INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MATHEMATICAL TRANSFORM TECHNIQUES**					
Course Code	AHSB11					
Programme	B.Tech					
Semester	II	AE | ECE | EEE | ME | CE				
Course Type	Foundation					
Regulation	IARE - R18					
Course Structure	**Theory**			**Practical**		
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**	
	3	1	4	-	-	
Chief Coordinator	Dr. S. Jagadha, Associate Professor					
Course Faculty	Dr. P. Srilatha, Associate Professor Ms. L Indira, Assistant Professor Ms. C Rachana, Assistant Professor Ms. P Rajani, Assistant Professor Ms. B. Praveena, Assistant Professor					

I. COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes root finding techniques, Interpolation and its applications, Curve fitting of linear and non linear curves, Laplace transforms, Fourier transforms and Partial differential equations with applications. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic principles of calculus

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Mathematical Transform Techniques	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✘	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✘	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with “either” or ‟choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

The AAT chosen for this course is given in section XIII.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	2	Presentation on real-world problems
PO 2	Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences	2	Seminar
PO 4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions	2	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Engineering Knowledge**: Graduates shall demonstrate sound knowledge in analysis, design laboratory investigations and construction aspects of civil engineering infrastructure along ith good foundation in mathematics basic sciences and technical communication.	1	Seminar
PSO 2	Broadness and Diversity: Graduates will have a broad understanding of economical societal, health and safety	-	-

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
	factors involved in infrastructural development and shall demonstrate ability to function within multidisciplinary teams ith competence in modern tool usage.		
PSO 3	Self-Leaarning and Service: Graduates ill be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibility.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Enrich the knowledge solving algebra and transcendental equations and understanding Laplace transforms.
II	Determine the unknown values of a function by interpolation and applying inverse Laplace transforms.
III	Fitting of a curve and determining the Fourier transform of a function.
IV	Solving the ordinary differential equations by numerical techniques
V	Formulate to solve partial differential equation

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Analyzing real roots of algebraic and transcendental equations by Bisection method, False position and Newton -Raphson method. Applying Laplace transform and evaluating given functions using shifting theorems, derivatives, multiplications of a variable and periodic function.	CLO 1	Evaluate the real roots of algebraic and transcendental equations by Bisection method, False position and Newton -Raphson method.
		CLO 2	Apply the nature of properties to Laplace transform of the given function.
		CLO 3	Solving Laplace transforms of a given function using shifting theorems.
		CLO 4	Evaluate Laplace transforms using derivatives and integrals of a given function.
		CLO 5	Evaluate Laplace transforms using multiplication and division of a variable to a given function.
		CLO 6	Apply Laplace transforms to periodic functions.
CO 2	Understanding symbolic relationship between operators using finite differences. Applyiing Newton's forward, Backward, Gauss forward and backward for equal intervals and Lagrange's method for unequal interval to obtain the unknown value. Evaluating inverse Laplace transform using derivatives, integrals,	CLO 7	Apply the symbolic relationship between the operators using finite differences.
		CLO 8	Apply the Newtons forward and Backward, Gauss forward and backward Interpolation method to determine the desired values of the given data at equal intervals, also unequal intervals.
		CLO 9	Solving inverse Laplace transform using derivatives and integrals.
		CLO 10	Evaluate inverse Laplace transform by the method of convolution.
		CLO 11	Solving the linear differential equations using Laplace transform.
		CLO 12	Understand the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems

