INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

COURSE DESCRIPTION

Course Title	**MATHEMATICS-II**			
Course Code	**A30006**			
Course Structure	Lectures	Tutorials	Practicals	Credits
	4	1	-	4
Course Coordinator	Mr. Ch. Kumara Swamy, Asst Professor			
Team of Instructors	Dr. M. Anita, Professor Mr. Ch. Kumara Swamy, Asst Professor Ms. K.. Rama Jyothi, Asst 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 vector calculus, Fourier series and transform, Interpolation, curve fitting, numerical techniques and boundary value problems. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

II. PREREQUISITE(S)

Level	Credits	Periods	Prerequisite
UG	4	5	Basic mathematics, calculus.

III. MARKS DISTRIBUTION

Sessional Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective test. The subjective test is for 20 marks, with duration of 2 hours. Subjective test of each semester shall contain 5 one mark compulsory questions in part-A and part-B contains 5 questions, the student has to answer 3 questions, each carrying 5 marks. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME

S.No	Component	Duration	Marks
1	I Mid examination	90 minutes	20
2	I Assignment	--	05
3	II Mid examination	90 minutes	20
4	II Assignment	--	05
5	External examination	3 hours	75

V. COURSE OBJECTIVES

The goal of this course is to provide students with better understanding of and preparation for mathematics which are applicable in most of engineering branches.

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

I. Analyze scalar and vector fields and compute the gradient, divergence and curl. They should be able to evaluate line, surface and volume integrals.
II. Develop functions in a Fourier series and Fourier transforms
III. Apply numerical methods to interpolate, extrapolate, differentiate and integrate functions IV. Solve differential equation using numerical methods and solve systems of equations.

VI. COURSE OUTCOMES

After completing this course the student must demonstrate the knowledge and ability to:

1. Analyze scalar and vector fields and compute the gradient, divergence and curl.
2. Evaluate line, surface and volume integrals.
3. Apply Green's Theorem, Divergence Theorem and Stoke's theorem to evaluate integrals.
4. Demonstrate Dirichlet's conditions by using them to evaluate infinite series
5. Explain fundamental understanding of Fourier series and be able to give Fourier expansions of a given function
6. Determine the Fourier transform of elementary functions from the definition
7. Compute the intermediate point for the data and find the most appropriate formula for a guessed relation of the data variables
8. Solve the model by selecting and applying a suitable mathematical method
9. Explain errors involved in computations and to estimate the errors
10. Solve algebraic and transcendental equations using Bisection method, Regula-falsi method and Newton-Raphson method
11. Solve systems of equations by Crout's, Jacobi and gauss-seidel methods.
12. Apply numerical methods to interpolate, extrapolate integrate functions.
13. Solve differential equation using numerical methods.(Taylor's series, Euler's, Picard's and Runge-Kutta method up to 4th order)
14. Apply power method to find the Eigen values of the given matrix

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program Outcomes		Level	Proficiency assessed by
PO1	Capability to apply the knowledge of Mathematics, science and Engineering in the field of Mechanical Engineering	H	Assignments, Tutorials

PO2	An Ability to analyze complex engineering problems to arrive at relevant conclusions using knowledge of Mathematics, Science and Engineering.	H	Assignments
PO3	Competence to design a system, component or process to meet societal needs within realistic constraints.	H	Assignments
PO4	To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies	S	Assignments
PO5	An ability to formulate solve complex engineering problem using modern engineering and Information technology tools.	S	--
PO6	To utilize the engineering practices, techniques, skills to meet needs of the health, safety, legal, cultural and societal issues.	S	--
PO7	To understand impact of engineering solutions in the societal context and demonstrate the knowledge for sustainable development	N	--
PO8	An understanding and implementation of professional and Ethical responsibilities	N	--
PO9	To function as an effective individual and as a member or leader in Multi-disciplinary environment and adopt in diverse teams	N	--
PO10	An ability to assimilate, comprehends, communicate, give and receive instructions to present effectively with engineering community and society	N	--
PO11	An ability to provide leadership in managing complex engineering projects at multi-disciplinary environment and to become a professional engineer.	N	--
PO12	Recognition of the need and an ability to engage in lifelong learning to keep abreast with technological changes.	N	--

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**UNDERSTANDING:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering	S	Lectures and Assignments
PSO 2	**ANALYTICAL SKILLS:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability	S	Guest Lectures
PSO 3	**BROADNESS:** To build the nation, by imparting technological inputs and managerial skills to become Technocrats	S	Assignments

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

IX. SYLLABUS

UNIT – I
Vector Calculus

Scalar point function and vector point function, Gradient- Divergence- Curl and their related properties. Solenoidal and irrotational vectors- Finding Potential function. Laplacian operator, Line integral – work done – Surface integrals - Volume integral. Green's Theorem, Stoke's theorem and Gauss's Divergence Theorems (Statement & their Verification).

