 mark each	12X1 mark = 12 marks
Eight questions to be answered carrying 2 marks each	8X2 marks = 16 marks
Eight questions to be answered carrying 3 marks each	8X3 marks = 24 marks
Four questions to be answered carrying 7 marks each	4X7 marks = 28 marks

SYLLABI FOR CBCS COURSE

Sem	CORE COURESE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	AECC-I AECC-III(EV-I)			GE-I-PHYSICS
	CORE-II				
II	CORE-III	AECC-II AECC-III(EV-II)			GE-II-CHEMISTRY
	CORE -IV				
III	CORE-V	AECC-III(EV-III)	SEC-I- QLT		GE-III-PHYSICS
	CORE-VI				
	CORE-VII				
IV	CORE-VIII	AECC-III(EV-IV)	SEC-II-CE		GE-IV-CHEMISTRY
	CORE-IX				
	CORE-X				
V	CORE-XI	AECC-III(EV-V)		DSE-I	
	CORE-XII			DSE-II	
VI	CORE-XIII	AECC-III(EV-VI)		DSE-III	
	CORE-XIV			DSE-IV / Project	

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons) (Mathematics Department)				
Yr.	Sl.No.	**Course Structure**	**Code**	**Credit Points**
FIRST YEAR		**SEMESTER-I**		
	1	Calculus	C-1.1	4+2
	2	Discrete Mathematics	C-1.2	6
	3	**Generic Elective: (GE)-I**	GE-1.3	6
	4	**Ability Enhancement Compulsory Course-EVS**	AECC-1.4	6
	5	Ethics & Values (Unit-I)	AECC-1.5	1
		TOTAL Credits		25
		SEMESTER-II		
	6	Real Analysis	C-2.1	6
	7	Differential Equations	C-2.2	4+2
	8	**Generic Elective: (GE)-II**	GE-2.3	6
	9	Ability Enhancement Compulsory Course-M.I.L	AECC-2.4	6
	10	Ethics & Values- **UNIT-II (E&V-II)_**	AECC-2.5	1
		TOTAL Credits		25
SECOND YEAR		**SEMESTER-III**		
	11	Theory of Real Functions	C-3.1	6
	12	Group Theory – I	C-3.2	6
	13	Partial Differential Equations and System of ODEs	C-3.3	4+2
	14	**Generic Elective: (GE)-**III	GE-3.4	6
	15	Quantitative and Logical Thinking (For Science Stream)	AEEC-3.5	4
	16	Ethics & Values (Unit-III)	AECC-3.6	1
		TOTAL Credits		31
		SEMESTER-IV		
	17	Numerical Methods and Scientific Computing	C-4.1	4+2
	18	Topology of Metric spaces	C-4.2	6
	19	Ring Theory	C-4.3	6
	20	**Generic Elective: (GE)-**IV	GE-4.4	6
	21	Quantitative and Logical Thinking (For Arts & Commerce Stream)	AEEC-4.5	6
	22	Ethics & Values (Unit-IV)	AECC-4.6	1
		TOTAL Credits		31
FINAL YEAR		**SEMESTER-V**		
	23	Multivariable Calculus	C-5.1	6
	24	Linear Algebra	C-5.2	6
	25	Linear Programming	DSE-5.3	6
	26	Probability and Statistics	DSE-5.4	6
	27	Ethics & Values (Unit-V)	AECC-5.5	1
		TOTAL Credits		25
		SEMESTER-VI		
	28	Complex Analysis	C-6.1	6
	29	Group Theory – II	C-6.2	6
	30	Differential Geometry	DSE-6.3	6
	31	Project Work / Number Theory	DSE-6.4	6 / 4+2
	32	Ethics & Values (Unit-VI)	AECC-6.5	1
		TOTAL Credits		25
		GRAND TOTAL		162

Notes:

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- SECC- Skill Enhancement Compulsory Course (Skill Based)
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours

SEMESTER-I

C-1.1 : CALCULUS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

Programme Outcomes:

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.

UNIT-I

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type $e^{ax+b}\ sin\ x$, $e^{ax+b}\ cos\ x$, $(ax+b)^n\ sinx$, $(ax+b)^n\ cosx$, 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 $\int sin^n xdx$, $\int cos^n xdx$, $\int tan^n xdx$, $\int sec^n xdx$, $\int(\log x)^n xdx$, $\int sin^n x\ cos^n xdx$, 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

***Course 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.

PRACTICAL

(Using any software/ MATH LAB to ~~be~~ performed on a Computer.)

1. Plotting the graphs of the functions e^{ax+b}, $\log(ax+b)$, $\frac{1}{ax+b}$, $\sin(ax+b)$, $\cos(ax+b)$ 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.

Reference Books :

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

C-1.2 : DISCRETE MATHEMATICS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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

Course 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.

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.

