INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**COMPUTATIONAL MATHEMATICS AND INTEGRAL CALCULUS**				
Course Code	AHS003				
Programme	B.Tech				
Semester	I	CSE | IT| ECE | EEE			
	II	AE| ME | CE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Ms. V Subba Laxmi Assistant Professor				
Course Faculty	Dr. S Jagadha, Professor Ms. L Indira, Assistant Professor Mr. Ch Somashekar, 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 types of interpolation, curve fitting, numerical solutions of ordinary differential equations, multiple integrals, vector calculus and special functions. 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
-	-	-	Differentiation, integration and properties of vectors

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Computational Mathematics and Integral 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 units and each unit 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 unit. 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 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	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 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five 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 / Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

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
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.	1	Term Paper

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	**Problem Solving**: Exploit the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	1	Seminar
PSO2	**Professional Skills:** Identify the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	-	-
PSO3	**Modern Tools in Electrical Engineering:** Comprehend the technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Enrich the knowledge of solving algebraic, transcendental and differential equation by numerical methods.
II	Apply multiple integration to evaluate mass, area and volume of the plane
III	Analyze gradient, divergence and curl to evaluate the integration over a vector field.
IV	Understand the Bessel’s equation to solve them under special conditions with the help of series solutions.

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
AHS003.01	CLO 1	Solve the algebraic and transcendental equations using bisection method, method of false position and Newton-Raphson method.	PO 1	3
AHS003.02	CLO 2	Apply numerical methods to interpolate the functions of values for equal intervals using finite differences.	PO2	3
AHS003.03	CLO 3	Understand the Newton-Raphson method to the real-world problem for a finite barrier quantum well.	PO 4	1
AHS003.04	CLO 4	Evaluate the functional value by using Lagrange's interpolation formula for unequal intervals.	PO2	2
AHS003.05	CLO 5	Understand the Lagrange's interpolation in real-world problem for neural network learning.	PO 4	1
AHS003.06	CLO 6	Apply method of least squares to fit linear and non linear curves.	PO1, PO 2	2
AHS003.07	CLO 7	Solve differential equation using single step method- Taylor"s series.	PO 1	3
AHS003.08	CLO 8	Solve differential equation using multi step methods- Euler's, Modified Euler's and Runge Kutta methods.	PO 2	2
AHS003.09	CLO 9	Understand the multistep methods in real-worl problem for real time Aircraft dynamics.	PO 4	1
AHS003.10	CLO 10	Understand the Runge-Kutta method in real-world problem for embedding the sensor signals into the iterative computation.	PO 4	1
AHS003.11	CLO 11	Evaluate double integral and triple integrals .	PO 1	2
AHS003.12	CLO 12	Utilize the concept of change order of integration to evaluate double integrals.	PO 1,PO2	2
AHS003.13	CLO 13	Determine the area and volume of a given curves using double and triple integration.	PO 2	3
AHS003.14	CLO 14	Understand transformation of co-ordinate system from plane to plane.	PO 1	3
AHS003.15	CLO 15	Analyze scalar and vector fields and compute the gradient, divergence and curl.	PO 2	3
AHS003.16	CLO 16	Understand integration of vector function .	PO 1	2
AHS003.17	CLO 17	Evaluate line, surface and volume integral of vectors.	PO 1	3
AHS003.18	CLO 18	Use Vector integral theorems to facilitate vector integration .	PO 2	2
AHS003.19	CLO 19	Analyze the concept of vector calculus in real-world problem for fluid dynamics.	PO 4	1
AHS003.20	CLO 20	Solve the Differential Equations by series solutions.	PO 1	3
AHS003.21	CLO 21	Understand Gamma function to evaluate improper integrals.	PO 1	2
AHS003.22	CLO 22	Analyze Bessel's function and study its properties	PO 1	3
AHS003.23	CLO 23	Analyze Bessel's function as a Solution to Schrödinger equation in a cylindrical function of the second kind.	PO 4	1
AHS003.24	CLO 24	Understand gamma function to find application diverse areas as quantum physics.	PO 4	1
AHS003.25	CLO 25	Possess the knowledge and skills for	PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		employability and to succeed in national and International level competitive examinations.		

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC 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												1		
CLO 2		3											1		
CLO 3				1									1		
CLO 4		2													
CLO 5				1											
CLO 6	2	2													
CLO 7	3														
CLO 8	2														
CLO 9				1									1		
CLO 10				1									1		
CLO 11	2														
CLO 12	2	2													
CLO 13		3													
CLO 14	3												1		
CLO 15		3													
CLO 16	2														
CLO 17	3												1		
CLO 18		2											1		
CLO 19				1									1		
CLO 20	3												1		
CLO 21		2													
CLO 22	3														
CLO 23				1											

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 24				1											
CLO 25				1											

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1 PO 2 PO 4	SEE Exams	PO 1 PO 2 PO 4	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 4						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	ROOT FINDING TECHNIQUES AND INTERPOLATION
Root finding techniques: Solving algebraic and transcendental equations by Bisection method, Method of False position, Newton-Raphson method; 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 .	
UNIT-II	CURVE FITTING AND NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS
Fitting a straight line; Second degree curves; Exponential curve, power curve by method of least squares; Taylor's series method; Step by step methods: Euler's method, modified Euler's method and Runge-Kutta method for first order differential equations .	
UNIT-III	MULTIPLE INTEGRALS
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.	
UNIT-IV	VECTOR CALCULUS
Scalar and vector point functions; Gradient, divergence, curl and their related properties; Solenoidal and irrotational vector point functions; Scalar potential function; Laplacian operator; 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.	
UNIT-V	SPECIAL FUNCTIONS
Gamma function, properties of gamma function; Ordinary point and regular singular point of differential equations; Series solutions to differential equations around zero, Frobenius method about zero; Bessel"s differential equation: Bessel functions properties, recurrence relations, orthogonality, generating function, trigonometric expansions involving Bessel functions.	
Text Books:	
1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014. 2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2012.	

