College of Engineering Pune
(An Autonomous Institute of Government of Maharashtra, Pune-411005)
Department of Mathematics
(MA 20006) Multivariate Calculus and Differential Equations
S.Y. B. Tech. (for Students Directly admitted to S.Y. after their Diploma)
Semester IV (All Branches)

Teaching Scheme
Lectures : 4 hrs / week
Tutorial : 1hr / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End Sem. Exam: 60 marks

Unit I : Review of first order differential equations, linear differential equations, homogeneous higher order linear differential equations, non-homogeneous higher order linear differential equations with constant coefficients (method of undetermined coefficients and method of variation of parameters). **[09 Hrs]**

Unit II : Laplace Transforms, its properties, Unit step function, Dirac delta functions, Convolution Theorem, periodic functions, solving differential equations using Laplace transform. **[07 Hrs]**

Unit III : Functions of several variables, level curves and level surfaces, partial and directional derivatives, differentiability, chain rule, local extreme values and saddle points. **[07 Hrs]**

Unit IV : Double integrals in Cartesian and polar co-ordinates, iterated integrals, change of variables, triple integrals in Cartesian, spherical and cylindrical co-ordinates, applications to area, mass, and volume. **[12 Hrs]**

Unit V : Vector differentiation, gradient, divergence and curl, line and surface integrals, path independence, statements and illustrations of theorems of Green, Stokes and Gauss. **[10 Hrs]**

Unit VI : Partial differential equations with separation of variables, boundary value problems: vibrations of a string, one dimensional heat equation. **[07 Hrs]**

Text Books :

- Thomas' Calculus (14th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.

- Advanced Engineering Mathematics (10th edition) by Erwin Kreyszig, Wiley eastern Ltd.

Reference Books :

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer Science and Business Media.
- Differential Equations with Applications and Historical notes by George Simmons, Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Functions of several variables by Wendell Fleming, Springer-Verlag, New York.
- Partial Differential Equations (4th edition) by Fritz John, Springer.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.
- Advanced Engineering Mathematics by Chandrika Prasad and Reena Garg, Khanna Publishing Company Private Limited, New Delhi.

Outcomes : Students will be able to

1. **know** first order ordinary differential equations, **list** Laplace transform formulae, **define** functions of several variables, double / triple integrals, vector differentiation, vector integration, and partial differential equations.
2. **understand** basic concepts of higher order ordinary differential equations, level curves and level surfaces, co-ordinate systems, iterated integrals, gradient, divergence and curl.
3. **solve** linear differential equations using different methods, **find** Laplace transforms of functions using properties and theorems, **evaluate** directional derivatives and extreme values, **evaluate** multiple integrals, **find** area / mass / volume using multiple integrals, **evaluate** line integrals and surface integrals.
4. **prove** theorems, **solve** ordinary differential equations using Laplace transforms, **apply** Green's / Stoke's / Divergence theorem to different type of problems, **model** one dimensional heat / wave equations, **solve** partial differential equations.

5. **apply** concepts of multivariate calculus and differential equations to various applications including real life problems.

Note 1 :

- To measure CO1, questions may be of the type- define, identify, state, match, list, name etc.
- To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.
- To measure CO3, questions will be based on applications of core concepts.
- To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.
- To measure CO5, some questions may be based on self-study topics and also comprehension of unseen passages.

Note 2 :

All the Course outcomes 1 to 3 will be judged by 75% of the questions and outcomes 4 and 5 will be judged by 25 % of questions.