



KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (KIIT)

(Deemed to be University)

DEPARTMENT OF MATHEMATICS SCHOOL OF APPLIED SCIENCES

SPRING SEMESTER 2022-23

Course Handout

Date: 06/02/2023

1. **Course Code:** MA 11002
2. **Course title:** Transforms and Numerical Methods
3. **L-T-P Structure:** 3-1-0
4. **Course Coordinator:** Dr. Sapan Kumar Samal
Assoc. Course Coordinator: Dr. Utkal Keshari Dutta

Name of the Course Faculty	Section

Prerequisite: Differential Equations and Linear Algebra

5. Course Objectives:

The objective of this course is to familiarize the students with the methods of Laplace and Fourier transformation and various numerical techniques to solve engineering problems.

6. Course outcomes:

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

- CO1: apply Laplace Transform to problems in the field of science and engineering.
- CO2: use Fourier series and Transform as a tool to solve differential equations.
- CO3: estimate the errors in the results obtained in the Numerical methods.
- CO4: solve the nonlinear equations that arise in engineering problems and interpolation.
- CO5: know various methods of differentiation and integration.
- CO6: apply numerical solution of differential equations and system of linear equations.

7. Course contents

Transforms:

(12 hours)

Laplace Transforms:

Laplace transform, Inverse Laplace transform, Linearity, Transforms of derivatives and integrals, Unit step function, Dirac's delta function, Second shifting theorem, Differentiation and integration of Transforms, Convolution, Solution of ODEs and integral equations by Laplace Transforms.

(12-hours)

Fourier Series and Transform:

Fourier series, Arbitrary periods, Even and odd functions, Half-range expansions, Fourier integral, Fourier cosine and sine transforms, Fourier transform, Inverse Fourier transform, Linearity, Fourier transform of derivatives, Convolution.

Numerical Methods:

(08-hours)

Approximations & Errors:

Approximation of numbers by truncation and rounding-off, Types of errors,

Numerical solution of Non linear equations:

Solutions by Bisection method, Fixed point iteration method, Newton-Raphson method, Regula-Falsi and Secant method, Rate of convergence of Secant & Newton-Raphson method.

(14-hours)

Interpolation & Approximation:

Finite differences, Operators and relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.

Numerical Differentiation & Integration:

Numerical differentiation of 1st and 2nd order using difference table. Trapezoidal rule, Simpson's 1/3rd and 3/8th rules, Gauss-Legendre's two points and three points formulae. Error in numerical integration.

(10-hours)

Numerical Solution to ODE:

Taylor series method, Euler's method, Modified Euler's method, Runge-Kutta methods of order 2 and 4, Reduction of 2nd order ODE to system of 1st order ODEs and its solution by Runge-Kutta method of order four.

Solution of system of linear equations: Solutions by Gauss-Seidel and Gauss-Jacobi methods.

8. Text Books:

- T1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley, INC, 10th Edition, 2011.
- T2. Numerical Methods for Scientific and Engineering Computation by Jain, Iyenger and Jain, New age International (P) Ltd., 6th Edition, 2014.

9. Reference Books:

- R1. Higher Engineering Mathematics by B.S. Grewal, Khanna Publishers, 44th edition, 2015.
- R2. Higher Engineering Mathematics by B.V. Ramana, TMH, 2007.
- R3. Numerical Methods by Arumugam, Thangapandi and Somasundaram, Scitech Publishers, 2nd Edition, 2002.

10. Lesson plan and active learning activities

<i>Unit No. and Topic</i>	<i>Lecture No.</i>	<i>Detail Topics to be covered</i>	<i>Article No./ Book</i>
Laplace Transform	1	Laplace Transform, Linearity and Ist shifting Theorem	6.1(T1)
	2	Transforms of Derivatives and integrals	6.2(T1)
	3	Unit Step Function (Heavyside Function)	6.3(T1)
	4	Tutorial (Problems Solving)	
	5	Second Shifting Theorem(t-Shifting)	6.3(T1)
	6	Short Impulses, Dirac's Delta Function	6.4(T1)
		Assignment-I	
	7	Convolution	6.5(T1)
	8	Tutorial (Problems Solving & discussion of problems of Assignment-I)	
	9	Solution of ODEs and Integral Equations	6.5(T1)
	10-11	Differentiation and Integration of Transforms	6.6(T1)
	12	Tutorial (Problems Solving)	
		Quiz-1	
Fourier Series & Transform	13	Fourier Series	11.1(T1)
	14	Arbitrary Period, Even and Odd Functions	11.2(T1)
	15	Half-Range Expansion	11.2 (T1)
	16	Tutorial(Problems Solving & discussion of problems of quiz-1)	
	17	Fourier Integral	11.7(T1)
	18	Fourier Cosine and Sine Transforms	11.8(T1)
	19	Fourier Transform	11.9(T1)
	20	Tutorial(Problems Solving)	
		Assignment-II	
	21	Inverse Fourier transforms,	11.9(T1)
	22	Linearity Property, Fourier Transform of Derivatives	11.9(T1)
	23	Convolution	11.9(T1)
	24	Tutorial(Problem Solving & discussion of problems of Assignment-II)	

