KISHKINDA UNIVERSITY

Established under the act No. 20 of 2023,
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Department of Mathematics

PhD Course Work Syllabus

Course Title:	**Advanced Fluid Dynamics**	Credits:	**04**
Course Code:	**24MAT01**	SEE Marks:	**100**
Course Type:	**Self-Study**	Exam Duration:	**03 Hrs**
COURSE WORK SYLLABUS FOR MATHEMATICS			

ADVANCED FLUID DYNAMICS	
Module 1	**Introduction and kinematics of fluids:** Concepts of continuum hypothesis, magneto fluid mechanics regimes in mechanics; fluid properties. **Kinematics of Fluids-** Methods of describing fluid motion-Lagrangian method, Eulerian method; translation, rotation and rate of deformation; stream lines, path lines and streak line; material derivative and acceleration; vorticity.
Module 2	**Governing Equations for Fluid Flow:** Nature of stress; transformation of stress-nature of strains; transformation of the rate of strain; relation between stress and rate of strain; Conservation equations for mass, momentum and energy-differential and integral forms; Euler's equations of motion, integration along the stream line; integration of steady and irrotational motion; integration for two-dimensional unsteady flow.
Module 3	**Exact and Approximate solutions of N-S Equations:** Parallel flow past a sphere; Oseen's approximation; Hydrodynamic theory of lubrication. **Mechanics of Laminar Flow:** Laminar and turbulent flows; viscous flow at different Reynolds number-wake frequency; laminar plane Poiseuille flow; stokes flow; flow through a concentric annulus.
Module 4	**Magneto Hydrodynamics:** Basic principles of Magneto Hydrodynamics and its applications, Maxwell's relations, basic equations of MHD, Lorentz force, Magnetic induction equation, MHD approximation, Ohm's law for a moving conductor, Hall current, Kinematic aspect of MHD.
Module 5	**Boundary Layer Theory:** Prandtl's boundary layer theory and its importance, some basic definitions, (a) Boundary layer thickness: (b) Drag and lift, (c) Local skin friction coefficient. Displacement, momentum and energy thickness for auxiliary symmetric flow. The boundary layer equations in two-dimensional flow: order of magnitude approach. Boundary layer flow over flat plate. Blasius-Toper solution.

References:

- M. D. Raisinghania, "Fluid Dynamics", S. Chand-2013.
- G. K. Batchelor, "An Introduction to Fluid Dynamics", Cambridge University Press, 2005.
- J. L. Bansal, "Fluid Dynamics".
- P. K. Kundu and I. M. Cohen, "Fluid Mechanics", 3rd Edition, Academic Press-2004.

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Department of Mathematics

PhD Course Work Syllabus

Course Title:	**Graph Theory**	Credits:	**04**
Course Code:	**24MAT02**	SEE Marks:	**100**
Course Type:	**Self-Study**	Exam Duration:	**03 Hrs**
COURSE WORK SYLLABUS FOR MATHEMATICS			

GRAPH THEORY	
Module 1	**Introduction:** Definition of graph, Finite and infinite graphs, Incident, degree and Adjacency, Complete graphs. **Paths and Circuits:** Graph Isomorphism, Subgraphs, Operation on Graphs, Walk, Path, Circuits, Connected, Disconnected Graphs and components, Shortest path problems, Hamiltonian paths and circuits, Euler's Graph.
Module 2	**Trees and Spanning Trees:** Definition of Tree, Properties of Tree, minimally connected graphs, Distance in a graph, Spanning Tree, Rooted and Binary Tree, Counting Trees. **Connectivity and Separability:** Cuts and Cut-sets, Finding all cut sets, Relation between fundamental cut-sets and Fundamental circuits, Connectivity and Separability.
Module 3	**Matrix representation of Graphs:** Incidence Matrix, Sub Matrix of A(G), Circuit matrix, Fundamental circuit matrix and Rank of circuit Matrix, Cut-set Matrix, Path matrix, Adjacency matrix, Power of adjacency matrix, Relationship between A(G) and X(G), Incidence matrix for Digraph, Circuit matrix for Digraph, Adjacency matrix for Digraph.
Module 4	**Planar and Dual Graphs:** Planar Graphs, Kuratowaski's Graphs, Conflict Graph, Planarity and Duality, Thickness of a Graph. **Network flows:** Networks, Max-Flow Min-Cut theory, Monger's theory.
Module 5	**Colouring Vertices and Edges:** Vertex colouring, Chromatic numbers, Lower and upper bounds of chromatic number, Colouring of critical graph, Hajos conjecture, Chromatic polynomials, Matching Theory, Edge colouring, Colouring of planar graphs, 5 Coloured Problem.

