INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

<table>
<tr><td>Course Title</td><td colspan="5">LINEAR ALGEBRA AND CALCULUS</td></tr>
<tr><td>Course Code</td><td colspan="5">AHSB02</td></tr>
<tr><td>Programme</td><td colspan="5">B. Tech</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4">AE | CSE | IT | ECE | EEE | ME |CE</td></tr>
<tr><td>Course Type</td><td colspan="5">Foundation</td></tr>
<tr><td>Regulation</td><td colspan="5">IARE - R18</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lectures</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>1</td><td>4</td><td>-</td><td>-</td></tr>
<tr><td>Chief Coordinator</td><td colspan="5">Ms. L Indira, Assistant Professor</td></tr>
<tr><td>Course Faculty</td><td colspan="5">Dr. M Anita, Professor
Dr. S Jagadha, Professor
Mr. Ch Somashekar, Associate Professor
Mr. V Subba Laxmi, Associate Professor
Mr. J Suresh Goud, Assistant Professor
Ms. P Srilatha, Assistant Professor
Ms. C Rachana, Assistant Professor
Ms. P Rajani, Assistant Professor
Ms. B Praveena, Assistant Professor</td></tr>
</table>

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 types of Matrices and its applications, maxima and minima of functions of several variables, solutions of higher order ordinary differential equations, multiple integrals and vector calculus. 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 Algebra and Calculus

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Linear Algebra and Calculus	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 XI.

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.	3	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

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products.	1	Seminar
PSO 2	**Problem-solving Skills**: Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	-	-
PSO 3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies.	-	-
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Analyze and solve linear system of equations by using elementary transformations.
II	Determine the maxima and minima of functions of several variables by using partial differential coefficients..
III	Apply second and higher order linear differential equations to solve electrical circuits.
IV	Apply multiple integration to evaluate mass, area and volume of the plane.
V	Analyze gradient, divergence and curl to evaluate the integration over a vector field.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB02.01	CLO 1	Demonstrate knowledge of matrix calculation as an elegant and powerful mathematical language in connection with rank of a matrix.	PO 1 PO 2	3
AHSB02.02	CLO 2	Determine rank by reducing the matrix to Echelon and Normal forms.	PO 1 PO 2	3
AHSB02.03	CLO 3	Determine inverse of the matrix by Gauss Jordon Method.	PO 1 PO 2	3
AHSB02.04	CLO 4	Interpret the Eigen values and Eigen vectors of matrix for a linear transformation and use properties of Eigen values	PO 1 PO 2	3
AHSB02.05	CLO 5	Understand the concept of Eigen values in real-world problems of control field where they are pole of closed loop system.	PO 1	3
AHSB02.06	CLO 6	Apply the concept of Eigen values in real-world problems of mechanical systems where Eigen values are natural frequency and mode shape.	PO2	2
AHSB02.07	CLO 7	Use the system of linear equations and matrix to determine the dependency and independency.	PO 2	2
AHSB02.08	CLO 8	Determine a modal matrix, and reducing a matrix to diagonal form.	PO 2	2
AHSB02.09	CLO 9	Evaluate inverse and powers of matrices by using Cayley-Hamilton theorem.	PO 2	2
AHSB02.10	CLO 10	Apply the Mean value theorems for the single variable functions.	PO 1 PO 2	3
AHSB02.11	CLO 11	Find partial derivatives numerically and symbolically and use them to analyze and interpret the way a function varies.	PO 1 PO 2	3
AHSB02.12	CLO 12	Find partial derivatives of and apply chain rule derivative techniques to multivariable functions.	PO 1 PO 2	3
AHSB02.13	CLO 13	Understand the techniques of multidimensional change –of –variables to transform the coordinates by utilizing the Jacobian. Determine Jacobian for the coordinate transformation.	PO 2	2
AHSB02.14	CLO 14	Apply maxima and minima for functions of several variable's and Lagrange's method of multipliers.	PO 1	3
AHSB02.15	CLO 15	Find the complete solution of a non-homogeneous differential equation as a linear combination of the complementary function and a particular solution.	PO 1	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AHSB02.16	CLO 16	Solving Second and higher order differential equations with constant coefficients.	PO 1, PO 2	3
AHSB02.17	CLO 17	Apply the second order differential equations for real world problems of electrical circuits.	PO 1, PO 2	3
AHSB02.18	CLO 18	Evaluate double integral and triple integrals of the given functions.	PO 1, PO 2	3
AHSB02.19	CLO 19	Utilize the concept of change order of integration and change of variables to evaluate double integrals.	PO 1, PO 2	3
AHSB02.20	CLO 20	Determine the area and volume of a given curve using double and triple integral.	PO 1, PO 2	3
AHSB02.21	CLO 21	Analyze scalar and vector fields and compute the gradient, divergence and curl.	PO 1	3
AHSB02.22	CLO 22	Understand integration of vector function with given initial conditions.	PO1	2
AHSB02.23	CLO 23	Evaluate line, surface and volume integral of vectors.	PO 1	3
AHSB02.24	CLO 24	Use Vector integral theorems to facilitate vector integration.	PO 2	2