UNIT – II
Fourier series and Fourier Transforms

Fourier series: Definition of periodic function. Fourier expansion of periodic functions in a given interval of length 2π Determination of Fourier coefficients – Fourier series of even and odd functions – Fourier series in an arbitrary interval – even and odd periodic continuation – Half-range Fourier sine and cosine expansions

Fourier Transforms: Fourier integral theorem - Fourier sine and cosine integrals. Fourier transforms – Fourier sine and cosine transforms– properties – inverse transforms – Finite Fourier transforms.

UNIT – III
Interpolation and Curve fitting

Interpolation: Introduction- Errors in Polynomial Interpolation – Finite differences- Forward Differences-Backward differences –Central differences – Symbolic relations and separation of symbols- Difference Equations – Differences of a polynomial-Newton's formulae for interpolation – Central difference interpolation Formulae – Gauss Central Difference Formulae –Interpolation with unevenly spaced points-Lagrange's Interpolation formula.

Curve fitting: Fitting a straight line –Second degree curve-exponential curve-power curve by method of least squares.

UNIT – IV: Numerical techniques
Solution of Algebraic and Transcendental Equations and Linear system of equations

Introduction – Graphical interpretation of solution of equations .The Bisection Method – The Method of False Position– the Iteration Method – Newton-Raphson Method.

Solving system of non-homogeneous equations by L-U Decomposition method (Crout's Method) Jacobi's and Gauss-Seidel Iteration method

UNIT – V:
Numerical techniques

Numerical Integration and Numerical solutions of First order differential equations:
Numerical integration - Trapezoidal rule, Simpson's 1/3rd and 3/8 Rule , Generalized Quadrature
Numerical solution of Ordinary Differential equations: Solution by Taylor's series method –Picard's Method of successive Approximation- single step methods-Euler's Method-Euler's modified method, Runge-Kutta(Second and Classical fourth order)Methods.

Boundary values &Eigen value Problems
Shooting method, Finite difference method and solving Eigen values problems, power method

Textbooks:

1. Electric Circuits - A.Chakrabarhty, DhanipatRai& Sons.
2. Network analysis - N.C Jagan and C. Lakhminarayana, BSpublications.

Referencebooks:

1. Mathematical Methods by T.K.V. Iyengar, B.Krishna Gandhi & Others, S. Chand.
2. Introductory Methods by Numerical Analysis by S.S. Sastry, PHI Learning Pvt. Ltd.
3. Mathematical Methods by G.ShankarRao, I.K. International Publications, N.Delhi
4. Advanced Engineering Mathematics with MATLAB, Dean G. Duffy, 3rd Edi, 2013, CRC Press Taylor &Francis Group.
5. Mathematics for Engineers and Scientists, Alan Jeffrey, 6ht Edi, 2013, Chapman & Hall/ CRC
6. Advanced Engineering Mathematics, MichaelGreenbreg, SecondEdition,Person Education
7. Mathematics For Engineers By K.B.Datta and M.A.S Srinivas,Cengage Publications

X. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
1	Introduction to vector calculus	**Define** vector calculus and vector fields and their properties	T1,R1
2-4	Gradient, divergent and curl	**Determine** Gradient, divergent and curl of vector fields	T1,R1
5-6	Line integral	**Calculate** line integral along smooth path and find work done	T1,R1
7	Surface integral	**Calculate** the surface area of field	T1,R1
8	Volume integral	**Calculate** volume of field	T1,R1
9	Green's theorem	**Use** Green's theorem to evaluate line integrals along simple closed contours on the plane	T1,R1
10-11	Stoke's theorem	**Use** Stokes' theorem to give a physical interpretation of the curl of a vector field	T1,R1
12-13	Gauss divergence theorem	**Use** the divergence theorem to give a physical interpretation of the divergence of a vector field	T1,R1
14-15	Fourier series	**Define** periodic functions and Fourier series and Fourier coefficients	T2,R1
16-17	Fourier expansion	**Apply** Fourier series for $(0, 2\pi.)$,$(- \pi, \pi)$	T2,R1
18-19	Fourier series of even, odd functions and half range.	**Determine** even and odd function and apply Fourier series in$(-\pi, \pi)$.and also half range series in $(0, \pi)$.	T2,R1
20-21	Fourier series in an arbitrary interval	**Determine** Fourier series in $(0,2l)$, $(-l,l)$.and also half range series in $(0, l)$.	T2,R1
22	**Fourier Transforms** Fourier integral theorem, Fourier sine and cosine integrals.	**Define** and apply Fourier transforms ,Fourier integral theorem , Fourier sine and cosine integrals	T2,R1
23	Fourier sine and cosine transforms- properties	**Use** properties to solve the given functions	T2,R1
24	Inverse transforms	**Define** and apply Inverse transforms	T2,R1
25	Finite Fourier transforms	**Define** and apply Finite Fourier transforms	T2,R1

