

Course Handout

Institute/School Name	Chitkara University Institute of Engineering and Technology		
Department Name	Department of Applied Sciences		
Programme Name	Bachelor of Engineering (B.E.), Computer Science & Engineering		
Course Name	Differential Equations and Transformations	Session	Jan 2025 - May-2025
Course Code	24APS2101	Semester/Batch	2 nd /2024
L-T-P(Per Week)	4-0-0	Course Credits	04
Pre-requisite	NA	NHEQF Level	4.5
Course Coordinator	Dr. Tania Bose	SDG Number	4, 9

1. Objectives of the Course

This course deals with the ability to apply mathematics for providing the innovative solutions of complex engineering and real life problems in a qualitative manner. It helps to identify, formulate and analyse the engineering problems which comes and to arrive at substantiated conclusions by using principles of mathematics.

The main objectives of the course are:

1. To introduce and develop the Fourier series, half range sine and cosine series on arbitrary intervals for different problems.
2. To find solution of second and higher order ordinary linear differential equations along with its applications in RLC circuits.
3. To understand the requirement of Laplace transform, inverse Laplace transform, properties and its application for the solution of differential equations.
4. To be familiar with formation of partial differential equations and their solutions and solve the Laplace, heat and wave equations for a variety of boundary conditions in domains of simple geometry and with simple boundary conditions; the techniques available will include separation of variables, Laplace and Fourier transform methods.
5. To determine continuity/differentiability/analyticity of a complex function.

2. Course Learning Outcomes (CLOs)

Student should be able to:

	CLOs	Program Outcomes (PO)	NHEQF Level Descriptor ¹	No. of Lectures
CLO01	Students will analyze and correlate many real-life problems mathematically and thus find the appropriate solutions for them using Fourier series and transforms (Fourier and Laplace transform).	PO1, PO2, P11	Q1, Q2, Q3, Q4, Q6	18

CLO02	Students will be able to solve various practical problems in science and engineering using ordinary differential equations.	PO1, PO2, PO4	Q1, Q3, Q4, Q5, Q6	15
CLO03	Students will possess an ability to recognize and find families of solutions for most real physical processes such as heat transfer, elasticity, quantum mechanics, water flow and other practical problems in science and engineering, which are governed by ordinary and partial differential equations.	PO1, PO2	Q1, Q3, Q4, Q5, Q6	9
CLO04	Student will be able to analyze functions of complex variables, techniques of complex integrals and compute integrals over complex surfaces.	PO1, PO2, PO4	Q1, Q4, Q5, Q6	6
Total Contact Hours				48 hrs

CLO-PO Mapping

CLO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	Type of Assessments
CLO01	H	H									H				Summative
CLO02	H	H		M											Summative
CLO03	H	H													Summative
CLO04	H	M		H											Summative

H=High, M=Medium, L=Low

3. Recommended Books:

- **B01:** Advanced Engineering Mathematics, R.K. Jain and S.R.K. Iyengar, Narosa Publishing House, 5th edition, 2016.
- **B02:** The Engineering Mathematics, Chitkara University Publication, Vol. II. 2nd Edition, 2013.
- **B03:** Higher Engineering Mathematics, B. V. Ramana, Tata McGraw-Hill Publishing Company Limited, Eight reprint, 2009.
- **B04:** Advanced Engineering Mathematics, Erwin Kreyszig, Wiley India Pvt. Ltd., 10th edition, 2011.
- **B05:** Engineering Mathematics, Srimanta Pal & Subodh C. Bhunia, Oxford University Press, 1st edition, 2015.
- **B06:** Calculus, Howard Anton, Irl Bivens, Stephens Davis, Wiley, 10th edition, 2015.

4. Other readings and relevant websites:

Serial No	Link of Journals, Magazines, websites and Research Papers
1.	https://www.slideshare.net/Pokar/fourier-series-32752445
2.	https://www.youtube.com/watch?v=spUNpyF58BY
3.	https://www.slideshare.net/lankeshssss/ordinary-differential-equation-137100520
4.	https://www.slideshare.net/Himel_Himo/presentation-on-laplace-transforms
5.	https://www.slideshare.net/isratzerin6/partial-differential-equation-amp-its-application

5. Recommended Tools and Platforms

Python, MATLAB

6. Course Plan: Theory

Theory Plan

Lecture No.	Topics
1-5	Fourier series: Introduction, Fourier series on arbitrary intervals.
6	Half-range cosine and sine series.
7-8	Fourier transform: Fourier transform of derivative, shifting and scaling, convolution, Fourier cosine and sine transform, linearity, shifting and scaling, Fourier cosine and sine transforms of derivatives, Parseval's identity.
9-10	Ordinary differential equations: Differential equations of first order and first degree, linear and Bernoulli equations.
11-12	Exact differential equations.
13-14	Equation solvable for p, y and x.
15	Clairaut's equation, applications to orthogonal trajectories.
16-18	Second and higher order ordinary linear differential equations with constant coefficients: Complimentary function, particular integrals (standard types), differential operator method.
ST1 (Syllabus=37.5% (Lect. No. 1-18))	
19-20	Variation of parameters, method of undetermined coefficients.
21-22	Cauchy-Euler differential equation, simultaneous linear differential equations (two variables) with constant coefficients.
23	Application to RLC circuit.
24-26	Laplace transform , Linearity and shifting property.
27-28	Inverse transforms properties.
29	Transforms of derivatives and integrals.