References

- "Graph Theory" Second Edition by Saurabh Pal, Umesh Publications.
- "Graph Theory with applications to engineering and computer science" by Narsingh DEO.
- "Discrete Mathematical Structures" By Ralph P Grimaldi.
- "Graph Theory" By Frank Harary

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PhD Course Work Syllabus

Course Title:	**Numerical Analysis**	Credits:	**04**
Course Code:	**24MAT03**	SEE Marks:	**100**
Course Type:	**Self-Study**	Exam Duration:	**03 Hrs**

COURSE WORK SYLLABUS FOR MATHEMATICS

NUMERICAL ANALYSIS	
Module 1	**Linear and Non-Linear Algebraic Equation:** Gauss-Elimination and LU Decomposition Method, Gauss-Jordan Method, Gauss-Seidel Method and Relaxation Method. Newton-Raphson Method, False-Position Method.
Module 2	**Interpolation:** Newton's Interpolation Formula, Newton's Divided Difference Interpolation Polynomial and Lagrangian Interpolation, Gauss Forward and Backward Interpolation, Sterling's and Bessel's Interpolation formula with proofs.
Module 3	**Ordinary Differential Equations: Initial Value Problems.** Runge Kutta 2^{nd} and 4^{th} order method, Euler's method, Modified Euler's method, Milne's and Adams-Bashforth techniques, General multi step integration methods, Picard's Method for Simultaneous Higher Order Differential Equations.
Module 4	**Ordinary Differential Equations: Boundary Value Problems.** Finite Difference Method, Rayleigh-Ritz Method, Shooting Methods, cubic spline method, Galerkin finite element method, Finite element method for one-dimensional, Finite element method for two-dimensional.
Module 5	**Numerical Solution of Integral Equations:** Chebyshev series method, Method of Invariant Imbedding, Method using generalized quadrature, Method for degenerate Kernels, Trapezoidal rule, Simpson's $1/3^{rd}$ rule, Simpson's $3/8^{th}$ rule, The cubic spline method, Bool's and Weddle's rule.

References

- "Numerical Methods for Ordinary Differential Equations" by J.C. Butcher.
- "Numerical Methods for Engineers and Scientists" by R.W. Hamming.
- "An Introduction to the Finite Element Method" by J.N. Reddy.
- "Introductory methods of numerical Analysis" by S. S. Sastry.
- "Numerical Methods for Engineering" by Santosh K Gupta.

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PhD Course Work Syllabus

Course Title:	**Linear Algebra and Probability**	Credits:	**04**
Course Code:	**24MAT04**	SEE Marks:	**100**
Course Type:	**Self-Study**	Exam Duration:	**03 Hrs**

COURSE WORK SYLLABUS FOR MATHEMATICS

LINEAR ALGEBRA AND PROBABILITY	
Module:1	**Linear Algebra**: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms.
Module:2	**Random Variable and Probability Distributions:** Probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem. Random variables (discrete and continuous), probability density functions, probability distribution - Binomial, Poisson and normal distribution-their properties.
Module:3	**Correlation**: Correlation, Types of correlation, Pearson's coefficient of correlation, Spearman's rank correlation coefficient, Properties of correlation coefficient, **Regression**: Meaning and types of regression equations, Derivation of regression equations, Properties of regression equations, regression of Y on line X & regression of X on Y. **Curve fitting**: Straight Line, Parabola and Exponential Curves.
Module:4	**Testing of Hypothesis**: Hypothesis testing: Null and Alternative Hypotheses; Type I and Type II errors; Testing of Hypothesis: one sample and two sample tests for means and proportions of large samples (Z-test), one sample and two sample tests for means of small samples (T-test), F-test for two sample standard deviations. ANOVA: one-way and Two-way. $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes.
Module:5	**Queuing Theory:** Introduction, Queuing system, Classification of queuing models, Transient and steady state, Poisson and exponential distributions in queuing systems, Solution of queuing models: Model-I :(M/M/1 : ∞/FCFS), Model-II - (M/M/1 : FCFS/ ∝ / ∝): (Birth - Death process), Model-III: (M/M/1 : N/FCFS) (Finite Queue Length Model), Model-IV: (M/M/S) : FCFS/N/N (Limited Population or Source Model), Steady-state solutions of Markovian queuing models of M/M/1, Multi-Channel Queuing Model: M / M / c: (∝ / FCFS), M/G/1 with Limited Waiting Spaces.

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Department of Mathematics

PhD Course Work Syllabus

Course Title:	**Linear Algebra**	Credits:	**04**
Course Code:	**24MAT05**	SEE Marks:	**100**
Course Type:	**Self-Study**	Exam Duration:	**03 Hrs**
COURSE WORK SYLLABUS FOR MATHEMATICS			