Reference Books:
1. T.K.V Iyengar, B.Krishna Gandhi, “Mathematical methods”, S. Chand & Co., 6th Edition, 2014. 2. R K Jain, S R K Iyengar, “Advanced Engineering Mathematics”, Narosa Publishers, 5th Edition, 2016. 3. S. S. Sastry, “Introduction Methods of Numerical Analysis”, Prentice-Hall of India Private Limited, 5th Edition, 2012.

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 Algebraic and Transcendental equations	CLO 1	T1:22.5 R1:2.3
2	Explain Bisection method to find the root of an equation.	CLO 1	T1:22.5 R1:2.4
3	Explain Method of False Position to to find root an equation.	CLO 1	T1:22.6 R1:2.6
4	Explain Newton-Raphson method to find root of an equation.	CLO 3	T1:22.7 R1:4.4
5	Define interpolation of the given data.	CLO 2	T1:22.7 R1:4.10
6	Explain symbolic relations the between the operators.	CLO 2	T1:22.8 R1:4.15
7	Define Newton’s forward interpolation formula for evenly spaced intervals.	CLO 2	T1:22.9 R1:5.4
8	Define Newton’s backward interpolation formula for evenly spaced intervals.	CLO 2	T1:22.9 R1:5.8
9	Define Gauss forward interpolation formula for evenly spaced intervals.	CLO 2	T1:23.10 R1:6.8
10	Define Gauss backward interpolation formula for evenly spaced intervals.	CLO 2	T1:23.10 R1:6.13
11	Demonstrate Lagrange’s formula for unequal intervals.	CLO 5	T1:23.9 R1:7.5
12	Describe the best fit of a straight line by method of least squares.	CLO 6	T1:23.10 R1:7.5
13	Describe the best fit of a second degree parabola by method of least squares	CLO 6	T1:23.10 R1:8.1
14	Describe the best fit of an exponential curve by method of least squares.	CLO 6	T1:23.1 R1:9.2
15	Describe the best fit of a power curve by method of least squares	CLO 6	T1:23.1 R1:9.4
16	Solve the ordinary differential equation by Taylors series method.	CLO 6	T1:23.1 R1:9.9
17	Solve the ordinary differential equation by Euler’s Method-Euler’s modified method.	CLO 8	T1:23.1 R1:9.10
18	Solve the ordinary differential equation by Runge-Kutta Method.	CLO 8	T2:27.5 R1:10.2
19	Evaluate double and triple integrals.	CLO 8	T2:27.7 R1:11.3
20	Use the Change of order of integration cartesian and polar form.	CLO 12	T2:27.8 R1:11.6
21	Explain Transformation of co-ordinate system .	CLO 11	T2:27.12 R1:11.7
22	Use double integration for finding the area.	CLO 14	T2:27.12 R1:11.8
23	Use triple integration for finding the volume.	CLO 14	T2:27.12

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
			R1:11.9
24	Define vector calculus and vector fields and their properties	CLO 19	T2:27.12 R1:11.10
25	Determine Gradient, divergent and curl of vector fields.	CLO 19	T2:27.14 R1:12.3
26	Solve line integral along smooth path and find work done.	CLO 17	T2:27.1 R1:12.7
27	Evaluate surface integral.	CLO 17	T2:27.17 R1:12.15
28	Use Green's theorem to evaluate line integrals along simple closed contours on the plane.	CLO 17	T2:27.18 R1:12.19
29	Use Stokes' theorem to give a physical interpretation of the curl of a vector field .	CLO 17	T2:27.19 R2:14.4
30	Use the divergence theorem to give a physical interpretation of the divergence of a vector field.	CLO 17	T2:27.19 R2:14.5
31	Explain Gamma function s for improper integrals and gamma properties .	CLO 21	T2:27.19 R2:14.5
32	Define Ordinary and regular point of a differential equation.	CLO 23	T2:27.20 R2:14.5
33	Determine the solution of ordinary differential equations in series form.	CLO 23	T2:27.20 R2:14.5
34	Explain Frobenius Method about zero.	CLO 20	T2:27.19 R2:14.5
35	Define Bessel's Differential equation.	CLO 22	T2:27.19 R2:14.5
36-37	Explain Bessel's differential functions and properties.	CLO 22	T2:27.19 R2:14.5
38-39	Explain Recurrence relations for Bessel's function.	CLO 23	T2:27.19 R2:14.5
40-42	Explain Orthogonality of Bessel's function.	CLO 23	T2:27.20 R2:14.5
43-44	Explain Generating function of Bessel's function.	CLO 23	T2:27.20 R2:14.5
45	Explain trigonometric expansions of Bessel's function.	CLO 23	T2:27.19 R2:14.5

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Newton Raphson method, Lagranges interpolation, method of least square and Runge-kutta method	Seminars / NPTEL	PO 2	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 4	PSO 1

Prepared by:
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