- show proficiency in using the software C-Programming.
- understand the use of various techniques of the software for effectively doing mathematics.
- obtain necessary skills in programming.
- understand the applications of mathematics through programming.

Syllabus

Problems from SCT 1.4 (Theory) may be solved with the help of C-Programming.

	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks: Examination	Marks: Internal Assessment	Marks: Total Marks	Credits	Examination duration (Hrs)
SEMESTER - II		**HARD CORE PAPERS**						
	HCT 2.1	Linear Algebra	4	80	20	100	4	3
	HCT 2.2	Real Analysis - II	4	80	20	100	4	3
	HCT 2.3	General Topology	4	80	20	100	4	3
	HCT 2.4	Partial Differential Equations	4	80	20	100	4	3
		SOFT CORE PAPER (ANY ONE)						
	SCT 2.1	Graph Theory / Classical Mechanics	4	80	20	100	4	3
		PRACTICAL						
	HCP 2.1	Programming Lab - II	4	40	10	50	2	3
		OPEN ELECTIVE PAPER (ANY ONE)						
	OET 2.1	Foundations of Mathematics / Financial and Business Mathematics	2	40	10	50	2	3
	Mandatory Credits: Computer Skill		2	---	---	---	2	---

HARD CORE PAPERS

Semester-II	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks: Examination	Marks: Internal Assessment	Marks: Total Marks	Credits	Examination duration (Hrs)
	HCT2.1	**Linear Algebra**	**4**	**80**	**20**	**100**	**4**	**3**

Course Objective(s):

- Students will learn definition and examples of vector spaces, subspaces and properties.
- Students will learn linear transformations and their representation as matrices.
- Students will learn eigenvalues and eigenvectors of a linear transformation, solutions of homogeneous systems of linear equations.
- Students will learn canonical forms – similarity of linear transformations.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- verify the existence of complementary subspace of a finite dimensional vector space.
- find out the properties of dual space, bidual space and natural isomorphism.
- find the bilinear, quadratic and Hermitian forms and get the solutions of homogeneous systems of linear equations.
- solve Jordan blocks and Jordan forms based on ranks and signature.

Syllabus

Unit I: Definition and examples of vector spaces. Subspaces.Sum and direct sum of subspaces.Linear span.Linear dependence, independence and their basic properties.Basis.Finite dimensional vector spaces.Existence theorem for bases. Invariance of number of elements of a basis set. Dimension.Existence of complementary subspace of a subspace of a finite dimensional vector space. Dimension of sums of subspaces. Quotient space and its dimension.

Unit II: Linear transformations and their representation as matrices. The algebra of linear transformations.The rank nullity theorem. Change of basis. Dual space.Bidual space and natural isomorphism.Adjoint of a linear transformation.

Unit III: Eigenvalues and eigenvectors of a linear transformation. Diagonalization.Annihilator of a subspace.Bilinear, Quadratic and Hermitian forms.Solutions of homogeneous systems of linear equations.

Unit IV: Canonical forms – Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms.Nilpotent transformations.Index of nilpotency.Invariants of a linear transformation.Primary decomposition theorem. Jordan blocks and Jordan forms. Hermitian transformations, unitary and normal transformations, real quadratic forms: Sylvester's law of inertia, rank and signature.

References:

1. I. N. Herstein: *Topics in Algebra* 2nd edition, John Willey and Sons, New York, 1975.
2. W. C. Brown: *A Second Course in Linear Algebra,* John Willey and Sons, New York, 1988.
3. W. Cheney and D. Kincaid: *Linear Algebra*, Jones and Bartlett Publishers, Canada, 2010.
4. J. Hefferon: *Linear Algebra* 3rd edition, Joshua publication,Colchester, Vermont USA, 2017.
5. K. Hoffman and R. Kunze: *Linear Algebra* 2nd edition, Prentice Hall, India, 2001.
6. V. K. Khanna & S. K Bhamri: *A Course in Abstract Algebra*, 4th edition, Vikas Publication, India, 2013
7. A. R. Vashishta, J. N. Sharma, A. K. Vashishta: *Linear Algebra*, Krishna Prakashan Media, India, 2010.