3 = High; 2 = Medium; 1 = Low

X. 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	PSO4
CLO 1	3	2											1			
CLO 2	3	2														
CLO 3	3	3														
CLO 4	3	2											1			
CLO 5	3															
CLO 6		2														
CLO 7		2														
CLO 8		3											1			
CLO 9		2											1			
CLO 10	3	2														
CLO 11	2	2											1			
CLO 12	3	3											1			
CLO 13		2														
CLO 14	3												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	PSO4
CLO 15	3															
CLO 16	3	2											1			
CLO 17	2	2											1			
CLO 18	2	1											1			
CLO 19	3	2											1			
CLO 20	3	1											1			
CLO21	2															
CLO22	3												2			
CLO23	3															
CLO24	2	2											2			

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

Module-I	THEORY OF MATRICES AND LINEAR TRANSFORMATIONS	Classes: 09
Real matrices: Symmetric, skew-symmetric and orthogonal matrices; Complex matrices: Hermitian, Skew-Hermitian and unitary matrices; Elementary row and column transformations; Rank of a matrix: Echelon form and normal form; Inverse by Gauss-Jordan method; Cayley-Hamilton theorem: Statement, verification, finding inverse and powers of a matrix; Linear dependence and independence of vectors; Eigen values and Eigen vectors of a matrix and Properties (without proof); Diagonalization of matrix by linear transformation.		
Module-II	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES**	**Classes: 09**
Mean value theorems: Rolle’s theorem, Lagrange’s theorem, Cauchy’s theorem-without proof; Functions of several variables: Partial differentiation, chain rule, total derivative, Euler’s theorem, functional dependence, Jacobian, maxima and minima of functions of two variables without constraints		

and with constraints; Method of Lagrange multipliers.		
Module-III	**HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS**	**Classes: 09**
Linear differential equations of second and higher order with constant coefficients, non-homogeneous term of the type $f(x) = e^{ax}, \sin ax, \cos ax$ and $f(x) = x^n, e^{ax}v(x), x^n v(x)$; Method of variation of parameters; Applications to electrical circuits.		
Module-IV	**MULTIPLE INTEGRALS**	**Classes: 09**
Double and triple integrals; Change of order of integration. Transformation of coordinate system; Finding the area of a region using double integration and volume of a region using triple integration.		
Module-V	**VECTOR CALCULUS**	**Classes: 09**
Scalar and vector point functions; Definitions of Gradient, divergent and curl with examples; Solenoidal and irrotational vector point functions; Scalar potential function; Line integral, surface integral and volume integral; Vector integral theorems: Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.		
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, 11th 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.		

XIV. 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	Define types of matrices	CLO 1	T2:32.1 R1:4.1
2	Apply Elementary row and column transformation	CLO 2	T2:32.1 R1:4.2
3	Determine the Rank of a matrix, by Echelon form and Normal form	CLO 2	T2:32.1 R1:4.3
4	Apply Gauss Jordan method to find inverse	CLO 3	T2:32.1 R1:4.3
5	Apply Cayley-Hamilton theorem to find inverse of matrix	CLO 9	T2:32.5 R1:4.6
6	Distinguish Linear dependency and independence\y of vectors	CLO 7	T2:32.5 R1:4.6
7	Define and find Eigen values and Eigen vectors.	CLO 4	T2:32.4 R1:4.5
8	Define and apply the properties of Eigen values and Eigen vectors	CLO 4	T2:32.4 R1:4.5
9	Use diagonalisation to diagonalise a square matrix and find higher powers of a matrix	CLO 8	T2:32.7 R1:4.8
10	Apply the Rolle's theorem	CLO 10	T2:7.1

