KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY (KIIT)
(Deemed to be University)
DEPARTMENT OF MATHEMATICS
SCHOOL OF APPLIED SCIENCES

AUTUMN SEMESTER 2022-23

Course Handout

Date: 20.09.2022

1. **Course Code: MA 11001**

2. **Course title: Differential Equations and Linear Algebra**

3. **L–T–P Structure: 3-1-0**

4. **Course Coordinator: Dr. Madhusmita Sahoo**

Name of the Course Faculty	Section

5. **Course Objective(s):**

> The objective of this course is to familiarize the prospective engineers with techniques in ordinary differential equations and linear algebra. It aims to equip the students to tackle advanced level of mathematics and applications that they would find useful in their disciplines.

6. **Course Outcomes:** At the end of the course, the students will be able to:

CO1: understand the concept of modelling and formulation of Differential equation
 of physical problems.
CO2: apply different methods to solve ODE problems involving growth-decay,
 cooling effects and electrical circuits etc.
CO3: develop an ability to solve 2nd and higher order ODEs.
CO4: apply the knowledge of special function in engineering problems.
CO5: use the essential tool of matrices and linear algebra in a comprehensive
 manner.
CO6: apply the knowledge of Eigen value and Eigen vector in the field of
 engineering and also get the concept of complex matrices.

7. **Course Contents**

(12 hours)

Ordinary Differential Equations of first order:
Introduction and formation of differential equations, Overview: separable method, homogeneous equations, equations reducible to homogeneous form. Exact differential equations, equations reducible to exact form, linear differential equations, equations reducible to linear form (Bernoulli's equation). Applications of differential equations: Growth-Decay Problem, Newton's Law of Cooling, Mixing problem, Orthogonal trajectories.

(10 hours)

Linear Differential Equations of second order:
Second order linear homogeneous equations with constant coefficients; differential operators; solutions of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solutions of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients. Applications of 2nd order differential equations in Electric circuit.

(14 hours)

Special Functions:
Improper Integrals for one variable, some test for convergence of improper integrals, Gamma function, Properties, Beta function, Relation between Gamma and Beta functions. Radius of convergence of power series, Legendre equation. Legendre polynomial. Recurrence relations and Orthogonality property of Legendre polynomial. Bessel's equation, Bessel's function, Recurrence relation.

(12 hours)

System of Linear Equations and Vector Space:
Linear system of equations; rank of matrix; consistency of linear systems; Solution of system of linear equations: Gauss elimination, inverse of a matrix by Gauss Jordan method, Vector Space, Sub-space, Basis and dimension, linear dependence and independence, Linear transformation.

(8 hours)

Matrix-Eigen value problems:
Eigen values, Eigen vectors, Eigen basis, quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; Diagonalization of matrices.

8. Text books

T1. "*Advanced Engineering Mathematics*" by Erwin Kreyszig, Wiley, INC, 10th Edition, 2011.

9. Reference books

R1. "*Higher Engineering Mathematics*" by B. S. Grewal, Khanna Publishers, 44th Edition, 2017.
R2. "*Introduction to Engineering Mathematics*" by H. K. Dass, S. Chand & Co. Ltd., Volume I & Volume II, 2018.
R3. "*Higher Engineering Mathematics*" by B.V. Ramana, TMH, 1st edition, 2006.
R4. "*A course on ordinary & partial differential Equation*" by J. Sinha Roy and S. Padhy, Kalyani Publication, 5th edition, 2022.

10. Lesson plan and active learning activities

Unit No. and Topic	Lecture No.	Detail Topics to be covered	Article No./ Book
First Order ODEs	1	Introduction and formation of differential equations	**1.1(T1)**
	2	Variable separable method, homogeneous ODEs	**1.3(T1)**
	3	Equations reducible to homogeneous form	**1.3(T1)**
	4	Tutorial (Problem Solving)	**1.1-1.3(T1)**
	5	Exact differential equations, equations reducible to exact form	**1.4(T1)**
		Assignment-I to be given after article no. 1.4	
	6	Linear differential equations	**1.5(T1)**
	7	Equations reducible to linear form (Bernoulli's equation)	**1.5(T1)**
	8	Tutorial (Problem Solving)	**1.4-1.5(T1)**
	9	Growth-Decay Problem	**1.3(T1)**
	10	Newton's Law of Cooling, Mixing problem	**1.3(T1)**
	11	Orthogonal trajectories	**1.6(T1)**
	12	Tutorial (Problem Solving)	**1.3 & 1.6 (T1)**
	13	**Assignment-I Problem discussion & Quiz-1 (To be conducted Centrally)**	