Reference Books :

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

AECC-1.5 (EV-I) : ETHICS & VALUES

UNIT-I : Issues Relating to Women

End Sem – 25 Marks
Full Marks – 25 Marks

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 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

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

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

SEMESTER-II

C-2.1 : REAL ANALYSIS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Reference Books :

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

C-2.2 : DIFFERENTIAL EQUATIONS

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

Programme Outcomes:

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.

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

a. 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.
b. Laplace transform : Introduction, Laplae transform, existence of Laplace transform, The Shifting Theorem, Unit step function, Unit impulse function, Laplace transform of periodic function.

Course 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.

PRACTICAL

(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,* 2nd Ed., Taylor and Francis group, London and New York, 2009.

Reference Books :

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

GE-2.3 : CALCULUS AND DIFFERENTIAL EQUATIONS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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, Taylors 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.

Course 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.

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.

Reference Books :

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

AECC-2.5 (EV-II) : ETHICS & VALUES

UNIT-II : Values and Good Citizenship

End Sem – 25 Marks
Full Marks – 25 Marks

2.1 Indian Constitution:

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

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

2.3 Volunteerism:

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

2.4 Work Ethics:

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

SEMESTER-III

C-3.1 : THEORY OF REAL FUNCTIONS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcome:

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.

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.

Course Outcomes*:*

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.

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.

Reference Books :

- A. Kumar, S. Kumaresan, *A basic course in Real Analysis*, CRC Press, 2014
- K. A. Ross, *Elementary analysis: the theory of calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004A.Mattuck, Introduction toAnalysis, Prentice Hall
- Charles G. Denlinger, *Elements of real analysis*, Jones and Bartlett (Student Edition), 2011.

C-3.2 : GROUP THEORY-I

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

UNIT-I

Definition of group and examples, Elementary properties of groups, Symmetries of a square, Dihedral groups, definition, Subgroups and examples, centralizer, normalizer, center of a group

UNIT-II

Cyclic groups, Properties of cyclic groups, classification of subgroups of cyclic groups, Permutations and permutation of group, Cycle notation, properties of permutations, even and odd permutations, alternating group

UNIT-III

Cosets, Properties of cosets, Product of two subgroups, Lagrange's theorem and consequences including Fermat's Little theorem, 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.

Course 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.

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.

Reference Books :

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

C-3.3 : PARTIAL DIFFERENTIAL EQUATIONS AND SYSTEM OF ODES

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

Programme Outcomes:

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.

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 nonhomogeneous 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.

Course 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.

PRACTICAL

LIST OF PRACTICALS (USING ANY SOFTWARE)

1. Solution of Cauchy problem for first order PDE.
2. Finding the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solution of wave equation $\frac{6^2u}{6t^2} - c\frac{6^2u}{6x^2} = 0$ for the following associated conditions
   a. $u(x,0) = \emptyset(x), u_t(x,0) = \Psi(x), x \in R, t > 0$
   b. $u(x,0) = \emptyset(x), u_t(x,0) = \Psi(x), u(0,t) = 0, x \in (0,\infty), t > 0$
   c. $u(x,0) = \emptyset(x), u_t(x,0) = \Psi(x), u_x(0,t) = 0, x \in (0,\infty), t > 0$
   d. $u(x,0) = \emptyset(x), ut(x,0) = \Psi(x), u(0,t) = 0,\ u(l,t) = 0,\ 0 < x < l\ , t > 0$
5. Solution of wave equation $\frac{6u}{6t^2} - k\frac{6^2u}{6x^2} = 0$ for the following associated conditions
   a. $u(x,0) = \emptyset(x), u(0,t) = a, u(l,t) = b,\ 0 < x < l\ , t > 0$
   b. $u(x,0) = \emptyset(x), x \in R,\ 0 < t < T$
   c. $u(x,0) = \emptyset(x), u(0,t) = a,\ x \in (0,\infty), t \geq 0$

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

Reference Books :

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

AEEC-3.5 : QUANTITATIVE AND LOGICAL THINKING
(FOR SCIENCE STREAM)

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

I. QUANTITATIVE APTITUDE & DATA INTERPRETATION

UNIT – I :

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 – II :

Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture

UNIT – III :

Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them

UNIT – IV :

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

UNIT – V :

Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability

II. LOGICAL REASONING

UNIT – I :

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 – II :

Logical Statements– Two premise argument, More than two premise argument using connectives

UNIT – III :

Venn Diagrams, Mirror Images, Problems on Cubes and Dices

Books Prescribed :

1. Quantitative And Logical Thinking – Odisha State Higher Education Council, Bhubaneswar

AECC-3.6 (EV-III) : ETHICS & VALUES

UNIT-III : Issues of Drug, Tobacco and Alcohol Addiction

End Sem – 25 Marks
Full Marks – 25 Marks

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, deaddiction 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

SEMESTER-IV

C-4.1 : NUMERICAL METHODS AND SCIENTIFIC COMPUTING

Full Marks – 100
Mid Sem – 15/1hr
End Sem Theory – 60/3 hrs
End Sem Practical – 25/3 hrs

THEORY

(Use of Scientific Calculator is allowed)

Programme Outcomes:

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.

