Transforms and Statistics			
Course Code	**1BMATM301**	Scheme	**2025**
Type of Course	**ASC**	Semester	III
Teaching Hours/Week (L: T: P)	3:2:0	CIE Marks	50
Total Hours of Pedagogy L:T:P:SL:TW	42:28:0:25:25	SEE Marks	50
Credits	4	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	03

Course Outcomes (Course Skill Set):

At the end of the course, the student will be able to:

1. Apply Fourier series techniques to represent periodic functions and perform harmonic analysis relevant to engineering applications.
2. Utilize Fourier Transforms and Z-Transforms to analyze engineering systems and solve difference equations arising in mechanical and allied engineering problems.
3. Formulate and solve partial differential equations and apply numerical methods for the solution of heat, wave, and Laplace equations encountered in engineering practice.
4. Employ Laplace Transform techniques to solve ordinary differential equations and engineering problems involving dynamic systems.
5. Analyze and interpret engineering data using statistical tools, measures of central tendency, dispersion, and data visualization techniques for informed decision-making.

Module-1: Fourier Series

Definition, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 2π and arbitrary period, half range Fourier series. Complex form of Fourier Series. Practical harmonic analysis.

Number of Hours: 8

Module-2: Fourier Transform & Z-Transform

Infinite Fourier transform, Fourier sine and cosine transforms, properties, Inverse Fourier transform, integral equations and related problems.

Z-Transform: Definition, standard Z-transforms, damping rule, shifting rule, initial value and final value theorems (statements only). Inverse Z- transforms, Problems on difference equations.

Number of Hours: 9

Module-3: Partial differential equations

Partial Differential Equations: Definitions, Formation of PDE by eliminating arbitrary constants and arbitrary functions, Solution of non-homogeneous PDE by direct integration and Lagrange's multiplier method.

Numerical solution of PDE: Classification of second order PDE. Finite difference approximation to derivatives, Numerical solution of One-dimensional Heat and Wave equations. Numerical solution of two-dimensional Laplace equation.

Number of Hours: 9

Module-4: Statistics-1

Measures of central tendency: mean, median and mode for grouped and ungrouped data. Measures of dispersion: range, variance, standard deviation, quartile deviation, moments and coefficient of variation. Concept of Skewness and Kurtosis.

Number of Hours: 8

Module-5: Statistics-2

Statistical Methods: Principles of least squares, Curve fitting by the method of least squares in the form: $y = a + bx$, $y = a + bx + cx^2$, and $y = ax^b$.

Correlation and Regression: Karl Pearson's coefficient of correlation and rank correlation (with repetition and without repetition) -problems. Regression analysis- lines of regression –problems.

Number of Hours: 8

Suggested Learning Resources:

Textbooks:

1. S C Gupta and V K Kapoor, "Fundamentals of Mathematical Statistics", 12th Ed., S. Chand Publishing.
2. R K Jain and S R K Iyengar, "Advanced Engineering Mathematics", 5th Ed., Narosa Publishing House.
3. B S Grewal, "Higher Engineering Mathematics", 45th Ed., Khanna Publishers.

Reference books / Manuals:

1. B V Ramana, "Higher Engineering Mathematics", Mc Graw-Hill Education, 2017
2. M R Spiegel, J Schiller, and R A Srinivasan, "Schaum's Outline of Probability and Statistics", McGraw Hill.
3. S P Gupta," Statistical Methods", 46th Ed., Sultan Chand & Sons, 2023.
4. V K Rohatgi and A K Md. Ehsanes Saleh, "An Introduction to Probability and Statistics", 2nd Ed., Wiley.

Web links and e-Resources:

- https://nptel.ac.in/courses/111105160
- https://nptel.ac.in/courses/127106019
- https://ocw.mit.edu/courses/18-335j-introduction-to-numerical-methods-spring-2019/
- https://ocw.mit.edu/courses/18-330-introduction-to-numerical-analysis-spring-2012/pages/syllabus/

Teaching-Learning Process (Innovative Delivery Methods):

The following are sample strategies that educators may adopt to enhance the effectiveness of the teaching-learning process and facilitate the achievement of 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 to learn groups 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).

Assessment Structure:

The assessment in each course is divided equally between Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE), with each carrying 50% weightage.

The CIE Theory component consists of average of TWO IA tests for 25 marks and Continuous Comprehensive Assessments (CCA) for 25 marks.