Semester-II	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	HCT2.2	Real Analysis - II	4	80	20	100	4	3

Course Objective(s):

- To present students the fundamentals and significance of the real analysis.
- To recognize the existence of Riemann-Stieltjes integral, sequences and series of functions.
- To enable the students to the functions of several variables and its related theorems.
- To understand the inverse and implicit theorems and its applications.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- understand the concept of Riemann integration and differentiation.
- understand Uuniform convergence and continuity.
- apply the Stone-Weierstrass theorem.
- analyze the concept of functions of several variables.

Syllabus

Unit I: Riemann-Stieltjes integral, its existence and linearity, the integral as a limit of sum, change of variables. Mean value theorems. Functions of bounded variation.The fundamental theorem of calculus.

UNIT-2: Sequences and Series of Functions: Pointwise and uniform convergence, uniform convergence& continuity, uniform convergence & integration, uniform convergence &differentiation, equicontinuous families of functions: point wise and uniformly bounded, equicontinuous family of functions, the Stone-Weierstrass theorem.

UNIT-III: Functions of Several Variables: Linear transformations, invertible linear operators, matrix representation, differentiation, partial derivatives, gradients, directional derivative, continuously differentiable functions, the contraction principle.

UNIT-IV: The Inverse and Implicit Function Theorem: The inverse function theorem, implicit function theorem with examples, Jacobians, derivatives of higher order and differentiation of integrals.

REFERENCES:

1. W. Rudin :*Principles of Mathematical Analysis*, McGraw Hill, USA 1983.
2. H. L. Royden and P. M. Fitzpatrick: *Real Analysis*, Prentice Hall, India, 2010.
3. T. M. Apostol: *Mathematical Analysis*, Narosa Publishing House, New Delhi, India 2004.
4. S. L. Gupta & N. R. Gupta: *Principles of Real analysis*, second edition Pearson education,Delhi, India, 2003.
5. S. Goldberg: *Methods of Real Analysis*, Oxford & IBH, USA 1970.
6. R. G. Bartle & D. R. Sherbert: *Introduction to real Analysis*, John Wiley & Sons, Inc, USA, 1982.
7. S. Lang: *Real and Functional Analysis*, Springer-Verlag, 1993.
8. S. C. Malik and S. Arora: *Mathematical analysis*, New Age International, India, 1992.

Semester-II	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	HCT 2.3	General Topology	4	80	20	100	4	3

Course Objective(s):

- Students will learn topological spaces.
- Students will learn continuous functions and mappings in topological spaces.
- Students will learn connectedness, compactness of topological spaces.
- Students will learn countability and separation axioms.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- know the definitions and some basics of topological spaces.
- know how to read and write proofs in topology.
- know a variety of examples and counterexamples in topology.
- distinguish Urysohn's lemma and the Tietze extension theorem.

Syllabus

Unit I: Topological Spaces: Topological Spaces, open sets, closed sets, closure, accumulation points, derived sets, interior, boundary. Bases and subbasis, dense sets, closure operator, neighborhood system, subspaces, convergence of sequences.

Unit-II:Continuity and other Maps: Continuous maps, continuity at a point, continuous maps into R, open and closed maps, homeomorphisms, finite product spaces, projection maps.

Unit III: Connectedness: Connected and disconnected spaces, separated sets, intermediate value theorem, components, local connectedness, path connectedness.

Unit IV: Compactness: Cover, subcover, compactness, characterizations, invariance of compactness under maps, properties.

References:

1. James. Dugundji: *Topology*, 1st edition, Allyn and Bacon, Inc., 1966.
2. J. R. Munkres: *Topology- A first course*, 2nd edition, Prentice-Hall, New Jersey, 2000.
3. S. Lipschutz:*General Topology*, Schaum's series, McGraw Hill Int, New York, 1981.
4. S. Willard:*General Topology*, Elsevier Pub. Co., 1970.
5. J. V. Deshpande:*Introduction to topology*, Tata McGraw Hill Co., India, 1988.
6. G. F. Simmons:*Introduction to Topology and Modern Analysis*, McGraw Hill Book Co.,1963.
7. *J. L. Kelley: General Topology,* Graduate Texts in Mathematicsseries,Springer-Verlag,New York ,1995.
8. C. W. Baker:*Introduction to topology*, Brown (William C.) Co,U.S., 1991.