COs	Course Outcome	CLOs	Course Learning Outcome
	convolution method. Finding solution to linear differential equation.		
CO 3	Applying linear and nonlinear curves by method of least squares. Understanding Fourier integral, Fourier transform, sine and cosine Fourier transforms, finite and infinite and inverse of above said transforms.	CLO 13	Ability to curve fit data using several linear and non linear curves by method of least squares.
		CLO 14	Understand the nature of the Fourier integral.
		CLO 15	Ability to compute the Fourier transforms of the given function.
		CLO 16	Ability to compute the Fourier sine and cosine transforms of the function
		CLO 17	Evaluate the inverse Fourier transform, Fourier sine and cosine transform of the given function.
		CLO 18	Evaluate finite and infinite Fourier transforms.
		CLO 19	Understand the concept of Fourier transforms to the real-world problems of circuit analysis, control system design
CO 4	Using Numericals methods such as Taylors, Eulers, Modified Eulers and Runge-Kutta methods to solve ordinary differential equations.	CLO 20	Apply numerical methods to obtain approximate solutions to Taylors, Eulers, Modified Eulers
		CLO 21	Runge-Kutta methods of ordinary differential equations.
CO 5	Analyzing order and degree of partial differential equation, formation of PDE by eliminating arbitrary constants and functions, evaluating linear equation b Lagrange's method. Applying the heat equation and wave equation in subject to boundary conditions.	CLO 22	Understand the concept of order and degree with reference to partial differential equation
		CLO 23	Formulate and solve partial differential equations by elimination of arbitrary constants and functions
		CLO 24	Understand partial differential equation for solving linear equations by Lagrange method.
		CLO 25	Learning method of separation of variables
		CLO 26	Solving the heat equation and wave equation in subject to boundary conditions
		CLO 27	Understand the concept of partial differential equations to the real-world problems of electromagnetic and fluid dynamics

X. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLOs	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB11.01	CLO 1	Evaluate the real roots of algebraic and transcendental equations by Bisection method, False position and Newton -Raphson method.	PO1	3
AHSB11.02	CLO 2	Apply the nature of properties to Laplace transform and inverse Laplace transform of the given function.	PO2, PO4	2
AHSB11.03	CLO 3	Solving Laplace transforms of a given function using shifting theorems.	PO1, PO2	2

CLO Code	CLOs	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB11.04	CLO 4	Evaluate Laplace transforms using derivatives of a given function.	PO1, PO2	2
AHSB11.05	CLO 5	Evaluate Laplace transforms using multiplication of a variable to a given function.	PO1	2
AHSB11.06	CLO 6	Apply Laplace transforms to periodic functions.	PO2	2
AHSB11.07	CLO 7	Apply the symbolic relationship between the operators using finite differences.	PO1	2
AHSB11.08	CLO 8	Apply the Newtons forward and Backward, Gauss forward and backward Interpolation method to determine the desired values of the given data at equal intervals, also unequal intervals.	PO2, PO4	2
AHSB11.09	CLO 9	Solving Laplace transforms and inverse Laplace transform using derivatives and integrals.	PO1, PO2	2
AHSB11.10	CLO 10	Evaluate inverse of Laplace transforms and inverse Laplace transform by the method of convolution.	PO2, PO4	2
AHSB11.11	CLO 11	Solving the linear differential equations using Laplace transform.	PO4	2
AHSB11.12	CLO 12	Understand the concept of Laplace transforms to the real-world problems of electrical circuits, harmonic oscillators, optical devices, and mechanical systems	PO4	1
AHSB11.13	CLO 13	Ability to curve fit data using several linear and non linear curves by method of least squares.	PO2	2
AHSB11.14	CLO 14	Understand the nature of the Fourier integral.	PO2	1
AHSB11.15	CLO 15	Ability to compute the Fourier transforms of the given function.	PO1, PO2	2
AHSB11.16	CLO 16	Ability to compute the Fourier sine and cosine transforms of the function	PO1	3
AHSB11.17	CLO 17	Evaluate the inverse Fourier transform, Fourier sine and cosine transform of the given function.	PO1	3
AHSB11.18	CLO 18	Evaluate finite and infinite Fourier transforms	PO1	2
AHSB11.19	CLO 19	Understand the concept of Fourier transforms to the real-world problems of circuit analysis, control system design	PO4	2
AHSB11.20	CLO 20	Apply numerical methods to obtain approximate solutions to Taylors, Eulers, Modified Eulers	PO1, PO2	3
AHSB11.21	CLO 21	Runge-Kutta methods of ordinary differential equations.	PO1, PO2	3
AHSB11.22	CLO 22	Understand the concept of order and degree with reference to partial differential equation	PO1	1