To qualify and become eligible to appear for SEE, in the **CIE**, a student must score at least **40% of 50 marks**, i.e., **20 marks**.

To pass the **SEE**, a student must score at least **35% of 50 marks**, i.e., **18 marks**.

Notwithstanding the above, a student is considered to have **passed the course,** provided the combined total of **CIE and SEE is at least 40 out of 100 marks**.

Continuous Comprehensive Assessments (CCA) + Internal Assessment Test (IA) = Continuous Internal Evaluation CIE [25+25=50 marks]

A minimum of **two Internal Assessment Tests (IA)**shall be conducted, carrying a total of **25 marks**.

In addition, **Continuous Comprehensive Assessment (CCA)** shall be conducted for a total of **25 marks**.

It is recommended to include **a maximum of two learning activities** as part of the CCA to foster the **holistic development of students**. These activities shall be:

Sl. No.	Name of the Learning activity	Maximum Marks
1.	Assignment (at RBL3 or RBL4 levels) for Teamwork	10
2.	GATE-based Aptitude Test	15

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester

Term work (includes seminars, micro projects, industrial visits, any other student activities etc.)

Sl. No.	Term Work (TW) Activity	Number of Hours / Semester
1.	Seminar on Fourier Series of periodic functions and harmonic analysis	5
2.	MATLAB/Python Simulation of Fourier and Z-Transform problems	5
3.	Mini Project on statistical Models in Engineering Applications	10
4.	Case Study on Signal Processing using Transform Techniques	5
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1	MOOCs/NPTEL Videos	25

Rubrics for Learning Activity (Based on the nature of learning activity, design the rubrics for each activity):
1. Sample Rubrics - Mini-Project

Criterion	Exemplary (3)	Proficient (2)	Basic (1)	Weight
Problem definition & data	Clear, relevant engineering questions; data source and limitations documented.	Mostly clear; minor gaps in context or data description.	Vague questions or poorly documented data.	10%
Data processing & descriptive statistics	Correct cleaning, visualization, and computation of key measures; patterns clearly highlighted.	Mostly correct; minor computational errors.	Significant errors, missing key measures or plots.	25%
Probabilistic modelling (distributions, inference)	Appropriate distributions and tests used; assumptions stated; results interpreted in context.	Reasonable choice of models; some assumptions implicit; interpretation mostly sound.	Inappropriate or poorly justified models; limited interpretation.	30%
Engineering insight / risk framing	Clear link to design/assessment decisions, safety and uncertainty; limitations discussed.	Some discussion of implications; limited treatment of limitations.	Minimal engineering interpretation on beyond numbers.	20%
Report & communication	Well-structured report, clear figures/tables, reproducible calculations; effective brief presentation.	Acceptable structure; some clarity issues; presentation adequate.	Disorganized or incomplete report; weak presentation.	15%

Students' activities for TW/SL under NCrF: Samples only
As per National credit formwork (NCrF) students must spend 120 hours of study for 4 credit courses, which include Course instructions (CI-70 hour) and Teamwork/ Self learning (TW/Sl-50 hours). Hence, students must complete minimum of two activities as part of NCrF. These learning activities shall be considered as CCA components of CIE. The evaluation activities will be done using set of rubrics developed for each activity. The course coordinator can also give their own TW/SL activities as per the course outcomes.

Continuous Internal Evaluation (CIE)

1. The CIE marks shall be decided based on internal tests and other outcome-based activities. The continuous internal evaluation shall be carried out by the teacher handling the course.
2. Out of 50 marks earmarked for CIE, 25 marks shall be assigned for internal tests. The first test shall be conducted after completing two modules of the syllabus and the second one after completing the remaining three modules.
3. The remaining 25 marks shall be assigned for Continuous Course Assessment (CCA), conducted as per the rubrics listed in the assessment section of the respective syllabus.
4. A student shall obtain a minimum of 40% marks or 20 out of 50 marks allotted to CIE to become eligible to appear for the SEE.

Passing requirement in SEE

1. For a pass in the Semester End Examination (SEE), a student shall secure a minimum of 35 marks out of 100.
2. For the declaration of a pass grade, the sum of the Continuous Internal Evaluation (CIE) marks (out of 50) marks and the SEE marks scaled down to 50 shall be greater than or equal to 40 marks.
3. If the total (CIE + SEE) is less than 40 marks, the student shall be awarded the grade 'F' (Fail).