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			R1:7.4
11	Apply Lagrange's Mean Value Theorem	CLO 10	T2:7.1 R1:7.4
12	Apply Cauchy's Mean Value Theorem	CLO 10	T2:7.1 R1:7.4
13	Find partial derivatives and apply chain rule	CLO 11	T3-4.10
14	Find total derivatives and apply Euler's theorem	CLO 11	T3-4.71
15	Apply Jacobian transformation	CLO 13	T3-4.42
16	Determine maximum and minimum of a function of several variables	CLO 14	T2:7.1 R1:7.4
17	Determine maximum and minimum of a function of several variables	CLO 14	T2:7.1 R1:7.4
18	Use the Lagrange multiplier method to find extreme of functions with constraints	CLO 14	T2:15.5 R1:7.4
19	Determine complementary function for homogeneous higher order linear differential equations	CLO 16	T3-2.9 R1:2.1
20	Solving non-homogeneous higher order linear differential equations: methods of finding particular integral	CLO 17	T3-2.15 R1:2.8
21	Determine particular non-homogeneous term of the type $f(x)=e^{ax}$	CLO 16	T3-2.5 R1:2.8
22	Determine particular non-homogeneous term of the type $f(x)=\sin ax, \cos ax$	CLO 16	T3-2.5 R1:2.8
23	Determine particular for non-homogeneous term of the type $f(x)=x^n$	CLO 16	T3-2.5 R1:2.8
24	Determine of finding particular for non-homogeneous term of the type $f(x)=e^{ax}v(x)$	CLO 16	T3-2.5 R1:2.8
25	Determine of finding particular integral for non-homogeneous term of the type $f(x)=x^n v(x)$	CLO 16	T3-2.5 R1:2.8
26	Solving second order linear differential equations using method of variation of parameters	CLO 16	T3-2.61 R1:2.10
27	Apply higher order differential method to electrical circuits	CLO 17	R1:2.12
28	Calculate double integrals of a function in Cartesian form	CLO19	T2:15.5 R1:7.5
29	Calculate double integrals of a function in polar form	CLO19	T2:16.5 R1:7.6
30	Use the Change of order of integrations Cartesian and polar form	CLO19	T2:16.5 R1:7.6
31	Use the Change of order of integrations Cartesian and polar form	CLO19	T2:16.5 R1:7.6
32	Use transformation of coordinate system to evaluate double integral	CLO19	T2:16.5 R1:7.6
33	Use transformation of coordinate system to evaluate double integral	CLO19	T2:16.5 R1:7.6
34	Calculate triple integrals in Cartesian form	CLO19	T2:11.1 R2:6.15
35	Apply double integration for finding the area	CLO20	T2:10.1 R1:16.1
36	Apply triple integration for finding the volume	CLO20	T2:10.1 R1:16.2
37	Define vector calculus and vector fields and their properties	CLO21	T2:10.3 R1:16.4
38	Determine Solenoidal and irrotational vector point function	CLO21	T2:11.3 R1:16.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
39	Determine Scalar potential function	CLO21	T2:11.3 R1:16.5
40	Calculate line integral along smooth path and find work done	CLO23	T2:11.3 R1:16.5
41	Calculate the surface area of field	CLO23	T2:11.3 R1:16.5
42	Calculate volume of field	CLO23	T2:11.3 R1:16.5
43	Use Green's theorem to evaluate line integrals along simple closed contours on the plane	CLO22	T2: 11.3 R1:16.11
44	Use Stokes' theorem to give a physical interpretation of the curl of a vector field	CLO22	T2: 11.3 R1:16.9
45	Use the divergence theorem to give a physical interpretation of the divergence of a vector field	CLO22	T2: 11.4 R1:16.18

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

S No	Description	Proposed Actions	Relevance With POs	Relevance With PSOs
1	Matrices and its applications, applications of maxima and minima of functions of single and several variable.	Seminars	PO 1	PSO 1
2	Change of order of integration, geometrical interpretation of vector integral theorems and properties of gamma and Bessel differential equation.	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:
Ms. L. Indira, Assistant Professor

HOD, FRESHMAN ENGINEERING