INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

COMPUTER SCIENCE AND ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**Computational Mathematics and Integral Calculus**			
Course Code	**AHS003**			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	3	1	-	4
Course Coordinator	Ms. V Subba Laxmi, Assistant Professor			
Team of Instructors	Mr. Ch Kumara Swamy, Mr. Ch. Somashekar Ms. L Indira, Mr. G Nagendra Kumar			

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.

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II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	6	Differentiation, Integration, Properties of vectors

III. MARKS DISTRIBUTION

Subject	SEE Examination	CIA Examination	Total Marks
Computational Mathematics and Integral Calculus	70 Marks	30 Marks	100 Marks

Semester End Examination 70 Marks All the Units (1, 2, 3, 4 and 5)	70 Marks (3 Hours)	5 questions to be answered. Each question carries 14 Marks

	Continuous Internal Assessment - 1

Average of two CIA Examinations	30 Marks (2 Hours)	Units I, II and III (half)	Continuous Internal Examination (CIE) (2 hours)	**Part - A** 5 questions to be answered out of 5 questions, each carries 1 mark.
				Part - B 4 questions to be answered out of 5 questions, each carries 5 marks.
			Quiz-I /Alternate Assessment Tool (AAT- I)	5 marks for assignment.
	Continuous Internal Assessment - 2			
	30 Marks (2 Hours)	Units III (half) IV and V	Continuous Internal Examination (CIE) (2 hours)	**Part – A** 5 questions to be answered out of 5 questions, each carries 1 mark.
				Part - B 4 questions to be answered out of 5 questions, each carries 5 marks.
			Quiz-II /Alternate Assessment Tool (AAT- II)	5 marks for assignment.

IV. EVALUATION SCHEME

S. No	Component	Duration	Marks
1	CIE - I Examination	2 hour	25
2	Quiz - I / AAT - I	-	05
TOTAL			30
3	CIE - II Examination	2 hour	25
4	Quiz - II / AAT - II	-	05
TOTAL			30
CIA Examination marks to be considered as average of above two CIA's			
5	EXTERNAL Examination	3 hours	70
GRAND TOTAL			100

V. COURSE OBJECTIVES

The goal of this course is to create awareness and acquire comprehensive knowledge in algebra and differential equations.

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 Bessels equation to solve them under special conditions with the help of series solutions.

VI. COURSE OUTCOMES

By the end of the module students should be able to

1. **Solve** algebraic and transcendental equations using Bisection method, Method of False position and Newton-Raphson method.
2. **Apply** numerical methods to interpolate.
3. **Apply** method of least squares to fit a curve .
4. **Solve** differential equation using numerical methods(Taylor's series, Euler's, Modified Euler's and Runge-Kutta methods).
5. **Evaluate** double and triple integrals .
6. **Evaluate** line, surface and volume integrals by expressing in other coordinate systems and find area and volume.
7. **Analyze** scalar and vector fields and compute the gradient, divergence and curl.
8. **Apply** Green's Theorem, Divergence Theorem and Stoke's theorem to evaluate integrals.
9. **Solve** the Differential Equations by series solutions
10. **Analyse** Bessel's function and study its properties.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program outcomes		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments
PO2	**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	H	Assignments
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	S	Assignments
PO4	**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.	S	Assignments
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	S	------
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	S	------
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	S	------
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	S	------
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	------
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design	N	------

	documentation, make effective presentations, and give and receive clear instructions.		
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	N	-----
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	H	------

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity.	S	Lectures, Assignments
PSO2	**Problem-solving Skills:** The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.	S	Assignments
PSO3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies.	S	Guest Lectures

N - None **S - Supportive** **H – Highly Related**

IX SYLLABUS

UNIT-I

ROOT FINDING TECHNIQUES AND INTERPOLATION: 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, modified Euler's and Runge-Kutta method.

UNIT – III

MULTIPLE INTEGRALS: Double and triple integrals; Change of order of integration. Change of variables: Polar, cylindrical and spherical; 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; Gauss divergence theorem-statements and verification.

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. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons Publishers, 9th Edition, 2014.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 42nd Edition, 2012.

Reference Books:

1. RK Jain & SRK Iyengar, "Advanced Engineering Mathematics", Narosa Publishers, 5th Edition, 2016.
2. S. S. Sastry, "Introduction methods of numerical analysis", Prentice-Hall of India Private Limited, 5th Edition, 2012.

