ORDINARY DIFFERENTIAL EQUATIONS (COMPULSORY) 3(3-0)

(Prerequisite : Caculus 2)

First Order Differential Equations and Solutions. N^{th} order Differential Equations. Existance and Uniqueness of Solutions. Solutions of 2^{nd}. Order and N^{th} Order Differential Equations. Solutions by Laplace Transform. Triangularization and Diagonalization of a Square Matrix. Systems of Equations. Application.

APPROXIMATE TEACHING HOURS

- First Order Diff. Equations and Solution (9 hrs.)
  Various types : separable variables, homogeneous equations, exact equations, linear 1^{st} order equations, reducible equations, Bernoulli's equation, nonlinear diff. equations, application.
- N^{th} Order Differential Equations (1 hrs.)
  Linear and nonlinear equations of second order. Homogeneous and nonhomogeneous types of equations of second order. Homogeneous and nonhomogeneous types of linear equations of arbitrary order.
- Existence and Uniqueness of Solutions (3 hrs.)
  Existence and uniqueness of solutions of equations. Initial value problem. The Wronskian.
- Solutions of 2^{nd} order and n^{th} order Differential Equations. (9 hrs.)
  Solutions of homogenesus equations of second and arbitrary order. Use of D - operator to find particular integrals. Methods of undetermined coefficients and variation of parametees.
- Solution by Laplace Transform (6 hrs.)
  Laplace Transforms of various functions, derivatives. Inverse Laplace Transforms. Transformation of ordinary differential equations.

- Triangularization and Diagonalization of a square matrix. (3 hrs.)
  Transformation of a square matrix into an upper or a lower triangular matrix.
  Transformationof a square matrix into a diagonal matrix.
- Systems of Equations (3 hrs.)
  Basic procedure for solving a system of linear differential equations with constant coefficients.
- Application (5 hrs.)

TOTAL 39 hrs.

VECTOR ANALYSIS (OPTIONAL) 3(3-0)

(Prerequisite : Calculus 2)

Elementary Operations. Partial Differentiation of Vector Functions. Line, Surface and Triple Integrals. Divergence Theorem. Green's Theorem. Stoke's Theorem. Application.

APPROXIMATE TEACHING HOURS

- Elementary Operations (3 hrs.)
  Addition, Subtraction, Multiplication by a scalar, The scalar product, The vector, product, Moment of a vector about a point or a directed line, Differentiation and Integration with respect to a scalar variable.
- Partial Differentiation of Vector Functions. (12 hrs.)
  Scalar and Vector fields, Directional derivatives, The operator del and its properties, Differentiation formulas, Curvilinear coordinates, ∇f, $\nabla . \vec{a}$ and $\nabla \times \vec{a}$ in curvilinear coordinates.
- Line, Surface and Triple Integrals (12 hrs.)
  Line integrals, Surface integrals, Triple integrals
- Divergence Theorem, Green's Theorem, Stoke's Theorem (6 hrs.)
- Application of vectors to engineering problems (6 hrs.)

TOTAL 39 hrs.

PARTIAL DIFFERENTIAL EQUATIONS (OPTIONAL) 3(3-0)

(Prerequisite Ordinary Differential Equations)

Partial Differential Equations Hyperbolic, Elliptic and Parabolic types. One Dimensional and Two Dinensional Wave Equations and Heat (or Diffusion) Equations with solutions. Laplacian Operatior in Polar Coordinates and in Spherical Coordinates. Laplace's Equations. Application.

APPROXIMATE TEACHING HOURS

- Partial Differential Equations Hyperbolic, Elliptic and Parabolic Types.	(3 hrs.)
- One dimensional wave equations and heat equations	(6 hrs.)
- Two dimensional wave equations and heat equations	(9 hrs.)
- Solutions	(6 hrs.)
- Laplacian Operator in Polar and Spherical Coordinates	(6 hrs.)
- Laplace's equations	(3 hrs.)
- Application	(6 hrs.)
TOTAL	39 hrs.

ELEMENTARY SPECIAL FUNCTIONS AND INTEGRAL TRANSFORMS (OPTIONAL) 3(3-0)

(prerequisite : calculus 2)

Gamma Function. Beta Function. Unit Step Function. Impulse Function. Legendre Polynomials $P_n(x)$. The generating function for $P_n(x)$. Bessel Functions of order zero and order one. Laplace Transform. Inverse Laplace Transform. Fourier Transform. Inverse Fourier Transform. Application.

