

Course : MTH102A Dept: MTH
Mathematics II : Linear Algebra & Ordinary Differential equation
Units : 3-1-0-11

Course Objectives: The main objective of this course is to introduce basic theory of linear algebra and ordinary differential equations.

Pre-requisite : MTH101A

Course Contents:

Linear Algebra: Matrices, System of linear equations, Gauss elimination method, Elementary matrices, Invertible matrices, Gauss-Jordan method for finding inverse of a matrix, Determinants, Basic properties of determinants. Cofactor expansion, Determinant method for finding inverse of a matrix, Cramer's Rule, Vector space, Subspace, Examples, Linear span, Linear independence and dependence, Basis, Dimension, Extension of a basis of a subspace, Intersection and sum of two subspace, Examples. Linear transformation, Kernel and Range of a linear map, Rank-Nullity Theorem. Rank of a matrix, Row and column spaces, Solvability of system of linear equations, some applications Inner product on Cauchy-Schwartz inequality, Orthogonal basis, Gram-Schmidt orthogonalization process. Orthogonal projection, Orthogonal complement, Projection theorem, Fundamental subspaces and their relations, Applications (Least square solutions and least square fittings). Eigen-values, Eigen-Vectors, Characterization of a diagonalizable matrix. Diagonalization: Example, An application. Diagonalization of a real symmetric matrix. Representation of real linear maps by matrices (optional)

Ordinary differential equations: Introduction to DE, Order of DE, First Order ODE $F(x,y,y')=0$. Concept of solution (general solution, singular solution, implicit solution etc.), Geometrical interpretations (direction fields, isoclines), Separable form, Reduction to separable form, Exact equations, Integrating factors (of the form $F(x)$ and $F(y)$). Linear equations, Bernoulli equation, orthogonal trajectories. Picard's existence and uniqueness theorem (without proof), Picard's iteration method. Numerical methods: Euler's method, improved Euler's method. Second order linear ODE: fundamental system and general solutions of homogeneous equations, Wronskian, reduction of order. Characteristic equations: real distinct roots, complex roots, repeated roots. Non-homogeneous equations: undetermined coefficients. Non-homogeneous equations: variation of parameters. Extension to higher order differential equations, Euler-Cauchy equation. Power series solutions: ordinary points (Legendre equation). Power series solutions: regular singular points (Bessel equation), Frobenius method, indicial equations. Legendre polynomials and properties, Bessel functions and properties, Sturm comparison theorem, Sturm-Liouville boundary value problems, orthogonal functions. Laplace transform: Laplace and inverse Laplace transforms, first shifting theorem, existence, transforms of derivative and integral. Laplace transform: Differentiation and integration of transforms, unit step function, Second shifting theorem. Laplace transform: Convolution and applications, initial value problems.

Course References :

1. G. Strang: Linear Algebra, Introduction to linear algebra, 41 Edition, Wellesley Cambridge Press
2. G. F. Simmons: Ordinary Differential Equations, Differential equations with applications and historical notes, 2nd Edition.
3. E. Kreyzig, Advanced Engineering Mathematics,
4. Lecture Notes by Prof. P. Shunmugraj available in his homepage,
5. Lecture Notes by Prof. Arbind Lal available in his homepage.
6. Lecture Notes by Prof. Abhijit Pal available in his homepage
7. Lecture Notes by Prof. S.Ghorai available in his homepage

Instructors : Prof. Abhijit Pal (In-Charge), Prof. S. Ghorai

Tutors : Prof. Mohua Banerjee, Prof. M.Gupta, Prof. S.Jha, Prof. A.K.Maloo, Prof. R.Rawat, Prof. P. Samuel, Prof. P. Sinha, Prof. A. Thakur, Prof. Prosenjit Roy

Class Schedule : Monday, Wednesday, Friday,
Sections under A : 10-11 am,
Sections under B: 4-5 pm

Venue: L20

Tutorial Schedule: Tuesday 10-11 am for Sections under A,
Thursday 4-5 pm for Sections under B.

Contacts : email: abhipal@iitk.ac.in, Ph. 0512-2596405

Course Organization :

All important informations, course materials, office hours and contacts of tutors are available in the website <https://sites.google.com/site/abhijitwebpage/teaching>. Important announcement will be communicated through emails and will be posted in the above website.

Evaluation Procedure: Total Marks 200

- (i) There will be one mid-semester examination of 60 Marks,
- (ii) There will be one end-semester examination of 100 Marks,
- (iii) There will be two quizzes each of 15 Marks, one before Mid-Sem exam and another one after Mid-Sem exam,
- (iv) 10 Marks will be awarded only to those students who fulfill 90% or more attendance.

Appearance in End-Semester examination is mandatory. Those who fail to appear in the End-semester examination and then does not give make-up examination will be awarded F grade.