Approximations & Errors:	25	Approximation of numbers by truncation and rounding-off, Types of errors	1.3(T2)
	26-27	Solutions by Bisection Method, Fixed Point Iteration Method	2.1,2.2(T2)
	28	Tutorial (Problem Solving)	
	29-30	Newton-Raphson Method, Regula-Falsi Method, Secant Method	2.3(T2)
	31	Rate of Convergence of Secant & Newton-Raphson Method	2.5(T2)
	32	Tutorial (Problem Solving)	
		Quiz-II	
Interpolation & Approximation:	33-34	Finite Differences, Operators and Relation between them	4.3(T2)
	35	Interpolation: Newton's forward and backward difference interpolation	19.3(T1)
	36	Tutorial (Problem Solving, discussion of problems of Quiz-II)	
	37-38	Newton's divided difference interpolation and Lagrange interpolation	4.2(T2)
	39	Numerical differentiation of 1 st and 2 nd order using difference table	5.2(T2)
	40	Tutorial (Problem Solving)	
	41-42	Trapezoidal rule, Simpson's 1/3 rd and 3/8 th rules	5.6(T2)
	43	Gauss-Legendre's two points formulae	5.8(T2)
	44	Tutorial (Problem Solving)	
	45-46	Gauss-Legendre's three points formulae, Error in Numerical Integration	5.2,5.6 and 5.8(T2)
Numerical Differentiation & Integration:	47	Taylor series Method	6.4(T2)
	48	Tutorial (Problem Solving)	
	49-51	Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4	6.4(T2)
	52	Tutorial (Problem Solving)	
	53	Reduction of 2 nd order ODE to system of 1st order ODEs and its solution by R-K method of order four	6.4(T2)
	54-55	Solution of System of Linear Equations: Solutions by Gauss-Seidel and Gauss-Jacobi methods	3.4 (T2)
		Assignment-III (Critical Thinking)	
		Quiz-3	
	56	Tutorial (Problem Solving)	
	57-60	Previous Year questions & answer	

		discussion	
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11. Internal Assessment components:

Sl. No.	Assessment Component	Duration	Weightage / Marks	Nature of the Component
1	Mid Semester Examination	90 min	20	Closed Book
2	End Semester Examination	3 Hours	50	Closed Book
3	Problem Solving (Assignment)	1 week	10	Open Book
4	Quiz Test	20 min	15	Closed Book
5	Critical Thinking	15 days	05	Open Book

12. Activity Calendar:

Sl. No.	Type of Activity/ Nature of the Component	Duration For Submission	Weightage / Marks	Schedule for Activities	Topic/Module	Mapping with COs
1	Assignment-1 (Open Book)	1 week	5	23/2/2023	article no. 6.1 to 6.4(T1)	CO1
2	Quiz -1 (Closed Book)	20min	5	4/3/2023	article no.6.1 to 6.6(T1)	CO1
3	Assignment-2 (Open Book)	1 week	5	17/3/2023	article no.6.5,6.6,11.1,11.8 (T1)	CO2
4	Quiz -2 (Closed Book)	20min	5	25/3/2023	Fourier Series & Transform and Approximations and Errors	CO2, CO3
5	Critical Thinking (Open Book)	15 days	5	6/5/2023	Whole Syllabus	CO1, CO2, CO3, CO4 & CO5
6	Quiz -3 (Closed Book)	20min	5	20/5/2023	Interpolation & Approximation, Numerical Differentiation & Integration, Numerical Solution to ODE	CO4, CO5 & CO6

13. Attendance: Every student is expected to be regular (in attendance) in all lecture classes, tutorials, labs, tests, quizzes, seminars etc. and in fulfilling all tasks assigned to him/her. Attendance will be recorded and 75% attendance is compulsory.

14. Makeup Examination:

- 1) No make-up examination will be scheduled for the mid semester examination. However, official permission to take a make-up examination will be given under exceptional circumstances such as admission in a hospital due to illness / injury, calamity in the family at the time of examination.

- 2) A student who misses a mid-semester examination because of extenuating circumstances such as admission in a hospital due to illness / injury, calamity in the family may apply in writing via an application form with supporting document(s) and medical certificate to the Dean of the School for a make-up examination.
 - 3) Applications should be made within five working days after the missed examination.
15. **Discussion of Mid Semester performance:** Performance of the mid semester examination will be discussed in the class room.
 16. **Pre-end semester total marks:** *Please see the SAP portal link:*
 17. **Course Management System: SAP Portal** is a software system designed to facilitate teachers in the management (instructional content, assessment and documentation) of the courses for their students, both teachers and students can monitor the system. Though usually considered as a tool and often used to complement the face-to-face classroom.
 18. **Chamber consultation hour for doubts clarification:**
 19. **Notices:** All the information regarding the course will be communicated through the respective course faculty (by WhatsApp/E-Mail/Google Class Room).