APPROXIMATE TEACHING HOURS

- Gamma Function. Beta Function Unit Step Function Impulse Function	3 hrs.
- Legendre polymomials $P_n(x)$ The generating function for $P_n(x)$	6 hrs.
- Bessel Functions of order Zero and order one.	6 hrs.
- Laplace Transform Inverse Laplace Transform	9 hrs.
- Fourier Transform Inverse Fourier Transform	9 hrs.
- Application	6 hrs.
TOTAL	39 hrs.

FUNCTIONS OF A COMPLEX VARIABLE (OPTIONAL) 3(3-0)

(prerequisite : calculus 2)

Complex numbers. Limit. Derivative. Analytic Function. Cauchy - Riemann Equation. Line Integral in the complex plane. Cauchy's Integral Theorem. Cauchy's Integral formula. The Calculus of Residues. Conformal Mapping.

APPROXIMATE TEACHING HOURS

- Complex numbers.	6 hrs.
- Limit. Derivative. Analytic Functions Cauchy - Riemann Equations	6 hrs.
- Line Integral in the complex plane	6 hrs.
- Cauchy's Integral Theorun	3 hrs.
- Cauchy - Integral formula	3 hrs.
- The Calculus of Residues	9 hrs.
- Bilinear (Mobius) Transformations Schwarz - Christoffel Transformation	6 hrs.
TOTAL	39 hrs.

NUMERICAL METHODS (OPTIONAL) 3(3-0)

(prerequisite : ordinary differential equation)

Accuracy and Error. Solution of Equations by Iteration. Finite Differences. Numerical Differentiation and Integration. Solutions of 1^{st} and 2^{nd} order Differential Equations by Numerical Methods. Least-Square Polynomial Approximation. Numerical Methods for computing Approximate Values for Eigenvalues.

Approximate teaching hours

- Accuracy and Error Solution of equations by iteration	6 hrs.
- Finite Differences	3 hrs.
- Numerical differentiation and integration	6 hrs.
- Solutionof 1 st order diff. equation by numerical methods. Solution of 2 nd order diff. equation by numerical methods.	9 hrs.
- Least-square polynomial approx.	6 hrs.
- Numerial method for computing apporox values for eigenvalues	9 hrs.
TOTAL	39 hrs.

CALCULUS I 3 (3-0)

Limits, continuity, derivatives, differentiation of algebraic functions, important theorems of differential calculus and their applications, integrals, integration, improper integrals, differentiation of transcendental functions, techniques of integration.

Course outline:

Limits and continuity 4 hrs

- Limits of sequences
- Sums of series
- Limits of functions
- Continuity

Derivatives and differentiation of algebraic functions 8 hrs

- Derivatives and some of their meanings, especially slope, velocity, acceleration
- Differentiation by using formulae on sum, difference, product, quotient
- Chain rule
- Differentials and approximation of functions by differentials

Important theorems of differential calculus and their applications 5 hrs

- Rolle's theorem and its consequences:
  - Mean value theorem
  - Cauchy's mean value theorem
  - L'Hospital's rules
  - Taylor's formula

Applications in curve sketching

Applications in extreme values problems

Integrals and integration 6 hrs

Integrals and some of their meanings, especially area, volume

Fundamental theorems of integral calculus and their applications in integration

Change of variable in integration

Improper integrals 3 hrs

Meanings of all the three types of improper integrals:

- Type I : unbounded interval of integration
- Type II : unbounded integrand
- Mixed type

Differentiation and integration of transcendental functions 8 hrs

Exponential functions and logarithms

Trigonometric functions and their inverses

Hyperbolic functions

Techniques of integrations 5 hrs

Integration by substitutions

Integration by parts

Integration by decomposition into partial fractions

Total 39 hrs

CALCULUS II 3 (3-0)

Matrices and determinants, derivatives of vector-valued functions, surfaces and planes, derivatives of real-valued functions of several variables, transformations and Jacobians, integrals of functions of several variables.

