Sankalchand Patel University

Faculty of Engineering and Technology

First Year Master of Technology - Mechanical Engineering (CAD - CAM)

In Effect from Academic Year 2016-17

Program Code: ET201	
Subject Code: 1ET2010106	**Subject Title:** APPLIED COMPUTATIONAL METHODS (Elective-I)
Pre-requisite Subject	**Differentiability of a function, Differentiation and Integration.**

Course Objective: To understand the applications of Ordinary differentiation equation and Partial differentiation equation in Mechanical Engineering. The course should enhance their ability to develop mathematical models and solve problems using analytical and numerical methods.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
				Theory		Practical		
Lecture	Tutorial	Practical	Credit	University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	Total
2	2	-	4	60	40	30	20	150

Subject Contents			
Sr. No	**Topic**	**Total Hours**	**Weight (%)**
01	**1st Order ODE**: Geometric Meaning of y'= ƒ(x, y), Direction Fields, Euler's Method; Separable ODEs; Exact ODEs (Integrating Factors Method, Existence and Uniqueness of Solution); Linear ODEs (Homogeneous and Non-Homogeneous, Reduction to Linear problems); Orthogonal Trajectories.	**03**	**15**
02	**2nd Order ODE**: Linear Dependence and Linear Independence; Homogeneous Linear ODEs of Second Order (Initial Value Problem, Boundary Value Problem); Homogeneous Linear ODEs with Constant Coefficients (Euler's formula and review of the circular and hyperbolic function, Exponential Solutions, Repeated Roots and Stability);Solution by[1/f(D)] r(x) method for finding particular integral. Differential Operator; Modelling of Free Oscillations of Spring-Mass System; Homogeneous Linear ODEs with Non Constant Coefficient (Cauchy-Euler Equation, Non-homogeneous ODE, Modelling of Forced Oscillations, Solution by Variation of Parameters.	**06**	**25**
03	**Laplace Transforms:** Laplace Transform, Linearity, First Shifting Theorem (s-Shifting);Transforms of Derivatives and Integrals, ODE; Unit Step Function(Heaviside Function), Second Shifting Theorem (t-Shifting); Short Impulses, Dirac's Delta Function, Partial Fractions; Convolution, Integral Equations; Differentiation and Integration of Transforms, ODEs with Variable Coefficients; Systems of ODEs.	**05**	**20**
04	**Fourier Analysis :** Fourier Series; Arbitrary Period, Even and Odd Functions, Half-Range Expansions; Forced oscillations; Approximation by Trigonometric Polynomials; Sturm–Liouville Problems, Orthogonal Functions; Orthogonal Series, Generalized Fourier Series; Fourier Cosine and Sine Transforms; Fourier Transform.	**05**	**20**

05	**PDE:** Basic Concepts of PDEs; Modeling: Vibrating String, Wave Equation;Solution by Separating Variables; Use of Fourier Series; D'Alembert's Solution of the Wave Equation, Characteristics; Modelling: Heat Flow from a Body in Space, Heat Equation: Solution by Fourier Series. Steady Two-Dimensional Heat Problems, Dirichlet Problem; Modelling Very Long Bars: Solution by Fourier Integrals and Transforms, **Modelling:** Membrane, Two-Dimensional Wave Equation; Rectangular Membrane, Double Fourier Series; Laplacian in Polar Coordinates, Circular Membrane, Fourier–Bessel Series; Laplace's Equation in Cylindrical and Spherical Coordinates, Potential; Solution of PDEs by Laplace Transforms.	**06**	**20**

Review Presentation: The student is expected to spend minimum 2 hours per week (as mentioned in the teaching and evaluation scheme) to refer at least two peer reviewed journal papers related to this domain/subject. The student is expected to identify issues/challenges and emerging trends in the domain/subject. Student is supposed to explore various video lectures (E.g. NPTEL) available in the domain/subject. Student is required to make a review-presentation on the work carried out for the same.
Recommended sites for journal papers are (1) asmedigitalcollection.asme.org (2) springer.com (3) sciencedirect.com (5) ieeexplore.ieee.org (6) scholar.google.co.in or others of similar repute.

Course Outcome:
After learning the course the students should be able to
1. Students will be able to develop mathematical models of physical phenomena.
2. Students will be able to solve ordinary and partial differential equations analytically as well as numerically.
3. Students will learn fundamentals and applications of algebra for engineering problems.

Tutorials:

1. Directional fields, Euler's Method; Separable ODEs; Exact ODEs (Integrating Factors Method, Existence and Uniqueness of Solution)
2. Linear ODEs (Homogeneous and Non-Homogeneous, Reduction to Linear problems); Orthogonal Trajectories.
3. Linear Dependence and Linear Independence; Homogeneous Linear ODEs of Second Order (Initial Value Problem, Boundary Value Problem); Homogeneous Linear ODEs with Constant Coefficients (Euler's formula and review of the circular and hyperbolic function, Exponential Solutions, Repeated Roots and Stability)
4. Solution by [1/f(D)] r(x) method for finding particular integral. Differential Operator; Modeling of Free Oscillations of Spring-Mass System
5. Homogeneous Linear ODEs with Non Constant Coefficient (Cauchy-Euler Equation, Non-homogeneous ODE, Modeling of Forced Oscillations, Solution by Variation of Parameters.
6. Laplace Transform, Linearity, First Shifting Theorem (s-Shifting);Transforms of Derivatives and Integrals, ODE; Unit Step Function(Heaviside Function)
7. Second Shifting Theorem (t-Shifting); Short Impulses, Dirac's Delta Function, Partial Fractions; Convolution, Integral Equations
8. Differentiation and Integration of Transforms, ODEs with Variable Coefficients; Systems of ODEs.
9. Fourier Series; Arbitrary Period, Even and Odd Functions, Half-Range Expansions; Forced oscillations
10. Approximation by Trigonometric Polynomials; Sturm–Liouville Problems, Orthogonal Functions; Orthogonal Series, Generalized Fourier Series
11. Fourier Cosine and Sine Transforms; Fourier Transform.
12. Wave Equation; Solution by Separating Variables; Use of Fourier Series; D'Alembert's Solution of the Wave Equation

13. Heat Flow from a Body in Space, Heat Equation: Solution by Fourier series. Steady Two-Dimensional Heat Problems
14. Dirichlet Problem; Modeling Very Long Bars: Solution by Fourier Integrals and Transforms, Membrane, Two-Dimensional Wave Equation; Rectangular Membrane, Double Fourier Series; Laplacian in Polar Coordinates, Circular Membrane, Fourier–Bessel Series; Laplace's Equation in Cylindrical and Spherical Coordinates, Potential; Solution of PDEs by Laplace Transforms.

List of References:

1. Advanced Engineering Mathematics, 9/e By Erwin Kreyszig JOHN WILEY & SONS, INC.
2. Higher Engineering Mathematics, By Dr. B.S. Grewal, Khanna Publishers.
3. Higher Engineering Mathematics, Vol. I, 7th edition By Dr. K.R. Kachot, Mahajan Publishing House.
4. Textbook of Engineering Mathematics, Revised Second Edition, By Debashis Datta, New Age International Publishers.