COURSE TITLE	**DIFFERENTIAL EQUATIONS AND TRANSFORMS**
COURSE CODE	**01EC0118**
COURSE CREDITS	**4**

Objective:

1 This course is designed to help students build a solid understanding of key mathematical concepts such as differential equations, Laplace and Fourier transforms, complex analysis, and partial differential equations. These topics play a vital role in solving real-world problems and are widely used in areas like signal processing, control systems, communication, and artificial intelligence. The goal is to strengthen students' analytical thinking and prepare them for advanced courses in electronics, communication, and machine learning.

Course Outcomes: After completion of this course, student will be able to:

1 Apply methods for solving first and second order ODEs and use complex number theory and analytic functions in frequency domain analysis. (Bloom's Level: Apply)

2 Analyze linear dynamic systems using Laplace transforms and formulate solutions to partial differential equations in wave propagation and other physical phenomena. (Bloom's Level: Analyze)

3 Evaluate the accuracy and effectiveness of various mathematical methods, such as Laplace and Fourier transforms, in solving real-world engineering problems. (Bloom's Level: Evaluate)

4 Apply Fourier series and Fourier transforms to solve problems in signal processing and data analysis. (Bloom's Level: Create)

Pre-requisite of course: Students must have prior knowledge of calculus, linear algebra, and vector calculus.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	1	0	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Ordinary Differential Equations (ODEs)** Exact, Linear, Bernoulli, Orthogonal Trajectories, Second Order Linear ODEs with Constant Coefficients, Cauchy-Euler Equations, Electrical Circuits, Mechanical Systems, Population Growth, Series Solution, Frobenius Method	10
2	**Laplace Transforms** Definition, Existence, Properties, Laplace Transforms of Elementary Functions, Inverse Laplace Transforms, Convolution Theorem, Solving ODEs Using Laplace Transforms	8

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Contents : Unit	Topics	Contact Hours
3	**Complex Analysis** Analytic Functions, Cauchy-Riemann Equations, Cauchy's Integral Theorem and Formula, Taylor Series, Laurent Series, Residue Theorem, Applications to Real Integrals	8
4	**Partial Differential Equations (PDEs)** Formation and Classification of PDEs, Method of Separation of Variables, One-Dimensional Wave Equation, One-Dimensional Heat Equation, Laplace Equation in Cartesian and Polar Coordinates	8
5	**Fourier Series and Transforms** Dirichlet's Conditions, Half-Range Expansions, Harmonic Analysis, Parseval's Theorem, Fourier Transforms and Inverse Transforms, Applications to Heat Conduction and Frequency Analysis	8
Total Hours		**42**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Tutorial-1** First-order ODEs – solving techniques and applications	1
2	**Tutorial-2** Second-order linear ODEs with constant coefficients.	1
3	**Tutorial-3** Cauchy-Euler and real-world modelling.	1
4	**Tutorial-4** Series solutions: Power series and Frobenius method.	1
5	**Tutorial-5** Laplace transforms – practice problems.	1
6	**Tutorial-6** Inverse Laplace and solving ODEs using transforms.	1
7	**Tutorial-7** Introduction to analytic functions and Cauchy-Riemann equations.	1
8	**Tutorial-8** Contour integration and residue theorem applications.	1
9	**Tutorial-9** Taylor & Laurent series with example problems.	1
10	**Tutorial-10** Solving basic PDEs using separation of variables.	1
11	**Tutorial-11** Applications of wave, heat and Laplace equations.	1
12	**Tutorial-12** Fourier series expansion problems.	1
13	**Tutorial-13** Practice on Fourier transforms and applications.	1

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
14	**Tutorial-14** Combined review: Applications in Signals, Systems, ML.	1
Total Hours		**14**

Textbook :

1 Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India, 2015

2 Higher Engineering Mathematics, B.S. Grewal, 44th Edition, Khanna Publishers, 2017

References:

1 Differential Equations and Applications, Differential Equations and Applications, S. C. Gupta, Krishna Prakashan, 2015

2 Advanced Engineering Mathematics, Advanced Engineering Mathematics, Dennis G. Zill, 6th Edition, Cengage Learning, 2018

3 Advanced Engineering Mathematics, Advanced Engineering Mathematics, R.K. Jain & S.R.K. Iyengar, 4th Edition, Narosa Publishing, 2013

4 Ordinary and Partial Differential Equations, Ordinary and Partial Differential Equations, M.D. Raisinghania, S. Chand, 2012

5 Complex Variables and Applications, Complex Variables and Applications, James Ward Brown & Ruel V. Churchill, 9th Edition, McGraw-Hill, 2013

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	20.00	40.00	10.00	10.00	10.00

Instructional Method:

1 Chalk & talk / whiteboard lectures

2 Power point presentations

3 Collaborative Learning

4 Simulation Based Learning

5 Problem Solving

Supplementary Resources:

1 NPTEL Online Course, Engineering Mathematics-II by Prof. Jeetendra Kumar (IIT Kharagpue), https://onlinecourses.nptel.ac.in/noc22_ma08/preview

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