Second Order Linear ODEs	14	Second order linear homogeneous ODEs	2.1(T1)
	15	Differential operators; solutions of homogeneous ODEs with constant coefficients	2.2 & 2.3 (T1)
	16	Euler-Cauchy ODEs	2.5(T1)
	17	Linear dependence and independence; Wronskian	2.6(T1)
	18	Tutorial (Problem Solving)	2.1-2.3 & 2.5-2.6(T1)
		Assignment-II to be given after article no. 2.6	
	19	Solutions of non-homogeneous equations: general solution, complementary function, particular integral	2.7(T1)
	20	Method of undetermined coefficients	2.7(T1)
	21	Method of undetermined coefficients	2.7(T1)
	22	Tutorial (Problem Solving)	2.6-2.7(T1)
	23	**Assignment-II Problem discussion & Quiz-2 (To be conducted Centrally)**	
	24	Method of variation of parameters	2.10(T1)
	25	Method of variation of parameters	2.10(T1)
	26	Applications of 2nd order differential equations in Electric circuit	2.9(T1)
	27	Tutorial (Problem Solving)	2.9-2.10(T1)
Special Functions	28	Improper Integrals for one variable	6.6(R3)
	29	Test for convergence of improper integrals	6.6(R3)
	30	Test for convergence of improper integrals	6.6(R3)
		Tutorial (Problem Solving)	6.6(R3)
	31	Gamma function, Beta function, Relation between Gamma and Beta functions, Properties	11.1 & 11.2 (R3)
	32	Introduction to Power Series; Radius of convergence of power series	5.1(T1)
	33-34	Legendre equation. Legendre polynomial	5.2(T1)
	35	Tutorial (Problem Solving)	11.1-11.2(R3) & 5.1-5.2(T1)
	36	Recurrence relations of Legendre polynomial and Orthogonality property	5.2(T1)
	37	Bessel's equation, Bessel's function (1st Kind)	5.4(T1)
	38	Recurrence relation of Bessel's functions	5.4(T1)
	39	Tutorial (Problem Solving)	5.2 & 5.4(T1)
System of Linear Equations and Vector Space	40-41	System of linear equations; Solution by Gauss elimination Method	7.3(T1)
	42-43	Vector Space, Sub-space; Linear dependence and independence	7.4(T1)
	44-45	Basis and dimension	7.4(T1)
	46	Rank of matrix; consistency of linear systems	7.4(T1)
	47	Tutorial (Problem Solving)	7.3 & 7.4(T1)
	48	Inverse of a matrix by Gauss Jordan method	7.8(T1)
	49-50	Linear transformation	7.9(T1)
	51	Tutorial (Problem Solving)	7.8 & 7.9(T1)
		Critical Thinking (Assignment-III) to be given after Chapter-7	
Matrix Eigen value Problems	52	Eigen values, Eigen vectors, Eigen basis	8.1(T1)
	53	Real Matrices; Quadratic form	8.3(T1)

	54	Complex Matrices, Hermitian, Skew-Hermitian forms	8.5(T1)
	55	Tutorial (Problem Solving)	8.1, 8.3 & 8.5(T1)
	56	Similar matrices	8.4(T1)
	57-58	Diagonalization of matrices	8.4(T1)
	59	Tutorial (Problem Solving)	8.4(T1)
	60	**Assignment-III Problem discussion**	
		Quiz-3 (To be conducted Centrally)	
	61-62	**Previous Year question & answer discussion**	

N.B: The problems in the tutorial class may be solved by touching the specific parts taught in the previous classes.

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

13. **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	Before Mid Semester (18.10.2022)	After article no. 1.4	CO1
2	Quiz -1 (Closed Book)	20min	5	Before Mid Semester (29.10.2022)	After Completion of Chapter-1	CO1 & CO2
3	Assignment-2 (Open Book)	1 week	5	Before Mid Semester (10.11.2022)	After article no. 2.6	CO3
4	Quiz -2 (Closed Book)	20min	5	Before Mid Semester (19.11.2022)	After completion of article no.2.7	CO3
5	Critical Thinking (Open Book)	15 days	5	After Mid and before End semester (24.12.2022)	After completing Chapter-7	CO1, CO2, CO3, CO4 &CO5
6	Quiz -3 (Closed Book)	20min	5	Before End semester (13.01.2023)	After completion of Chapter-8	CO5 & CO6

14. **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.

15. **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.

16. **Discussion of Mid Semester performance:** Performance of the mid semester examination will be discussed in the class room.

17. **Pre-end semester total marks**: *Please see the SAP portal link:*

18. 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.

19. Chamber consultation hour for doubts clarification:

20. Notices: All the information regarding the course will be communicated through the respective course faculty (by WhatsApp/E-Mail/Google Class Room).

Sd/-
Course Coordinator
(Dr. Madhusmita Sahoo)