II Semester

ADVANCED CALCULUS AND NUMERICAL METHODS			
Course Code	**21MAT21**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: The goal of the course Advanced Calculus and Numerical Methods - 21MAT21 is,

- To facilitate the students with a concrete foundation of integral calculus.
- To facilitate the students with a concrete foundation of vector calculus, partial differential equations, and numerical methods enabling them to acquire the knowledge of these mathematical tools.

Teaching-Learning Process (General Instructions):

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples
3. Support and guide the students for self-study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress
5. Encourage the students for group learning to improve their creative and analytical skills
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lecture activity).
   - As additional examples (post-lecture activity).
   - As an additional material of challenging topics (pre and post-lecture activity).
   - As a model solution of some exercises (post-lecture activity)

Module-1: Integral Calculus

Multiple Integrals: Evaluation of double and triple integrals, evaluation of double integrals by change of order of integration, changing into polar coordinates. Applications to find Area and Volume by a double integral. Problems.

Beta and Gamma functions: Definitions, properties, the relation between Beta and Gamma functions. Problems.

Self-Study: Centre of gravity.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Vector Calculus

Vector Differentiation: Scalar and vector fields. Gradient, directional derivative, curl and divergence - physical interpretation, solenoidal and irrotational vector fields. Problems.

Vector Integration: Line integrals, Surface integrals. Applications to work done by a force and flux. Statement of Green's theorem and Stoke's theorem. Problems.

Self-Study: Volume integral and Gauss divergence theorem.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-3: Partial Differential Equations (PDE's)

Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only. Solution of Lagrange's linear PDE. Derivation of one-dimensional heat equation and wave equation. **Self-Study**: Solution of one-dimensional heat equation and wave equation by the method of separation of variables.	
Teaching-Learning Process	Chalk and talk method / Power Point Presentation
Module-4: Numerical methods -1	
Solution of polynomial and transcendental equations: Regula-Falsi and Newton-Raphson methods (only formulae). Problems. Finite differences, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference formula and Lagrange's interpolation formula (All formulae without proof). Problems. N**umerical integration**: Simpson's $(1/3)^{rd}$ and $(3/8)^{th}$ rules(without proof). Problems. S**elf-Study**: Bisection method, Lagrange's inverse Interpolation, Weddle's rule	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5: Numerical methods -2	
Numerical Solution of Ordinary Differential Equations (ODE's): Numerical solution of ordinary differential equations of first order and first degree: Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth-order, Milne's predictor-corrector formula (No derivations of formulae). Problems. **Self-Study:** Adam-Bashforth method.	
Teaching-Learning Process	Chalk and talk method/PowerPoint Presentation

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

- Apply the concept of change of order of integration and change of variables to evaluate multiple integrals and their usage in computing the area and volume.
- Illustrate the applications of multivariate calculus to understand the solenoidal and irrotational vectors and also exhibit the interdependence of line, surface, and volume integrals.
- Formulate physical problems to partial differential equations and to obtain solutions for standard practical PDE's.
- Apply the knowledge of numerical methods in modeling various physical and engineering phenomena.
- Solve first-order ordinary differential equations arising in engineering problems.

Assessment Details (both CIE and SEE)

Continuous Internal Evaluation(CIE):

Semester End Examination(SEE):

3.

Suggested Learning Resources:

Text Books

1. **B.S. Grewal**: "Higher Engineering Mathematics", Khanna publishers, 44 th Ed.2018
2. **E. Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed.(Reprint), 2016.

Reference Books:

1. **V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. **Srimanta Pal & Subodh C. Bhunia:** "Engineering Mathematics" Oxford University press, 3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A text book of Engineering Mathematics" Laxmi Publications, Latest edition
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co. Newyork, Latest ed.
5. **Gupta C.**B, **Sing S.R and Mukesh kumar**: "Engineering Mathematics for Semester I and II", Mc-Graw Hill Education(India) Pvt.Ltd. 2015
6. **H.**K.**Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics" S. Chand Publication (2014).
7. **James Stewart: "**Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- VTU e-Shikshana Program
- VTU EDUSAT Program

Activity Based Learning (Suggested Activities in Class) / Practical Based learning

- Quizzes
- Assignments
- Seminars