GUJARAT TECHNOLOGICAL UNIVERSITY
B. E. SECOND YEAR (SEMESTER - III)

Subject Name: **ADVANCED ENGINEERING MATHEMATICS**

Subject Code : **130002**

Course Objectives

Students entering in Advanced Engineering Mathematics should have a firm grasp of Calculus, linear algebra and vector calculus. They should be able to graph functions, integration and differentiation of functions, partial derivative of functions, optimization and evaluation of multiple integral.

The objective of Advanced Engineering Mathematics is for students to learn the basics of Modeling and solution of differential equations. They will study standard functions with graph, geometrical meaning of differential equations, modeling and solution of ordinary and partial differential equations also application of Fourier series, Fourier integral and Laplace transform.

More generally, the students will improve their ability to think critically, to analyze a real problem and solve it using a wide array of mathematical tools. These skills will be invaluable to them in whatever path they choose to follow, be it as a mathematics major or in pursuit of a career in one of the other sciences.

They will also able to apply these ideas to a wide range of problems that include the engineering equations. The students should be able to interpret the concepts of modeling algebraically, graphically and verbally.

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

- expansion of functions in terms of basic trigonometric functions.
- analyze differential equations.
- solve differential equations by using tool like Laplace transform and Fourier series.
- create a modeling of engineering problems.
- solve ODEs and PDEs

The course is designed in such a way that it can be covered comprehensively in period of semester.

Advanced Engineering Mathematics

Sr No.	Course Content	Total Hrs
1	**Introduction to Some Special Functions:** Gamma function, Beta function, Bessel function, Error function and complementary Error function, Heaviside's function, pulse unit height and duration function, Sinusoidal Pulse function, Rectangle function, Gate function, Dirac's Delta function, Signum function, Saw tooth wave function, Triangular wave function, Half wave rectified sinusoidal function, Full rectified sine wave, Square wave function.	02
2	**Fourier Series and Fourier integral:** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Forced oscillations, Fourier integral.	05
3	**Ordinary Differential Equations and Applications:** First order differential equations: basic concepts, Geometric meaning of y' = f(x,y) Direction fields, Exact differential equations, Integrating factor, Linear differential equations, Bernoulli equations, Modeling , Orthogonal trajectories of curves. Linear differential equations of second and higher order: Homogeneous linear differential equations of second order, Modeling: Free Oscillations, Euler- Cauchy Equations, Wronskian, Non homogeneous equations, Solution by undetermined coefficients, Solution by variation of parameters, Modeling: free Oscillations resonance and Electric circuits, Higher order linear differential equations, Higher order homogeneous with constant coefficient, Higher order non homogeneous equations. Solution by [1/f(D)] r(x) method for finding particular integral.	11
4	**Series Solution of Differential Equations:** Power series method, Theory of power series methods, Frobenius method.	03
5	**Laplace Transforms and Applications:** Definition of the Laplace transform, Inverse Laplace transform, Linearity, Shifting theorem, Transforms of derivatives and integrals Differential equations, Unit step function Second shifting theorem, Dirac's delta function, Differentiation and integration of transforms, Convolution and integral equations, Partial fraction differential equations, Systems of differential equations	09
6	**Partial Differential Equations and Applications:** Formation PDEs, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients, Equations reducible to Homogeneous linear form, Classification of second order linear PDEs. Separation of variables use of Fourier series, D'Alembert's solution of the wave equation, Heat equation: Solution by Fourier series and Fourier integral	12

Text Books:

1. Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007). (1.1, 1.2, 1.5, 1.6, 1.7, 1.8, 2.1 to 2.15, 4.1, 4.2, 4.4, 5.1 to 5.9, 10.1 to 10.4, 10.6, 10.8, 11.3, 11.4, 11.5, 11.6)
2. Engineering Mathematics Vol 2, by Baburam, Pearson(1.12, 4.20,5.1 to 5.8)

Reference Books:

1. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).
2. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).
3. T.M.Apostol, Calculus , Volume-2 (2nd Edition), Wiley Eastern , 1980

Projects

The following projects are recommended for the students to perform during semester. One of the projects may be performed by a group of 4 students under the guidance of Maths faculty. Optionally it is suggested that 50% weightage from the internal component of 50 marks may be given to this project.

1. Fourier Series and integral :
Forced Oscillation, Approximation by trigonometric polynomials, Applications of Fourier Series, Application of Fourier Integral etc.

2. Ordinary Differential Equations :
Mixing problem, Population model, Newton's law of cooling, Electric circuits, Heart pacemaker, Orthogonal trajectory of streamlines and isotherms, Mass-spring system, Pendulum clock, Torsional vibrations, electric potential field, Free Oscillations resonance and Electric circuits, Elastic beam, Applications of ODE etc.

3. Laplace Transforms :
Single Square wave, Response of a damped vibrating system to a single square wave, Use of Laplace Transforms in electric circuits, Damped force vibrations, Mixing problem by Laplace Transforms, Two mass spring etc.

4. Partial Differential Equations:
Modeling of vibrating string, Heat equations etc.