LINEAR ALGEBRA	
Module:1	Rank of a matrix. Consistency and Solution of system of linear equations - Gauss-Elimination method, Gauss-Jordan method and approximate solution by Gauss-Seidel method. Solution of system of equations by Gauss-Jacobi iterative method, LU Decomposition method, Diagonalization of a square matrix, Inverse of a square matrix by Cayley-Hamilton theorem.
Module:2	Multiplication Ax Using Columns of A, Matrix-Matrix Multiplication AB ., The Four Fundamental Subspaces, Elimination and A = LU, Orthogonal Matrices and Subspaces, Eigenvalues and Eigenvectors, Symmetric Positive Definite Matrices, Singular Values and Singular Vectors in the SVD, Principal Components and the Best Low Rank Matrix, Rayleigh Quotients and Generalized Eigenvalues, Norms of Vectors and Functions and Matrices, Factoring Matrices and Tensors: Positive and Sparse
Module:3	Numerical Linear Algebra, least Squares: Four Ways, Three Bases for the Column Space , Randomized Linear Algebra, Changes in A^{-1} from Changes in A, Interlacing Eigenvalues and Low Rank Signals.
Module:4	Mean, Variance, and Probability, Probability Distributions, Moments, Cumulates, and Inequalities of Statistics, Covariance Matrices and Joint Probabilities, Multivariate Gaussian and Weighted Least Squares, Markov Chains.
Module:5	The Construction of Deep Neural Networks, Convolutional Neural, Nets Back propagation and the Chain Rule, Hyper parameters: The Fateful Decisions ,The World of Machine Learning

References

- Linear algebra and Learning from Data: Gilbert Strang, WELLESLEY- CAMBRIDGE PRESS
- Y. S. Abu-Mostafa et al, Learning from Data, AMLBook (2012).
- C. M. Bishop, Pattern Recognition and Machine Learning, Springer (2006).
- F. Chollet, Deep Learning with Python and Deep Learning with R, Manning (2017).
- G. Montavon, G. Orr, and K. R. Muller, eds, Neural Networks: Tricks of the Trade, 2nd edition, Springer (2012).
- M. Nielsen, Neural Networks and Deep Learning, (title).com (2017)

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References

- David C Lay: "Linear Algebra and its Applications", Pearson Publishers, 4th Ed., 2018.
- Gareth Williams: "Linear Algebra with Applications", Jones Bartlett Publishers Inc., 6th Ed., 2017.
- Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
- S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
- S. Ross, A First Course in Probability, Pearson Education India, 2002.
- W. Feller, An Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.
- Operations Research: An Introduction" by Hamdy A. Taha published by Prentice-Hall, India, 2006, 8th edition.

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PhD Course Work Syllabus

Course Title:	**Partial Differential Equations and Transform Calculus**	Credits:	**04**
Course Code:	**24MAT06**	SEE Marks:	**100**
Course Type:	**Self-Study**	Exam Duration:	**03 Hrs**
COURSE WORK SYLLABUS FOR MATHEMATICS			

PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORM CALCULUS	
Module:1	**Partial Differential Equations:** Solutions of PDE by Direct Integration, Linear Partial Differential Equations of 1st order, Non- Linear Partial Differential Equations of 1st order, Charpit's method, Homogeneous linear equations with constant co-efficient, Non-Homogeneous linear equations and Non-linear equations of 2^{nd} order by Monge's method.
Module:2	**Numerical solutions of PDE's:** Wave equation, One-Dimensional and Two-Dimensional heat equations and their solutions by the method of separation of variables and by De-Alembert's method, Solution of Partial Differential Equations: Finite Difference Approximation to Derivatives, Elliptic Equations, Solutions of Laplace equations, Poisson's equations, Parabolic equations, Hyperbolic equations, Solution of Wave equation.
Module:3	**Laplace Transforms & Inverse Laplace Transforms:** Transforms of Elementary functions, Properties of Laplace Transforms, Transforms of Periodic functions, Transforms of special functions, Transforms of derivatives, Transforms of Integrals, Multiplication by t^n. Inverse Transforms, Other methods of finding Inverse transforms, Convolution theorem, Application of Differential equations, and Simultaneous Linear equations by constant co-efficient, Unit-Step functions and Unit-Impulse functions.
Module:4	**Fourier transforms:** Fourier Integrals- Fourier sine and cosine transforms, finite Fourier sine and cosine transforms, properties of f-transforms, Convolution theorem for F transforms, Parseval's identity for F- transforms, Relation between Fourier and Laplace transforms, Fourier transforms of the derivatives of a function. Inverse Laplace transforms by method f residues. Application of transforms by Boundary value problems.
Module:5	**Z Transforms:** Some standard Z transforms, Linearity property, Damping rule, Shifting U_n to the right and to the left. Multiplication by n. Convolution theorem, convergence of Z transforms, and two – sided Z Transforms, evaluation of inverse Z – transforms, Applications to difference equations.

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References:

- Higher Engineering Mathematics by B S Grewal
- The Laplace Transform: Theory and Applications by Joel Schiff and Schaum's outline series
- Laplace Transforms and Their Applications to Differential Equations (Dover Books on Mathematics). by N.W. McLachlan
- Partial Differential Equations for Scientists and Engineers by Stanley J. Farlow
- Partial Differential Equations (Graduate Texts in Mathematics) by Jurgen Jost
- A student's guide to Fourier Transforms: With Applications in Physics and Engineering (Student's Guides) by JF James.

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