Semester-II	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	HCT2.4	**Partial Differential Equations**	**4**	**80**	**20**	**100**	**4**	**3**

Course Objective(s):

- To learn theory of partial differential equations and solution methods.
- Provide advanced knowledge and good understanding of nature of PDEs like parabolic,elliptic, hyperbolic.
- Learn to solve systems of linear and non-linear equations.
- Solve wave, Laplace and heat equations in cylindrical and spherical polar coordinates.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- classify PDEs, apply analytical methods, and physically interpret the solutions.
- understand basic properties of standard PDEs.
- Demonstrate accurate and efficient use of Duhamel's Principle techniques and their applications in the theory of PDE.
- Demonstrate capacity to model physical phenomena using PDEs.

Syllabus

UNIT-I: First Order Partial Differential Equations: First order partial differential equations: Basic definitions, Origin of PDEs, classification. The Cauchy problem, the method of characteristics for semi linear, quasi linear and non-linear equations, complete integrals,

UNIT-II: Second Order Partial Differential Equations: Definitions of linear and non-linear equations, linear superposition principle, classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, reduction to canonical forms, solution of linear homogeneous and non-homogeneous with constant coefficients, variable coefficients, Monge's method.

UNIT-III: Wave equation: Solutions by Separation of variables and integral transforms. The Cauchy problem. Solution of wave equation in cylindrical and spherical polar coordinates

Laplace equation: Solutions by Separation of Variables and integral transforms. Dirichlet's and Neumann's problems, Dirichlet's problem for a rectangle, half plane and circle. Solution of Laplace equation in cylindrical and spherical polar coordinates

UNIT-IV: Diffusion equation: Solutions by separation of variables and integral transforms. Duhamel's Principle.Solution of diffusion equation in cylindrical and spherical polar coordinates. Solution of nonlinear PDE`s: similarity solutions.

REFERENCES:

1. N. Sneddon: *Elements of PDE's*, McGraw Hill Book company Inc., 2006.
2. L Debnath: *Nonlinear PDE's for Scientists and Engineers*, Birkhauser, Boston, 2007.
3. F. John: *Partial differential equations*, Springer, 1971.
4. F. Treves: *Basic linear partial differential equations*, Academic Press, 1975.
5. M.G. Smith: *Introduction to the theory of partial differential equations*, Van Nostrand, 1967.
6. Shankar Rao: *Partial Differential Equations*, PHI,Newdelhi, 2006.
7. P. Prasad and R. Ravindran: *Partial Differential Equations*, Wiley Eastern (1998)
8. S. J. Farlow: *P. D. E. for Scientists and Engineers*, John Wiley (1998).

SOFT CORE PAPER (ANY ONE)

Semester-II	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	SCT 2.1	Advanced Graph Theory	4	80	20	100	4	3

Course Objective(s):

- Students will learn Graph Isomorphism and Connectivity using Factorization, Covering matching.
- Students will study different Graph valued functions like Line graphs, subdivision graph and total graphs along with properties.
- Students will learn the concept of Graph Coloring, proper coloring, properties, Chromatic numbers and chromatic polynomials and domination of graphs.
- Students will learn the algebraic application of graph theory in the form of Spectra.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- factorize the given graphs and verify their connectivity index.
- draw different Graph Invariants using properties of edges and vertices.
- study the Graphs based on their proper coloring and properties when sorted into chromatic polynomials.
- algebraically construct the graphs with the given Adjacency incidence matrices, find their eigenvalue spectra further studying group of graphs and automorphism properties.

Syllabus

UNIT - I: Graph Isomorphism and Connectivity: Factorization, 1- factorization, 2 factorizations, decomposition and labeling of graphs.Covering: covering. edge covering, independence number, matching and matching polynomial.

UNIT - II: Graph valued functions: Line graphs, subdivision graph and total graphs along with properties. Graph homomorphism, isomorphism.Planarity: Planar graphs, outerplanar graphs. Kuratowaskicriterionplanarity and Euler polyhedron formula.

UNIT - III: Coloring: Graph Coloring, proper coloring, properties, Chromatic numbers and chromatic polynomials. Domination: Dominating sets, domination number, domatic number and its bounds, independent domination number of a graph. Theory of External graphs and Ramsey Theory.

UNIT - IV: Spectra of Graphs: Adjacency matrix, incidence matrix. characteristic polynomials, eigenvalues, graph parameters, strongly regular graphs and Friendship Theorem.Groups and Graphs: Automorphisin group of a graph, operation on permutation graphs and composition of graphs.

