Transform Techniques and Optimization Theory			
Course Code	**1BMATEC301**	Scheme	2025
Type of Course	Applied Science Course (ASC)	Semester	3
Teaching Hours/Week (L:T:P)	70(4:2:0)	CIE Marks	50
Total Hours of Pedagogy per semester L /T/P/SL&TW:	120(42:28:0:50)	SEE Marks	50
Credits	**4**	Total Marks	100
Examination type (SEE)	Theory	Exam Hours	3

Course outcome (Course Skill Set)

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

CO1: Develop Fourier series representations of periodic functions and perform harmonic analysis for functions with different periodicities, discontinuities, and symmetry properties.

CO2: Apply Fourier transforms, including sine, cosine, discrete Fourier transforms (DFT), and Fast Fourier Transforms (FFT), to analyze signals and solve engineering problems involving differential equations.

CO3: Utilize Z-transforms, their properties, inverse transforms, and convolution techniques to analyze discrete-time systems and solve difference equations.

CO4: Formulate and solve Linear Programming Problems using graphical, simplex, and Big-M methods to obtain optimal solutions in engineering and management applications.

CO5: Apply transportation and assignment models, including optimization techniques such as Vogel's Approximation Method and Hungarian Method, to solve resource allocation and decision-making problems

Module-1: Fourier series

Periodic functions, Euler's Formula, Conditions for Fourier expansion (Dirichlet's condition), Fourier series of functions- having points of discontinuity, with period 2π, with change of interval, (arbitrary period) and Even and odd functions. Half range Fourier series. Practical harmonic analysis.

Number of Hours:8+5T

Module-2: Fourier transforms.

Fourier Transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Properties-Linear property, Change of scale, shifting property, Modulation theorem. Inverse transforms, Convolution theorem and its significance, Fourier transform of derivatives and integrals, Solution of PDE's using Fourier transforms. Discrete Fourier transform (DFT), Inverse DFT, Fast Fourier transform (FFT).

Number of Hours:9+6T

Module-3: Discrete Transforms - Z transforms

Z-transform of Standard functions, Linearity property, Damping rule, Shifting property, Initial and final value theorems (statement only),
Inverse Z-transform- Power series method, Partial fraction method, inverse integral method. Convolution theorem, Application of Z-transforms to solve difference equations.

Number of Hours:9+6T

Module-4: Linear programming problems

Introduction to optimization techniques, nature and characteristics of operation research; Introduction to Linear programming, graphical solution, solution by simplex and Big M method.

Number of Hours:8+5T

Module-5: Transportation problems

Formulation of transportation problem, Initial Basic feasible solution by North-West Corner method, Least cost method, Vogel's approximation method. Optimal solutions-Problems. Formulation of assignment problems, Hungarian method-Problems

Number of Hours:8+6T

Suggested Learning Resources: (Text Book/ Reference Book/ Manuals):
Text books:

1. **B.S. Grewal**, *Higher Engineering Mathematics*, 45th Edition, Khanna Publishers.
2. **Hamdy A. Taha**, *Operations Research: An Introduction*, Pearson Education.
3. **H.K. Dass and Er. Rajnish Verma**, *Higher Engineering Mathematics*, S. Chand Publications.

Reference books / Manuals:

1. **Ruel V. Churchill and James Ward Brown**, *Fourier Series and Boundary Value Problems*, McGraw-Hill Education.
2. **Erwin Kreyszig**, *Advanced Engineering Mathematics*, 10th Edition, Wiley India.
3. **Schaum's Outline of Fourier Analysis and Applications**, McGraw-Hill.
4. **Murray R. Spiegel, John Schiller and R. Alu Srinivasan**, *Schaum's Outline of Probability and Statistics*, McGraw-Hill.
5. **S. D. Sharma**, *Operations Research*, Kedar Nath Ram Nath Publications.

Web links and Video Lectures (e-Resources):

- NPTEL Courses on Engineering Mathematics
- MIT OpenCourseWare Mathematics
- SWAYAM Online Courses

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. **Flipped Classroom Approach**
   - Students review video lectures and reading materials before class.
   - Classroom sessions focus on problem-solving, discussions, and applications of transform techniques and optimization models.
2. **Problem-Based Learning (PBL)**
   - Real-world engineering problems involving Fourier Transforms, Z-Transforms, and Linear Programming are assigned for collaborative solution development.
3. **ICT-Enabled Teaching** (may be conducted in Tutorial hours)
   - Use of MATLAB, Python, and online simulation tools to visualize transforms, optimization problems, and signal-processing applications.
4. **Collaborative Learning** (may be conducted in Tutorial hours)
   - Group assignments and mini-projects on optimization models and transform applications.

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.

- 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 EvaluationCIE [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 and RBL4 levels based on Team Work(TW) activities.	10
2.	GATE-based Aptitude Test.	15

Rubrics **for Learning Activity–1: Assignment (10 Marks)**

Performance Indicator	Superior (10)	Good (8)	Fair (6)	Needs Improvement (5)
Understanding of Concepts	Demonstrates excellent conceptual clarity and application	Good understanding with minor errors	Basic understanding	Poor understanding
Problem Solving Ability	Solves all problems correctly with proper methodology	Solves most problems correctly	Partial solutions with errors	Unable to solve problems effectively
Mathematical Accuracy	Calculations and derivations are error-free	Minor computational errors	Several errors	Significant errors
Presentation & Organization	Well-structured, neat, and professionally presented	Organized with minor deficiencies	Average presentation	Poor presentation

Rubrics for Learning Activity–2: GATE-Based Aptitude Test (15 Marks)

Performance Indicator	**Superior (15)**	**Good (12)**	**Fair (10)**	**Needs Improvement (8)**
Quantitative Aptitude	≥90% correct responses	75–89% correct	60–74% correct	<60% correct
Analytical Thinking	Excellent logical reasoning and interpretation	Good reasoning ability	Moderate reasoning	Weak reasoning
Time Management	Completes all questions within allotted time	Completes most questions	Requires additional time	Unable to complete
Accuracy & Precision	Very high accuracy	Good accuracy	Moderate accuracy	Low accuracy

Term Work (TW) and Self Learning (SL) components in Number of Hours per semester		
Term work (includes assignments, 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 Linear Programming Models in Engineering Applications	5
4.	Case Study on Signal Processing using Transform Techniques	5
SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.		
Sl. No.	**Self-Learning (SL) Activity**	**Number of Hours / Semester**
1.	Application of Fourier Series in signal representation and on harmonic analysis of periodic signals.	6
2.	Explore applications of DFT and FFT in digital signal processing.	6
3.	Solve a set of difference equations using Z-transforms	6
4.	Develop and solve two real-world optimization problems	6
5.	Study industrial applications of transportation and assignment models	6

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).