CLO Code	CLOs	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB11.23	CLO 23	Formulate and solve partial differential equations by elimination of arbitrary constants and functions	PO1, PO2	2
AHSB11.24	CLO 24	Understand partial differential equation for solving linear equations by Lagrange method.	PO2, PO4	2
AHSB11.25	CLO 25	Apply method of separation of variables.	PO2, PO4	2
AHSB11.26	CLO 26	Apply the heat equation and wave equation in subject to boundary conditions	PO2, PO4	2
AHSB11.27	CLO 27	Understand the concept of partial differential equations to the real-world problems of electromagnetic and fluid dynamics	PO4	2

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XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)			Program Specific outcomes (PSOs)
	PO 1	PO 2	PO 4	PSO1
CO 1	3	2	**2**	1
CO 2	**2**	2	2	**1**
CO 3	3	2	2	1
CO 4	3	3		
CO 5	2	2	**2**	**1**

XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3														
CLO 2		2		2											
CLO 3	2	2											1		
CLO 4	2	2											1		
CLO 5	2														
CLO 6		2													
CLO 7	2														
CLO 8		2		2											
CLO 9	2	2											1		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CLO 10		2		2									1		
CLO 11				2											
CLO 12				1									1		
CLO 13		2													
CLO 14		1													
CLO 15	2	2											1		
CLO 16	3														
CLO 17	3												1		
CLO 18	2														
CLO 19				2									1		
CLO 20	3	3													
CLO 21	3	3													
CLO 22	1														
CLO 23	2	2													
CLO 24		2		2											
CLO 25		2		2											
CLO 26		2		2									1		
CLO 27				2									1		

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO2, PO 4	SEE Exams	PO 1, PO2, PO 4	Assignments	-	Seminars	PO 1, PO2, PO 4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 1, PO2, PO 4	Video	PO 1, PO2, PO 4				

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XV. SYLLABUS

Module-I	**ROOT FINDING TECHNIQUES AND LAPLACE TRANSFORMS**	**Classes: 09**
ROOT FINDING TECHNIQUES: Root finding techniques: Solving algebraic and Transcendental equations by bisection method, Method of false position, Newton-Raphson method. **LAPLACE TRANSFORMS**:Definition of Laplace transform, Linearity property, Piecewise continuous function, existence of Laplace transform, Function of exponential order, First and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, Multiplied by t, Divided by t, Laplace transform of periodic functions.		
Module-II	**INTERPOLATION AND INVERSE LAPLACE TRANSFORMS**	**Classes: 09**
INTERPOLATION:Interpolation: Finite differences, Forward differences, Backward differences and central differences; Symbolic relations; Newton's forward interpolation, Newton's backward interpolation; Gauss forward central difference formula, Gauss backward central difference formula; Interpolation of unequal intervals: Lagrange's interpolation. **INVERSE LAPLACE TRANSFORMS:**Inverse Laplace transform: Definition of Inverse Laplace transform, Linearity property, First and second shifting theorems, Change of scale property, Multiplied by s, divided by s; Convolution theorem and applications.		
Module-III	**CURVE FITTING AND FOURIER TRANSFORMS**	**Classes: 09**
CURVE FITTING: Fitting a straight line; Second degree curves; Exponential curve, Power curve by method of least squares. **FOURIERTRANSFORMS**:Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, Properties, Inverse transforms, Finite Fourier transforms.		
Module-IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**Classes: 09**
STEP BY STEP METHOD: Taylor's series method; Euler's method, Modified Euler's methodfor first order differential equations. **MULTI STEP METHOD:** Runge-Kutta method for first order differential equations.		
Module-V	**PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS**	**Classes: 09**
PARTIAL DIFFERENTIAL EQUATIONS: Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, Solutions of first order linear equation by Lagrange method. **APPLICATIONS:**Method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.		
Text Books:		
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010. 2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008. 3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11^{th} Reprint,2010.		
Reference Books:		
1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. 2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008. 3. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005. 4. Dr. M Anita, Engineering Mathematics-I, Everest Publishing House, Pune, First Edition, 2016.		

