



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Biotechnology

Subject Code: BE04004051

Subject Name: Fourier Series, Partial Differential Equations and Complex Variables

w. e. f. Academic Year:	2024-2025
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	Integral and Vector Calculus, Laplace and Fourier Transforms
Rationale:	This subject equips students with mathematical techniques such as Fourier series, partial differential equations, and complex variables to model and analyze physical, engineering, and scientific problems effectively.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Obtain the Fourier series for a given function	15
CO-2	Classify the PDE	15
CO-3	Determine the solution of a PDE by variable separable method	25
CO-4	Understand and use of complex variables	25
CO-5	Evaluate a real definite integral	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.



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Content:

Sr. No.	Content	Total Hrs
1	Fourier Series: Introduction and basic definitions; Expansion of a function in Fourier series for a given range; Half range sine and cosine expansions.	15
2	Partial Differential Equations: Classification of higher order partial differential equations; Method of separation of variables - Solution of one-dimensional wave equation, one-dimensional heat conduction equation and two-dimensional steady state heat conduction equation with illustrations.	15
3	Complex Variables: Analytic function – Cauchy-Riemann equations, Harmonic functions, Conjugate functions; Complex integration - Line integrals in complex plane, Cauchy's theorem (simple proof only) and Cauchy's integral formula; Taylor's and Laurent's series expansions; Zeros and singularities; Residues - Residue theorem, Use of residue theorem to evaluate the real definite integral of the type $\int_{2\pi} (\cos\theta, \sin\theta)$ and $\int_{\infty} f(x)dx$. Concept of conformal mapping with simple illustrations.	15
TOTAL		45

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	20	20	10	10

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 2016, 5th Edition
2. M.D. Rai Singhania, Ordinary and Partial Differential Equations, S. Chand and Co., 2024, 20th Edition



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List of Experiments / Practical Demonstrations

1. Plot and analyze Fourier series for square, triangular, and sawtooth waves using Python/GeoGebra. Solving the 1D Heat Equation by the method of separation of variables using numerical tools.
2. Solve 1-D heat conduction equation using separation of variables (analytical vs numerical method). Compare analytical and computational results.
3. Model vibration of a stretched string using wave equation. Interpret effect of boundary conditions.
4. Verify Cauchy-Riemann equations for given complex functions using SymPy. Visualize analytic vs non-analytic functions.
5. Compute contour integrals and evaluate residues for complex poles using MATLAB/Python. Apply residue theorem practically.
6. Apply Fourier Transform to image compression or signal filtering. Connect math theory with real-world digital signals.

Major Equipment

1. Computers with Python/MATLAB
2. Projector/Smartboard for visual demonstration
3. Graph plotting tools

Open-Source Software / Learning Websites

1. Python (NumPy, SymPy, Matplotlib)
<https://numpy.org/>, <https://www.sympy.org/>, <https://matplotlib.org/>
2. GeoGebra
<https://www.geogebra.org/>
3. NPTEL Mathematics lectures
<https://nptel.ac.in/course.html>
4. Wolfram Alpha
<https://www.wolframalpha.com/>

List of suggested activities for Term Work / Self Learning:

1. Prepare a report comparing analytical and numerical Fourier solutions.
2. Code simulation of PDEs using Python.
3. Short seminar on applications of complex analysis in engineering.