REFERENCES:

1. M. Behzad, G.ChartrandandL. Lesniak:*GraphsandDiagraphs*, Cambridge University Press.1981.
2. J. A. Bondy and V. S. R. Murthy: *Graph theory with Applications*, MacMillan Press, London, 1976.
3. F. Buckley and F. Harary: *Distance in Graphs*, Addison-Wesley Publication, Redwood city,CA, 1990.
4. D. Cvetkovic, M. DoobandH.Sachs:*SpectrainGraphs*,AcademicPress,NewYork, 1980.
5. N. Deo: *Graph Theory with Applications to Engineering and Computer Science*, Prentice hall press, India, 1995.
6. F.Harary: *Graph Theory*, Addison Wesley, Readingmass, l969.
7. D. B. West: *Introduction to Graph Theory*, Prentice hall, India, 2001.
8. K. Ulrich and K .Kolja: *Algebraic Graph Theory*, De Gruyter, Berlin, Germany, 2011.

Semester-IV	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	SCT 2.5	Classical Mechanics	4	70	30	100	4	3

Course Objective(s):

- To develop familiarity with the physical concepts and facility with the mathematical methods of classical mechanics.
- To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.
- Students will learn the applications of Magnetohydrodynamics in daily life.
- To develop skills in formulating and solving physics problems

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- demonstrate the knowledge of core principles in mechanics.
- interpret complex and difficult problems of classical dynamics in a systematic way.
- apply the variation principle for real physical situations.
- identify the existing symmetries and the corresponding integrals of motion and analyze the qualitative nature of dynamics.

Syllabus

UNIT I:Analytical dynamics: Generalized Co-ordinates, Holonomic and non-Holonimic systems. Seleronomic and Rheonomic systems.D'Alembert's principle and Lagrange's equation from D'Alembert's principle. Velocity dependent potentials and the dissipation function. Energy equation for conservative field.Generalized momenta and Hamilton's canonical equations. Rigid body and Eulerian angles, infinitesimal rotations. Coriolis theorem.Motion relative to rotating earth.Euler's dynamics equations of Motion of a symmetrical top.

UNIT II :Hamilton's principle of least action. Deduction of Lagrange and Hamilton equation from Hamilton's principle.Hamilton's variational principle.Poincare integral invariants. Whittaker's equation, Jacobi's equations, statement of Lee Hwa Chung's theorem, Hamilton- Jacobi's equation and it's complete integral. Solution of Harmonic oscillator problem by Hamilton-Jacobi method.

UNIT III :Cyclic Co-ordinates, Routh's equation, Poisson's identity, Lagrange's Bracket condition of canonical character of transformation in term of Lagrange's Bracket. Poisson's bracket. Invariance of Lagrange's brackets and Poisson brackets under canonical transformations.

UNIT IV :Motivation problems of calculus of variations. Shortest distance.Maximum surface of revolution.Brachistochrome problem, Geodesic.Fundamental lemma of calculus of variations. Euler's equation for one independent function and its generalization to (a) 'n' independent function (b) higher order derivatives. Conditional extremum under geometry constraints and under integral constraints.

REFERENCES:

1. A.S.Ramsey, Dynamics Part II, The English Language Book society and Cambridge University Press, (1972)
2. F.Gantmacher, Lectures in Analytical Mechanics, MIR PUBLISHER, Mascow, 1975
3. H.Goldstein, Classical Mechanics (2nd edition), Narosa Publishing house,New Delhi.
4. I.M.Gelfand and S.V.Fomin, Calculus of Variations, Prentice Hall.
5. Narayan Chandra Rana and Sharad Chandra Joag.Classical Mechanics, Tata McGraw Hill. 1991
6. Louis N.Hand and Janet D.Finch, Analytical Mechanics, Cambridge University Press. 1998.

Hod (Dr. Hanuman Rao)

Semester-IV	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	SCP 2.1	Programming Lab - II	4	40	10	50	2	3

Course Objective(s):

- It enables the student to explore mathematical concepts through the use of MATHEMATICA, MATLAB and *Free and Open-Source Software (FOSS) Tool.*
- To enhances the skills in effective programming in *Free and Open-Source Software (FOSS) Tool.*
- To utilize the software knowledge for academic research.
- To solve problems in applied mathematics through programming

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- effectively use the mathematical softwares like Mathematica, Matlab to solve various mathematical problems.
- understand the use of various techniques of the softwares for effectively doing mathematics.
- obtain necessary skills in programming to solve ODEs.
- understand the applications of applied mathematics.

