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Course code: MAT301R01
Semester: IV

ENGINEERING MATHEMATICS - IV

(COMMON FOR ALL BRANCHES OF ENGINEERING) (EXCEPT FOR ICT AND MECHATRONICS)

Course Objectives:
The course aims to train the learner to:

- Understand the techniques to solve various Partial Differential Equations (PDEs) used in Engineering disciplines.
- Understand properties of Fourier transforms and their applications
- Understand numerical methods and apply them to solve engineering problems.
- Impart numerical techniques to solve boundary value problems in Engineering computations.

Unit 1: Partial Differential Equations (PDEs) 15 Periods

Formation of PDE - Eliminating arbitrary constants- Eliminating arbitrary functions – First order nonlinear PDE: $f(p , q)= 0$, $f(z ,p ,q)= 0$, $f (x, p)= g(y , q)$, Clairaut's equation - Lagrange's linear equation – Homogeneous linear PDE of Higher order with constant coefficients.

Applications: Draining of liquid down the side of a vessel (first-order equations involves the draining of liquid from a vessel, a procedure common to many industrial processes), The transmission-line equations and Deflections of a plate.

Unit 2: Fourier Transforms 15 Periods

Fourier integral theorem (statement only) – Infinite and finite Fourier and its inverse transform - Fourier sine and cosine transform- Transform of derivatives- Convolution and Parseval's theorem (statement only) - Initial and boundary value problems .
Applications: Electrical Oscillation in simple circuit, Transverse vibration of a continuous string and Transverse vibration of a thin membrane.

Unit 3: Numerical solution of various equations, Interpolation, Numerical Differentiation and Integration 15 Periods

Newton Raphson method - Gauss Jordan Method - Gauss Seidel Method- Interpolation – Newton's Forward & Backward difference – Lagrange's interpolation – Numerical differentiation – Newton's forward and backward difference formula - Numerical Integration - Trapezoidal's Rule – Simpson's one-third rule and Simpson's three-eighth rule .

Applications: Computation of Velocity and Acceleration by Numerical differentiation. Determine the total quantity of heat and Root Mean square current by Numerical integration.

Unit 4: Numerical solution of initial value and boundary value problems 15 Periods

Euler – Improved Euler- Modified Euler - Fourth order Runge-Kutta Method for first and second order ODE –Liebmann's Process for solution of Laplace's equation – Poisson equation – Parabolic equation Bender- Schmidt Method – Crank Nicholson Method – Solution of Hyperbolic equation.

Applications: Swinging pendulum problems and Physical problems governed by elliptic, parabolic and hyperbolic PDE's.

TEXT BOOKS

1. Glyn James, Advanced Modern Engineering Mathematics, 5th edition, Pearson Education Limited , England, 2018
2. Steven C. Chapra and Raymond . P. Canale, *Numerical Methods for Engineers,* 6 edition, Tata McGraw-Hill publications, 2012.

REFERENCES

1. Wylie, C.R and L.C.Barrett, *Advanced Engineering Mathematics*, 6/e,McGrawHill,2012
2. Ian. N. Sneddon, *Fourier Transforms*, Dover publications, New York, McGraw-Hill, 1951
3. G. D. Smith*, Numerical Solution of Partial Differential Equations*: Finite Difference Methods, Oxford University Press, 1985.
4. Wei-Chau Xie, *Differential Equations for Engineers*, Cambridge university press, 2010.

ONLINE MATERIAL

1. **https://nptel.ac.in/courses/111/105/111105093/**
2. **https://nptel.ac.in/courses/111/102/111102129/**

UNIT-WISE LEARNING OUTCOMES

Upon successful completion of the course, the learners will be able to:

Unit I	Classify and solve partial differential equations of first and higher orders
Unit II	Formulate and solve one dimensional heat conduction problems using standard techniques developed using Fourier Transforms
Unit III	Determine the values of derivatives of single variable functions using standard numerical techniques and evaluate definite integrals using Trapezoidal and Simpsons' rules

Unit IV	Apply standard techniques of numerical methods to solve boundary value problems.

COURSE LEARNING OUTCOMES

After the successful completion of the course, the student will be able to:

CO No.	Course Outcome	Knowledge Level
CO 1.	Apply the fundamental concepts of Partial Differential Equations and the basic methods for their resolution.	K3
CO 2.	Use knowledge of partial differential equations (PDEs) for modelling, the general structure of solutions and apply analytic and numerical methods for solutions to solve them	K3
CO 3.	Apply the concept of even-odd functions and use the resulting simplifications for transforms.	K3
CO 4.	Understand the difficulty of solving problems analytically and the need to use numerical approximations for their resolution.	K3
CO 5.	Use computational tools to solve problems involving applications of Ordinary Differential Equations	K3
CO 6.	Classify PDEs, apply analytical methods, and physically interpret the solutions	K3
CO 7.	Use computational tools to solve problems involving applications of Partial Differential Equations.	K3