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, Richard-son extrapolation.

Course Outcomes:

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.

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PRACTICAL

(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:

1. Calculate the sum $\frac{1}{1}+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\ldots\ldots\ldots\ldots+\frac{1}{N}$.
2. To find the absolute value of an integer.
3. Enter- 100 integers into an array and sort them in an ascending' order.
4. Any two of the following
   a. Bisection Method
   b. Newton Raphson Method
   c. Secant Method
   d. Regular Falsi Method
5. Gauss-Jacobi Method
6. SOR Method or Gauss-Siedel Method
7. Lagrange Interpolation or Newton Interpolation
8. 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.

Reference Books :

❖ B. Bradie, *A Friendly Introduction to Numerical Analysis,* Pearson Education, India, 2007.

❖ Kendall E. Atkinson: An Introduction to Numerical Analysis

❖ C. F. Gerald and P. O. Wheatley, *App.ied Numerical Analysis,* Pearson Education, India, 7th Edition, 2008

❖ S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.

C-4.2 : TOPOLOGY OF METRIC SPACES

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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,

Course 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.

Books Recommended :

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

Reference Books :

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

C-4.3 : RING THEORY

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Course Outcomes:

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

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.

Reference Books :

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

GE-4.4 : ALGEBRA

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Course 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.

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.

Reference Books :

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

AEEC-4.5 : QUANTITATIVE AND LOGICAL THINKING (FOR ARTS & COMMERCE STREAM)

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

I. QUANTITATIVE APTITUDE & DATA INTERPRETATION

UNIT – I :

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 – II :

Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture

UNIT – III :

Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them

UNIT – IV :

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

UNIT – V :

Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability

II. LOGICAL REASONING

UNIT – I :

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 – II :

Logical Statements– Two premise argument, More than two premise argument using connectives

UNIT – III :

Venn Diagrams, Mirror Images, Problems on Cubes and Dices

Books Prescribed :

1. Quantitative And Logical Thinking – Odisha State Higher Education Council, Bhubaneswar

AECC-4.6 (EV-IV) : ETHICS & VALUES

UNIT-IV : Ethical Values for Student Life

Full Marks – 25
End Sem – 25/1 hr

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!)

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

4.3 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, Positivie Friendship)

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

SEMESTER-V

C-5.1 : MULTIVARIATE CALCULUS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Pragramme Outcomes:

The objective of this course to introduce functions of several variable 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.

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.

Course 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 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.

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

Reference Books :

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

C-5.2 : LINEAR ALGEBRA

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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

UNIT-I

Vector spaces, subspaces, examples, algebra of subs paces, 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.

Course 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.

Books Recommended :

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

Reference Books :

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

DSE-5.3 : LINEAR PROGRAMMING

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Course 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.

Books Recommended :

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

Reference Books :

- S. Hillier and G.J. Lieberman, *Introduction to Operations Research- Concepts and Cases* (9th Edition),

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

DSE-5.4 : PROBABILITY AND STATISTICS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Course Outcomes:

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.

Books Recommended :

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

Reference Books :

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

AECC-5.5 (EV-V) : ETHICS & VALUES

UNIT-V : Vulnerable Sections of Society: Understanding their Issues

Full Marks – 25
End Sem – 25/1 hr

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 Relatng 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

SEMESTER-VI

C-6.1 : COMPLEX ANALYSIS

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Course 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.

Books Recommended :

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

Reference Books :

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

Springer-Verlag New York, Inc., New York, 1997.

C-6.2 : GROUP-THEORY-II

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

The objective of this course **i**s 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.

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.

Course 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.

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.

Reference Books :

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

DSE-6.3 : DIFFERENTIAL GEOMETRY

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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.

Course Outcomes:

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.

Books Recommended :

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

Reference Books :

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

DSE-6.4 : NUMBER THEORY

Full Marks – 100
Mid Sem – 20/1hr
End Sem – 80/3 hrs

Programme Outcomes:

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.

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 th'e-1o.retic 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 vg h v g gv ublic key cryptography, RSA encryption and decryption, the equation $x^2+y^2=z^2$, Fermat's Last Theorem.

Course Outcomes:

Upon successful completion of this course students will 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.

Books Recommended :

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

Reference Books :

- Thomas Koshy, *Elementary Number Theory with Applications (*2nd Edition), Academic Press, 2007.
- Neville Robinns, *Beginning Number Theory* (2ndEdition), Narosa Publishing House Pvt. Limited, Delhi,2007.

OR

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	:	

AECC-6.5 (EV-VI) : ETHICS & VALUES

UNIT-VI : Environmental & Techno Ethics

End Sem – 25 Marks
Full Marks – 25 Marks

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 benefits of society and cruelty against animal.

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.

6.3 Ethics and Technology:
Ethics and Technology with reference to Science, gadget, machine etc. and interaction with each other,
Agricultural, Industrial, Digital, Globalized Age etc

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

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