30-31	Unit step function, Dirac's delta function.
32-33	Applications to differential equations.
ST2 (Syllabus = 68.7% (Lect. No. 1-33))	
34	Partial differential equations (PDE): Formation of partial differential equations, equation of first order.
35-36	Lagrange's linear equation, Charpit's method.
37	Standard types of first order non-linear partial differential equations.
38-39	Solutions of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral.
40-41	Classification of PDE of second order – parabolic, elliptic and hyperbolic equations, solution by separation of variables.
42	Solution of one-dimensional wave equation, solution of two-dimensional Laplace equation using Fourier series.
43	Functions of complex variables: Limit, continuity, derivative of complex functions.
44-45	Analytic function, Cauchy-Riemann equations.
46	Harmonic functions, conformal mapping, complex integration.
47-48	Cauchy's theorem, Cauchy integral formula, Taylors and Laurent's Expansion.
End Term Exam (Syllabus=100% (Session No. 1-48))	

7. Delivery/Instructional

Resources Theory Plan:

Lecture No.	Topics	CLO	Book No, CH No, Page No	TLM	ALM	Web References	Audio-Video
1 - 6	Fourier series: Introduction, Fourier series on arbitrary intervals.	CLO01	B03, CH 17, Page No. 17.1 - 17.14	Lecture	Quiz, Test questions	https://www.slideshare.net/Pokar/fourier-series-32752445	https://www.youtube.com/watch?v=r18Gi8lSkfM

7 - 8	Fourier transform with properties: Fourier transform linearity property, Fourier transform of derivative, shifting and scaling, convolution, Fourier cosine and sine transforms and properties: Fourier cosine and sine transform, linearity, shifting and scaling, Fourier cosine and sine transforms of derivatives, Parseval's identity.	CLO01	B03, CH 20, Page No. 20.3 - 20.12.	Lecture	Quiz, Test questions	https://archive.nptel.ac.in/courses/11/103/11103021/	https://www.youtube.com/watch?v=gZNm7L96pfY
9 - 23	Ordinary differential equations: Differential equations of first order and first degree, linear and Bernoulli equations, exact differential equations, equation solvable for p, y and x, Clairaut's equation, applications to orthogonal trajectories, second and higher order ordinary linear differential equations with constant coefficients: complimentary function, particular integrals (standard types), differential operator method, variation of parameters, method of undetermined coefficients, Cauchy-Euler differential equation,	CLO02, CLO03	B03, CH 8, Page No. 8.1 – 8.39, CH 9, Page No. 9.1 – 9.59	Lecture	Test Questions	https://nptel.ac.in/courses/122104018	https://www.youtube.com/watch?v=OET0qwat15o&list=PLdM-WZokR4tbGKbeK8fDI dEN0N EcvAQ IC

	simultaneous linear differential equations (two variables) with constant coefficients, application to RLC circuit.						
24 - 33	Laplace transform: Laplace transform, linearity and shifting property, inverse transforms properties, transforms of derivatives and integrals, unit step function, Dirac's delta function, applications to differential equations.	CLO01	B03, CH 12, Page No. 12.1 – 12.38	Lecture	Test Questions	https://archive.nptel.ac.in/courses/11/106/11106139/	https://www.khanacademy.org/math/differential-equations/laplace-transform
34 - 42	Partial differential equations (PDE): formation of partial differential equations, equation of first order, Lagrange's linear equation, Charpit's method, standard types of first order non-linear partial differential equations, solutions of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral, classification of PDE of second order – parabolic, elliptic and hyperbolic equations, solution by separation of variables, solution of one-dimensional	CLO02, CLO03	B03, CH 18, Page No. 18.1 – 18.18 CH 19, Page No. 19.1 – 19.17	Lecture	Test Questions, Quiz	https://archive.nptel.ac.in/courses/11/103/111103021/	https://nptel.ac.in/courses/111108144

	wave equation, solution of two-dimensional Laplace equation using Fourier series.						
43 - 48	Functions of complex variables: limit, continuity, derivative of complex functions, analytic function, Cauchy-Riemann equations, harmonic functions, conformal mapping, complex integration, Cauchy's theorem, Cauchy integral formula, Taylors and Laurent's expansion.	CLO04	B03, CH 22, Page No. 22.1 – 22.5 CH 23, Page No. 23.1 – 23.27 CH 25, Page No. 25.1 – 25.15	Lecture	Test Questions	https://www.slideshare.net/slideshow/complex-variables-155523314/155523314#4	https://archive.nptel.ac.in/courses/111/106/111106141/

8. Remedial Classes

After every Sessional Test, different types of learners will be identified and special discussions will be planned and scheduled accordingly.