Course outline:

Matrices and determinant 4 hrs

Operations on vectors and matrices

Determinants

Crammer's rule

Determination of inverse matrices

Derivatives of vector-valued functions 5 hrs

Representations of curves by vector equations and parametric equations

Derivatives of vector-valued functions (including complex-valued functions)

Some meanings, especially those concerning tangent, velocity, acceleration

Surfaces and planes 4 hrs

Surfaces and their representations by equations, both parametric form and cartesian form

Planes and determination of their equations

Determination of equations of intersections by planes

Derivatives of real valued-functions of several variables 7 hrs

Directional derivatives and partial derivatives

Gradients and differentials

Talor's formula for functions of several variables

Determinations of extreme values and saddle points

Transformations and Jacobians 7 hrs

Transformations and their total differentials

Oftenly used transformations:

- transformation into polar coordinates
- transformation into cylindrical coordinates
- transformation into spherical coordinates

Chain rules for total differentials of transformations and of partial derivatives

Implicit differentiation

Integrals of functions of several variables 12 hrs

Integration of vector-valued functions (including complex-valued functions)

Line integration

Multiple integration

Surface integration

Total 39 hrs

PROBABILITY AND STATISTICS 3 (3-0)

Elementary probability theory, random variables and distributions, moments, moment generating functions and characteristic functions, limit theorems, random samples and sampling distributions, estimations, tests of hypotheses.

Course outline:

Elementary probability theory 4 hrs

Empirical and mathematical probabilities

combinatorial method for computing probabilities

conditional probabilities

statistical independence

Bayes' theorem

Random variables and distributions 10 hrs

Random variables and distribution functions

Discrete and continuous random variables

Some important distributions:

- Binomial distrbutions
- Poisson distributions
- Uniform distributions
- Normal distributions
- Weibull distributions
- Gamma distributions

Multidimensional random variables

Marginal distributions

Conditional distributions

Distributions of functions of random variables, including uses of Jacobian of transformation in derivations of functions of random variables

Moments, moment generating functions and characteristic functions 4 hrs

Expectations

Moments and central moments

Moment generating functions and characteristic functions

Determination of distributions of linear functions of a random variable by using moment generating functions or characteristic functions

Determination of distributions of sums of independent random variables by using moment generating functions or characteristic functions

Limit theorems 4 hrs

Determination of limit distributions by using moment generating functions or characteristic functions

Law of large numbers

Approximation of binomial distributions by Poisson distributions

Central limit theorem

Random samples and sampling distributions 4 hrs

Random samples and statistics

Distribution of arithmetic means of samples from normal populations

Chi-square distributions

t distributions

Estimations 5 hrs

Point estimation and some desirable properties, covering estimation of proportions, arithmetic mean, variances

Interval estimation, covering estimation of proportions, arithmetic mean, variances

Tests of hypotheses 8 hrs

Tests of simple hypotheses against simple alternatives, the two types of errors are to be considered

Tests of composite hypotheses

Power of tests and OC-curves

Tests concerning proportions

Tests concerning arithmetic means

Tests concerning variances

Total 39 hrs

STATISTICAL METHODS 3 (3-0)

Sampling distributions concerning two populations, tests concerning two populations, analysis of variances, regression analysis, uses of orthogonal polynomials in polynomial regressions, designs of experiments, non-parametric methods for testing hypotheses.

Sampling distributions concerning two populations, 3 hrs

Distributions of differences of arithmetic means of two samples

Distributions of ratios of variances of two samples

Distributions of differences of proportions of two samples

Tests concerning two populations 5 hrs

Tests of equalities of arithmetic means of two populations

Tests of equalities of variances of two populations

Tests of equalities of proportions of two populations

(In each topic, both cases of small and large samples are to be considered)

Analysis of variances 6 hrs

General linear models

One way analysis of variances

Two way analysis of variances

Tests of hypotheses by using confidence intervals of contrasts

Tests of equalities of variances of several populations

Regression analysis 6 hrs

Simple linear regression

Multiple linear regression

Polynomial regression

Non-linear regression

Correlation analysis

Tests of equalities of slopes

Transformations of data in regression analysis

Uses of orthogonal polynomials in polynomial regressions 6 hrs

Uses of orthogonal polynomials and some of the advantages

Determination of the best fit polynomial by testing significance of coefficients

Designs of experiments 7 hrs

Completely randomized designs

Randomized complete block designs

Latin square designs

Greco-Latin square designs

Factorisl designs

Analysis of covariances

Non-parametric methods of testing hypotheses 6 hrs

Sign test

Rank test

Rank-sum test

Non-parametric methods in analysis of variances

Total 39 hrs