XVI. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1	Defining the terms of Algebraic and Transcendental equations	CLO 1	T1:28.1 R1:17.1
2	Apply Bisection method to determine the root of Algebraic and Transcendental equations	CLO 1	T1:28.2 R1:17.2
3	Apply False Position method to determine the root of Algebraic and Transcendental equations	CLO 1	T1:28.2 R1:17.2
4	Apply Newton-Raphson method to determine the root of Algebraic and Transcendental equations	CLO 1	T1:28.2 R1:17.2
5	Define Laplace transform and its properties	CLO 2	T1:21.1,21.4 R1:5.1
6	Define Piecewise continuous function, Existence of Laplace transform, Function of exponential order	CLO 2	T1:21.2 R1:5.1
7	Apply Shifting theorems, Change of scale property to evaluate Laplace Transform of a given function	CLO 3	T1:21.4 R1:5.1
8	Apply Laplace transforms of derivatives and integrals, multiplied by t, divided by t to a given function	CLO 4 CLO 5	T1:21.7-21.10 R1:5.2-5.4
9	Define periodic functions	CLO 6	T1:21.5 R1:5.2
10	Define the term interpolation of the given data	CLO 7	T1:29.1-29.3 R1:17.3
11	Explain symbolic relations the between the operators	CLO 7	T1:29.4-29.5 R1:17.3
12	Apply Newton"s forward and backard interpolation formulae for evenly spaced intervals	CLO 8	T1:29.6 R1:17.3
13	Apply Gauss forward and backard interpolation formulae for unevenly spaced intervals	CLO 8	T1:29.7-29.8 R1:17.3
14	Apply Lagrange"s interpolation formulae for unevenly spaced intervals	CLO 8	T1:29.9-29.10 R1:17.3
15	Solve Inverse Laplace transform	CLO 9	T1:21.12 R1:5.1,5.6
16	Define and apply shifting theorem, change of scale property	CLO 9	T1:21.13 R1:5.1,5.3
17	Solve multiplied by s, divided by s	CLO 9	T1:21.13 R1:5.4
18	Define and apply Convolution theorem	CLO 10	T1:21.14 R1:5.5
19	Describe the best fit of a straight line by method of least squares	CLO 13	T1:24.4-24.5 R1:18.5
20	Describe the best fit of a second degree parabola by method of least squares	CLO 13	T1:24.4-24.5 R1:18.5
21	Describe the best fit of an exponential curve by method of least squares	CLO 13	T1:24.6 R1:18.5
22	Describe the best fit of a power curve by method of least squares	CLO 13	T1:24.6 R1:18.5
23	Apply Fourier integral theorem to find integrals	CLO 14	T1:22.1-22.2 R1:10.8
24	Apply Fourier sine and cosine integrals to find integrals	CLO 14	T1:22.3 R1:10.8
25	Define and apply Fourier transforms	CLO 15	T1:22.4 R1:10.9

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
26	Use properties to solve the given functions	CLO 15	T1:22.5 R1:10.9
27	Define and apply Inverse transforms and finite Fourier transforms	CLO 17	T1:22.4 R1:10.9
28-30	Solve the ordinary differential equation by Taylor"s series method	CLO 20	T1:32.3 R1:19.1
31-33	Solve the ordinary differential equation by Euler"s Method- Euler"s modified method	CLO 20	T1:32.4-32.5 R1:19.1
33-36	Solve the ordinary differential equation by Runge-Kutta Method	CLO 21	T1:32.7 R1:19.1
37	Formulate partial differential equations by elimination of arbitrary constants and arbitrary functions	CLO 24	T1:17.1-17.2 R1:16.1-16.2
38-39	Determine Solutions of first order linear equation by Lagrange method	CLO 24	T1:17.5-17.6 R1:16.3.1
40-41	Apply method of separation of variables	CLO 25	T1:18.1-18.2 R1:16.4
42-45	Solving One dimensional heat and wave equations under initial and boundary conditions.	CLO 26	T1:18.4-18.5 R1:16.4

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S .No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Newton Raphson method, Lagranges interpolation, method of least square and Runge-kutta method	Seminars	PO 1	PSO 1
2	Fourier Integral Transforms, Convolution theorem in Fourier Transforms	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations	NPTEL	PO 4	PSO 1

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