Action Plan for different types of learners:

Learner Type-I	Learner Type- II	Learner Type- III
Remedial Classes, Doubt Sessions	Doubt Sessions	Extra Assignments using Python Programming/ Coursera Courses

9. Self-Learning

Assignments to promote self-learning, survey of contents from multiple sources.

S. No	Topics	CLO	ALM	References/MOOCs
1	Differential Equations for Engineers	CLO02, CLO03	Think – Pair-Share, Peer Review	https://www.coursera.org/learn/differential-equations-engineers
2	Differential Equations Part 1 Basic Theory	CLO02, CLO03	Think – Pair-Share, Peer Review	https://www.coursera.org/learn/ordinary-differential-equations

10. Delivery Details of Content Beyond Syllabus

Content beyond syllabus covered (if any) should be delivered to all students that would be

planned, and schedule notified accordingly.

S. No	Advanced Topics, Additional Reading, Research papers and any	CLO	POs	ALM	References/MOOCs
1	Exploring Differential Equations and Transformations through MATLAB: A Comprehensive Approach	CLO01, CLO02, CLO03	PO1, PO4, PO12	PO2, PO11,	Think – Pair- Share, Peer Review https://web.pdx.edu/~gjay/teaching/mth271_2020/pdf/OER.pdf https://matlabacademy.mathworks.com/details/solving-ordinary-differential-equations-with-matlab/odes https://www.geeksforgeeks.org/solve-differential-equations-with-odeint-function-of-scipy-module-in-python/

11. Evaluation Scheme & Components:

Assessment Type	Evaluation Component	Type of Component	No. of Assessments	% Weightage of Component	Max. Marks	Mode of Assessment	CLO
Summative	Component2	Sessional Tests(STs)	03*	40%	40	Computer based Assessment	CLO01-CLO04
Summative	Component3	End Term Examination	01**	60%	60	Computer based Assessment	CLO01-CLO04
Total			100%				

*All the ST's are mandatory.

**As per Academic Guidelines minimum 75% attendance is required to become eligible for appearing in the End Semester Examination.

12. Syllabus of the Course:



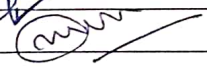
Subject: Differential Equations and Transformations (24APS2101)			
S. No.	Topic(s)	No. of Lectures	Weightage %

	convolution, Fourier cosine and sine transforms and properties: Fourier cosine and sine transform, linearity, shifting and scaling, Fourier cosine and sine transforms of derivatives, Parseval's identity.		
2	Ordinary differential equations: Differential equations of first order and first degree, linear and Bernoulli equations, exact differential equations, equation solvable for p, y and x, Clairaut's equation, applications to orthogonal trajectories, second and higher order ordinary linear differential equations with constant coefficients: complimentary function, particular integrals (standard types), differential operator method, variation of parameters, method of undetermined coefficients, Cauchy-Euler differential equation, simultaneous linear differential equations (two variables) with constant coefficients, application to RLC circuit.	15	31%
3	Laplace transform: Laplace transform, linearity and shifting property, inverse transforms properties, transforms of derivatives and integrals, unit step function, Dirac's delta function, applications to differential equations.	10	21%
4	Partial differential equations (PDE): Formation of partial differential equations, equation of first order, Lagrange's linear equation, Charpit's method, standard types of first order non-linear partial differential equations, solutions of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral, classification of PDE of second order – parabolic, elliptic and hyperbolic equations, solution by separation of variables, solution of one-dimensional wave equation, solution of two-dimensional Laplace equation using Fourier series.	9	19%
5	Functions of complex variables: limit, continuity, derivative of complex functions, analytic function, Cauchy-Riemann equations, harmonic functions, conformal mapping, complex integration, Cauchy's theorem, Cauchy integral formula, Taylors and Laurent's expansion.	6	12%

13. Academic Integrity Policy:

Education at Chitkara University builds on the principle that excellence requires freedom where Honesty and integrity are its prerequisites. Academic honesty in the advancement of knowledge requires that all students and Faculty respect the integrity of one another's work and recognize the importance of acknowledging and safeguarding intellectual property. Any breach of the same will be tantamount to severe academic penalties.

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr Tania Bose	
Program Incharge	Dr Reetu Malhotra	
Dean	Dr Mohit Kumar Kakkar	
Date(DD/MM/YYYY)	14/01/2025	