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Course Content Delivery --- Lecture Wise Break-up of Topics

I Spell

Unit	Lecture Number	Topic Planned to be covered	Learning Objective	References
I	1	**Solution of Algebraic and Transcendental Equations**. Introduction	**Define** Algebraic and Transcendental equations	T-2, R-2
	2	Bisection Method	**Apply** Bisection method to find the root	T-2, R-2
	3	Method of False Position	**Apply** False Position method to find the root	T-2, R-2
	4	Newton-Raphson Method	**Apply** Newton-Raphson method to find roots	T-2, R-2
	5	Interpolation	**Define** what interpolation is	T-2, R-2
	6	Symbolic relations and separation of symbols	**Explain** the relation between symbols	T-2, R-2
	7	Newton's forward difference	**Solve** the problems by Newton's forward method	T-2, R-2
	8	Newton's backward difference	**Solve** the problems by Newton's backward method	T-2, R-2
	9	Gauss forward difference	**Solve** the problems by Gauss forward method	T-2, R-2
	10	Gauss backward difference	**Solve** the problems by Gauss backward method	T-2, R-2
	11	Lagrange's and Newton's dividend difference interpolation	**Solve** the problems by lagrange's and Newtons dividend difference	T-2, R-2
II	12	**Curve fitting**: Fitting straight line	**Solve** a straight line	T-2, R-2
	13	Fitting a second degree curve	**Solve** a second degree parabola	T-2, R-2
	14	Fitting an exponential curve	**Solve** an exponential curve	T-2, R-2
	15	Fitting a power curve	**Solve** a power curve	T-2, R-2
	16	**Numerical solution of Ordinary Differential equations:** Taylor's series method	**Solve** the ODE by Taylor's series method	T-2, R-2
	17	Euler's Method	**Solve** the ODE by Euler's Method-Euler's modified method	T-2, R-2
	18	Euler's modified method,	**Solve** the ODE Euler's modified method	T-2, R-2
	19	Runge-Kutta Methods	**Solve** the ODE by Runge-Kutta Methods	T-2, R-2
III	20-21	**Multiple Integrals**	**Calculate** double and triple integrations	T-2, R-2
	22-23	Change of order of integration	**Use** the Change of order for multiple integrals	T-2, R-2

II Spell

Unit	Lecture Number	Topic Planned to be covered	Learning Objective	References
III	24-26	Change of variables	**Use** the Change of variables in multiple integrals	T-1, R-1
	27-28	Area of a region using double integration	**Apply** double integration for finding the area	T-1, R-1
	29-30	Volume of a region using triple integration	**Apply** triple integration for finding the volume	T-1, R-1
IV	31	**Introduction to vector calculus**	**Define** vector calculus and vector fields and their properties	T-1, R-1
	32	Gradient, divergent and curl	**Determine** Gradient, divergent and curl of vector fields	T-1, R-1
	33	Line integral	**Calculate** line integral along smooth path and find work done	T-1, R-1
	34	Surface integral	**Calculate** the surface area of field	T-1, R-1
	35	Volume integral	**Calculate** volume of field	T-1, R-1
	36	Green's theorem	**Use** Green's theorem to evaluate line integrals along simple closed contours on the plane	T-1, R-1
	37	Stoke's theorem	**Use** Stokes' theorem to give a physical interpretation of the curl of a vector field	T-1, R-1
	38	Gauss divergence theorem	**Use** the divergence theorem to give a physical interpretation of the divergence of a vector field	T-1, R-1
V	39-40	**Improper Integrations** Gamma function	**Apply** gamma function for improper integrals	T-1, R-1
	41-42	**Identify** ordinary points, singular points and regular singular points for the given ODE	Motivation for series solution Ordinary and regular point of a differential equation	T-1, R-1
	43-44	**Determine** the solution of ordinary differential equations in series form	Transformation of non-zero singular point to zero singular point Series solutions of differential equations around zero	T-1, R-1
	45-46	**Apply** the Frobenius method to obtain a series solution for the given linear ODE	Frobenius Method about zero	T-1, R-1
	47-48	**Demonstrate** Bessel's Differential equation	Bessel's Differential equation, Bessel functions properties: – Recurrence relations, Orthogonality, Generating function	T-1, R-1
	49-50	**Explaining** trigonometric expansions	Trigonometric expansions involving Bessel functions.	T-1, R-1

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H											S	S	
II	S	H											S	S	
III	H												S		
IV	S												S		

S = Supportive **H = Highly related**

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF TSHE PROGRAM OUTCOMES

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	H	S										S	S	
2	H	S											S		
3	S	S		S										S	
4	H												S		
5	S		H										S		
6	H													S	
7		H											S		
8	H													S	

S = Supportive **H = Highly related**

Prepared by: Ms. V Subba Laxmi, Assistant Professor

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