Syllabus

Problems from HCT 2.4 (Theory) may be solved with the help of MATLAB, MATHEMATICA OR FOSS.

Head
C Dr. Hanumanthaiah

Semester- ~~III~~ II	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
	OET 2.1	**Foundations of Mathematics (Interdisciplinary-Elective paper)**	2	40	10	50	2	2

Course Objective(s):

- To enable students to understand fundamentals of set theory.
- Students will learn mathematical logic and principle of mathematical induction.
- To enable students to learn quantitative aptitude.
- Students will learn interpret data.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- identify relations and functions.
- solve permutation and combination problems.
- find GCD, LCM of numbers, simple interest and compound interest.
- plot bar graph, pie-graph and line graph.

Syllabus

Unit I: Set Theory: Union, intersection, Complementation, cross product of sets, relations, functions, properties functions, Equivalence relation,

Unit-II: Mathematical Logic, Logical connectives, two valued & three valued logics, Applications.Mathematical Induction, Permutations and Combinations, Binomial Theorem.

Unit-III: Quantitative Aptitude: Arithmetic ability, Percentage, Profit and Loss, Ratio and Proportion, Partnership, Numbers GCD & LCM, Time and Work, Simple and Compound Interest, Volume surface and area,

Unit-IV: Mental / logic ability and data interpretation –Races & Games of skills, Stocks and Shares, Bankers Discount, Heights and distance, odd man out series, Tabulation, Bar graph, Pie graph, Line graphs.

REFERENCES:

1. R. S. Agarawal, *Quantitative Aptitude*, S. Chand & Co.
2. N. D. Vohra, *Quantitative Techniques in Management*, Tata McGraw Hill.

Semester	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
II	OET 2.1	**Financial and Business Mathematics (Interdisciplinary-Elective paper)**	2	40	10	50	2	2

Course Objective(s):

- To enable students to understand fundamentals of operations of mathematics in real world life.
- To enable students to learn quantitative aptitude.
- Students will learn interpret data.

Course Outcome(s):

Upon the successful completion of the course, students will be able to

- Evaluate business problems involving complex linear relationships between decision variables and their determining factors.
- Explain mathematical formulation and solution of problems related to finance including different methods of interest calculation, future and present value of money

Units 1: Ratio, Proportion and Percentage

Ratio- Definition, Continued ratio, Inverse Ratio, Proportion - Continued proportion, Direct proportion, Inverse proportion, Variation - Inverse variation, Joint variation Percentage- Meaning and computation of percentage

Unit 2: Profit and Loss

Terms and formulae, Trade discount, Cash discount, problems involving cost price, selling price, trade discount, cash discount. Introduction to Commission and brokerage – problems on commission and brokerage

Unit 3: Interest and Annuity

Simple interest, compound interest, Equated monthly instalments, reducing balance and flat rate of interest Annuity immediate- present value and future value Stated annual rate and effective annual rate

Unit 4: Shares and Mutual Fund

Shares- Concept, face value, market value, dividend, Equity shares, preference shares, bonus shares, Mutual Fund- Simple problems on calculation of net income after considering entry load, exit load, dividend, change in net asset value

REFERENCES:

1. R. S. Agarawal, *Quantitative Aptitude*, S. Chand & Co.
2. N. D. Vohra, *Quantitative Techniques in Management*, Tata McGraw Hill.

	Subject / Paper Code	Title of the Paper	Instruction Hrs/ Week	Marks			Credits	Examination duration (Hrs)
				Examination	Internal Assessment	Total Marks		
SEMESTER - III	**HARD CORE PAPERS**							
	HCT 3.1	Measure Theory and Integration	4	80	20	100	4	3
	HCT 3.2	Complex Analysis - I	4	80	20	100	4	3
	HCT 3.3	Fluid Mechanics	4	80	20	100	4	3
	HCT 3.4	Numerical Methods - I	4	80	20	100	4	3
	SOFT CORE PAPER (ANY ONE)							
	SCT 3.1	Advanced Topology / Number Theory	4	80	20	100	4	3

Dr. Hanumantha (Hand)
coordinator
Dept. of Mathematics, ASMVUR.