26	Interpolation	**Define** what interpolation is	T1,R2
27	Symbolic relations and separation of symbols	**Explain** the relation between symbols	T1,R2
28	Newton's forward difference	**Solve** the problems by Newton's forward method	T1,R2
29-30	Newton's backward difference	**Solve** the problems by Newton's backward method	T1,R2
31	Gauss forward difference	**Solve** the problems by Gauss forward method	T1,R2
32	Gauss backward difference	**Solve** the problems by Gauss backward method	T1,R2
33	Lagrange's interpolation	**Solve** the problems by lagrange's method	T1,R2
34	Difference equation	**Formulate** difference equation and solve	T1,R2
35	**Curve fitting**: Fitting straight line	**Solve** a straight line	T1,R2
36-37	Fitting a second degree curve	**Solve** a second degree parabola	T1,R2
38-39	Fitting an exponential curve	**Solve** an exponential curve	T1,R2
40	Fitting a power curve	**Solve** a power curve	T1,R2
41-42	**Solution of Algebraic and Transcendental Equations**. Introduction	**Define** algebraic and transcendental equations and Explain graphical solution.	T1,R2
43	Bisection Method	**Apply** bisection method to find the root	T1,R2
44	Method of False Position	**Apply** False Position method to find the root	T1,R2
46	Newton-Raphson Method	**Apply** Newton-Raphson method to find the root	T1,R2
47-48	**Linear system of equations.Solving system of non-homogeneous equations.** L-U Decomposition method	**Apply** Crout's method to find the solution of square matrix	T1,R2
49-50	Jacobi's Iteration method	**Solve** the linear system of equations by Jacobi's Iteration method	T1,R2
51-52	Gauss-Seidel Iteration method	**Solve** the linear system of equations by Gauss-Seidel Iteration method	T1,R2
53-54	**Numerical Integration** Numerical integration	**Calculate** integration by Trapezoidal and Simpson's 1/3 and 3/8 rule	T1,R2
55-56	Gauss-Legendre one, two and three point	**Calculate** integration Gauss-Legendre	T1,R2

57	**Numerical solution of Ordinary Differential equations:** Taylor's series method	**Solve** the ODE by Taylor's series method	T2,R3
58	Picard's Method	**Solve** the ODE by Picard's method	T2,R3
59	Euler's Method	**Solve** the ODE by Euler's Method- Euler's modified method	T2,R3
60	Euler's modified method,	**Solve** the ODE Euler's modified method	T2,R3
61	Runge-Kutta Methods	**Solve** the ODE by Runge-Kutta Methods	T2,R3
62	**Boundary Value Problems:** Shooting method	**Solve** the BVP by Shooting method	T2,R3
63	Finite difference method	**Solve** the BVP by Finite difference method	T2,R3
64	**Eigen Value Problems:**	**Solve** the Eigen Values Eigen value problems	T2,R3
65	Power Method	**Solve** the Eigen Values by Power method	T2,R3

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									S		S
II	H	S		S									S		
III	H	H	S	S				S					S	S	
IV	H	S							S				S	S	

N = None **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												S		
2	H		S										S	S	

3	H												S		
4		S	S										S	S	S
5	S			S									S		
6	H	H	S										S		
7													S		
8		H													S
9			S												
10		S		S									S		
11	S												S	S	S
12	H		S										S	S	
13	H												S	S	
14	S			S											

N = None **S = Supportive** **H = Highly related**

Prepared by: Mr. Ch. Kumara Swamy, Asst Professor
Ms.K.Rama Jyothi, Asst Professor

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HOD, FRESHMAN ENGINEERING